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Implementation of Python-Based Network Automation Technology for Computer Infrastructure Optimization

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Abstract: *This research presents the development and implementation of a network automation program using Python to assist network administrators in configuring MikroTik routers. Traditional manual configuration processes are often time-consuming and error-prone, creating a need for an efficient solution. The proposed automation program streamlines the configuration process, enabling administrators to complete tasks more quickly while significantly reducing the likelihood of errors. Through user testing, network administrators from RT/RW Net Dengkol confirmed that the program effectively enhances the configuration efficiency of MikroTik routers. Additionally, the tool features capabilities for exporting configurations as files, further facilitating network management. Despite its advantages, the program currently relies on a command-line interface, highlighting the need for future enhancements such as a graphical user interface and improved login functionality. Overall, this research demonstrates the potential of Python-based automation in optimizing network management and supporting administrators in their daily tasks.*

Introduction

Network administrators play a crucial role in the effective management of both hardware and software components within a computer network. Their responsibilities encompass tasks such as network setup, routine maintenance, and monitoring, all while ensuring the security and reliability of the systems under their care. These professionals manage network configurations, oversee IP addressing, and evaluate network performance, ensuring that the systems function optimally. By implementing security protocols, firewalls, and regular updates, network administrators safeguard organizational networks against security threats. Their technical expertise and analytical skills are essential for troubleshooting complex network issues, minimizing system downtime, and enhancing user experience. In addition, network administrators contribute to the seamless communication and data exchange within an organization by ensuring that all components of the network work harmoniously. Their role

extends to various specialized areas, such as network analysis, but they typically operate at a technical level, focusing on the systems rather than directly engaging with end-users.

One major challenge faced by network administrators is the manual setup of devices like MikroTik routers, which can be labor-intensive and error-prone. Manual configuration of network features such as IP addressing, firewall rules, and routing protocols requires meticulous attention, often leading to mistakes that can result in network outages or vulnerabilities. Python has emerged as a solution to this problem, offering automation capabilities that streamline these repetitive tasks. With Python, network administrators can automate configuration processes, thereby reducing the likelihood of human errors and conserving time. Python libraries such as Paramiko and Netmiko facilitate secure interactions with network devices via Secure Shell (SSH), allowing administrators to configure multiple routers efficiently. This automation not only enhances operational efficiency but also ensures consistency across network configurations, addressing discrepancies that often arise from manual setups. Ultimately, network automation with Python can optimize network performance and security, allowing administrators to focus on more strategic tasks, improving the reliability and scalability of the network infrastructure.

The object of this research is the development and implementation of a Python-based network automation system, specifically targeting MikroTik routers. Network automation is becoming increasingly important in modern networking due to its ability to streamline complex and time-consuming configuration processes. This research focuses on designing and testing a Python-based automation program that simplifies the configuration tasks associated with MikroTik routers. Python libraries such as Paramiko and Netmiko are employed to enable secure and automated interactions with network devices via SSH. The program will be tested in a controlled environment using VMware to install RouterOS as the testing platform, allowing for the automation of tasks such as IP addressing, firewall configuration, and routing protocols. The system will also be applied in a real-world network environment, specifically the RT/RW Net Dengkol, a local neighborhood network that relies on MikroTik RouterBoard devices. This environment provides a practical setting for demonstrating the efficiency and effectiveness of network automation in small-to-medium-sized networks. By automating network tasks that are traditionally performed manually, this research seeks to reduce the workload of network administrators, minimize errors, and improve the overall performance of the network infrastructure.

The phenomenon this research addresses is the inefficiency and high error rates associated with manual network configurations, particularly when working with MikroTik routers. In many small-to-medium-sized networks, administrators must manually configure network features such as IP addressing, firewall rules, and routing protocols. This labor-intensive process often leads to human errors, which can result in network outages, security vulnerabilities, or inconsistent configurations across devices. As networks grow in complexity, the challenges of manual configuration become more pronounced, highlighting the need for an automated solution. Python has emerged as a powerful tool for addressing these challenges, offering a means to automate repetitive tasks such as router configurations. By leveraging

Python's capabilities, administrators can implement automated systems that streamline the configuration process, reduce errors, and save time. This research specifically examines the application of Python for automating configurations in MikroTik routers, focusing on improving efficiency, enhancing network performance, and minimizing the risk of human error. The use of Python in network automation represents a significant shift in how network configurations are managed, particularly in environments where manual processes have traditionally dominated.

While there has been extensive research on the use of Python for automating specific network tasks, a gap exists in the holistic application of Python-based automation systems for complete network management, particularly in small-to-medium-sized networks. Previous studies, such as those by Anggi and Dzikri Abrariansyah (2020), Malik (2020), and Ginting, Suroso, and Hadi (2020), have demonstrated the benefits of Python for automating tasks like OSPF protocol configuration and hotspot management. However, these studies primarily focus on isolated aspects of network automation rather than developing comprehensive systems that handle multiple areas, such as IP addressing, firewall configuration, and routing protocols. Moreover, most research has been conducted in controlled environments, such as schools or virtual networks, without extensive application to real-world environments. This gap presents an opportunity for further exploration of Python-based automation systems that address the full spectrum of network management needs in environments like RT/RW Net Dengkol. By applying automation to multiple aspects of network configuration and testing the system in both virtual and real-world networks, this research aims to provide a more comprehensive solution for network administrators, building on previous findings and filling the gap in current studies.

This research aims to develop a Python-based network automation system to simplify MikroTik router configuration, focusing on tasks like IP addressing, firewall management, and routing. By automating these processes, it seeks to reduce the time and effort needed for network administration, particularly in small-to-medium-sized networks where manual configuration is common. Automation enhances network performance by reducing errors and ensuring consistent configurations, improving scalability and adaptability to changing demands. The findings aim to benefit network administrators by improving reliability and security, allowing them to focus on strategic objectives and paving the way for more efficient, scalable network operations in both small and large networks.

Research Methods

The research was conducted between February and March at RT/RW Net Dengkol, focusing on automating the configuration of MikroTik routers using Python. The data collection method employed in this study was observation, where the researchers closely examined the existing network and configurations applied to the MikroTik RB750Gr3 routers. This router was configured with various network features such as Interface Bridge, IP Address, IP Pool, DHCP Server, Hotspot, Firewall Mangle, Firewall NAT, and Firewall Address List, in addition to bandwidth management using Simple Queue and Queue Tree. Data collected included the network's connected users, router types, bandwidth capacity, and configurations implemented. The network topology at RT/RW Net Dengkol consists of devices like a modem connected to

the internet, a MikroTik RB750Gr3 router connected to the modem, access points, and a switch. The switch connects to two PCs and two access points, which in turn connect to user devices such as tablets, smartphones, and notebooks. The manual configuration process involves setting up each feature of the MikroTik router one by one to ensure it functions as a network gateway and handles bandwidth management. The flowchart of manual configuration illustrates how administrators configure the router's Interface Bridge, IP Address, IP Pool, DHCP, and Firewall. After completing the manual configuration, tests are conducted to verify the router's performance. The automation system was then tested against this manual process, comparing results in terms of time efficiency and accuracy. The system was further tested for its ability to apply multiple configurations automatically, ensuring that it could effectively manage the essential features of the MikroTik router.

Result and Discussion

The network automation program developed using Python assists network administrators in configuring MikroTik routers efficiently. This program features two main configuration options: manual input and automatic configuration. In the manual input mode, administrators can specify various settings, including IP addresses, DHCP names, and IP pools, allowing for flexible configuration according to the network's needs. This flexibility enables administrators to manage IP assignments effectively. On the other hand, the automatic configuration option simplifies the process by requiring minimal input from the administrator. In this mode, the administrator only needs to enter the router's IP address, along with the username and password. Subsequently, the program automatically applies the necessary configurations to the MikroTik router, which includes setting up interfaces, DHCP settings, firewall rules, and bandwidth management. This automation not only streamlines the configuration process but also significantly reduces the potential for human error, enhancing overall network reliability and performance. By automating routine tasks, the program frees administrators from repetitive configuration tasks, allowing them to focus on more strategic aspects of network management. Thus, the program provides a comprehensive solution for optimizing MikroTik router configurations, ensuring that networks operate efficiently and effectively (Adhyatmaka Wiryawan & Rohman Rosyid, 2019).

The system analysis phase identifies issues, obstacles, and requirements to develop effective solutions for automating MikroTik router configuration. A major problem is the time-consuming and error-prone process of manual configuration, such as setting IP addresses and DHCP servers. To address this, the solution involves creating a program that helps administrators configure MikroTik routers more efficiently. The program would allow for manual input of settings like IP addresses, DHCP names, and IP pools, while also supporting automatic configuration and exporting settings in RSC format.

In the requirements analysis, both functional and non-functional needs are assessed. Non-functional requirements include software specifications, such as Windows 10, Python 3.8, and PyCharm, alongside hardware specifications like an Intel Celeron D or AMD A4 processor, 2GB RAM, and 80GB storage. Functional requirements focus on inputs and outputs, detailing how the system operates, from manual input to automated configurations (4.2.2). The design

phase aims to create a new system that addresses the identified problems, enhances work effectiveness, and optimizes time management through technology. The proposed system provides a comprehensive solution for network administrators by streamlining the configuration process of MikroTik routers. The program features manual input options and an automated configuration mode, where the administrator simply logs in with their credentials to apply configurations automatically. Additionally, the system enables the verification of configurations and the exporting of settings for future reference Use cases illustrate the interactions between the administrator and the program, including login, configuration input, automated setup, configuration checks, and exporting configurations

To summarize, the proposed network automation program enhances the efficiency and accuracy of router configurations by minimizing manual effort and errors. By leveraging a user-friendly interface for configuration management, the system not only saves time for network administrators but also improves overall network reliability and security, ultimately leading to better resource utilization in network management.

The testing results for the network automation program developed using Python demonstrate its effectiveness in assisting network administrators with MikroTik router configurations. The program significantly reduces the time required for configurations and minimizes potential errors associated with manual setups. The advantages of the automation program include its ability to aid network administrators in configuration tasks, decrease the likelihood of configuration mistakes, and expedite the overall process of setting up MikroTik routers. However, the program does have some drawbacks, such as relying solely on a Command Line Interface (CLI), which may be less user-friendly, and an issue where the program exits if login attempts fail

Comparative analysis between manual configurations and the automated program reveals that while manual setups often lead to configuration errors, the automation tool maintains minimal errors and significantly reduces the time required for setups. The administrator from RT/RW Net Dengkol reported that the automation program efficiently streamlines MikroTik router configurations, saving valuable time during implementation. However, the absence of a graphical interface necessitates the manual input of commands, which may hinder usability for some users. Overall, the automation program presents a promising solution for improving the efficiency and accuracy of network configuration tasks, while also highlighting areas for further development, particularly regarding user interface enhancements.

Conclusion and Recommendation

In conclusion, the research findings indicate that the network automation program significantly assists network administrators at RT/RW Net Dengkol in configuring MikroTik routers. This program enables rapid configuration while effectively minimizing errors commonly associated with manual setups. The automation tool not only enhances efficiency in configuration tasks but also features the capability to export applied settings as a file, facilitating better management of router configurations. However, there are several areas for improvement

based on the implementation and testing phases. First, incorporating a graphical user interface (GUI) could greatly enhance usability, allowing administrators to configure settings more intuitively. Additionally, improving the login process would prevent the program from exiting when incorrect IP addresses, usernames, or passwords are entered. Lastly, the program could be further developed by adding more configuration options for MikroTik routers, such as routing protocols or VLAN settings, to broaden its functionality. These enhancements would make the automation program more versatile and user-friendly, ultimately leading to even greater efficiency in network management tasks.

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