

# Leverage Networking Tasks Using Network Programmability

Abdurraouf Fathi<sup>1</sup>, YaseeinSoubhi Hussein<sup>2</sup> and NorAfifahSabri

Asia Pacific University of Technology and Innovation,

Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur, Malaysia

1Abdulraoufsweli58@gmail.com, 2dr.yaseein@staffemail.apu.edu.my, 3afifah@staffemail.apu.edu.my

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## Abstract

Network computing has grown tremendously in various aspects such as the network design, number of users, and complexity. With this expansion, managing, monitoring, and configuring networking devices efficiently is vital to ensure the network is running with its best performance. Network automation and programmability have gained wide adoption by prominent networking vendors and experts as well as researchers. The approach has proven that it would be the future of networking field as it simplifies the process of configuring and managing networking devices, especially for enterprises. This paper presents new design and development of a network automation tool that helps network administrators to automate and shorten the process of configuring and managing networking devices. This research also identifies the importance of network programmability and automation and how they can help network engineers and organizations.

**Keywords:** Network automation, programmability, Network monitoring, and analysis.

## 1. Introduction

In this revolutionized era, information technology has become a primary element in our life as technology solutions have helped people to perform their tasks seamlessly with accurate results in different areas [1]. One of the essential technology areas is network computing, which provides the means in which multiple users can be connected to share resources. Networks can differ in size based on the number of users and the distance between the nodes. They range from a small sized one to a big enterprise that has different branches in several places around the world. Network engineers and administrators are needed to install, configure, and monitor networks. They play a pivotal role, and the bigger the network is, the more administrators it needs to manage accordingly. Many technologies and protocols are proposed by experts to improve and enhance the way networks are configured and deployed to satisfy the increased demand for implementing networks and improvise the current

situation such as Software Defined Networks (SDN) and Digital Network Architecture (DNA) [2].

## 2. Background

Although small networks such as school, laboratory or university campus are not hard to manage and control as the number of users and networking devices are not a significant number. Large networks like a network that connects bank branches in wide area can be complicated when the network consists of a considerable number of users and networking devices, which requires more resources to implement the network efficiently. Hiring more network engineers will not address the issue as the traditional way should be re-evaluated. Therefore, finding a different approach to configure networks and monitor them is a key that will make a difference in the networking industry nowadays. This is where network automation and programmability come

into play to simplify the process of deploying networks.

### 2.1. Formulating problems

Most of the networking tasks are manually done such as device configuration, and the process is quite old with the revolution in the information technology field with technologies such as IoT and software as a service. Configuring and carrying out networking tasks that are usually repeated and follows the same approach or steps is not an agile and flexible way to do so mainly where delivery models and a pressing need for businesses to be active and having high tech solutions like automated deployments and configuration is essential. Maintaining networks require various tasks to be performed appropriately, and that can be complex and not reasonably simple if it is not programmed or automated. As the network enlarges, providing support manually for users and devices becomes arduous.

Time subsequently plays an essential role in managing and configuring multiple networks where a significant number of users needs to be handled accordingly, and vast networks consume more time than any small Local Area Networks. For example, configuring a network that can accumulate 1000 users is diverse from a network of 50 users regarding managing the network engineer time. This also might be apt for wrong outputs and results as the possibility of human-generated errors, which is highly expected to happen no matter how experienced the network engineer is. Thus, this will produce a network downtime which will undoubtedly cost time and money.

As a result, network engineers should be cautious in doing these critical tasks and here where network programmability and automation come into play to increase the speed in which changes can be done quickly, and the number of human errors is reduced. Another real-world example in which the accuracy of result can disturb significant parts of the configuration process is when the network administrator needs to add a

considerable number of users for a VLAN, and mistakenly some of them are not assigned.

Lastly, the gap between programmers and network engineers have been evident in recent years. The networking field has confronted an apparent reality where bringing a new skill like programming to the engineer arsenal is necessary and can simplify many daily tasks. Without network programmability and scripting methods, making changes to a scaled network without the need of accessing hundreds of devices is impossible [3].

### 2.1.Domain research

The way networks are installed, configured, and maintained have become harder when the network goes bigger and complex. An ongoing study indicates how overwhelming this issue has moved toward. This study shows that about three-quarters (76.8 percent) of network engineers time and resources are consumed maintaining existing environments, and less than one-quarter (23.2 percent) of their time is used up on other activities that enhance the network performance, as shown in Fig 1. Based on the study's analysis, about 50 percent of the network engineer's time and assets are spent on monitoring the infrastructure such as health monitoring and performance and troubleshooting [4].

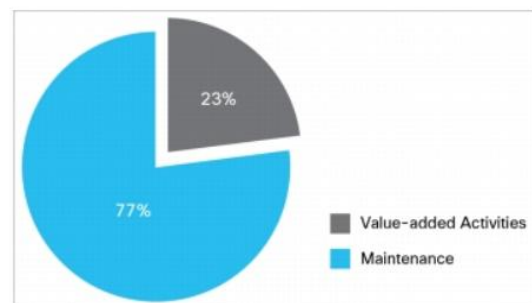


Figure 1 IT Staff Time and Resources Distribution

Simultaneously with the difficulties of adjusting to these issues in the IT business, experts and researchers have spent more time and effort to address the problem and try to come up with new technology and solution such as VMware NSX

which brings efficiency in the way networks are configured, managed and maintained [5]. These primary activities are part of any network, and they consume more than three quarters of the network engineers or administrators' time. The solution must ensure exceptional services with fewer effort and increase the emphasis on the deployment of new features for the business. Therefore, network automation and programmability concept can decrease the cause of these issues as it enables end-to-end automated management process. Networking devices such as routers or switches should support various automation features and offer robust APIs to access from external tools and integrate them to these devices. This will allow to automatically run network resources, provide dynamic bandwidth allocation, and overcome latency as well as monitor the network performance and improve its availability.

A recent survey performed by The Enterprise Strategy Group [6] shows that organizations have realized that network programmability and automation is an essential key to any business to acquire agility and innovation. Figure 2 illustrates the survey that involved 300 networking professionals and experts, 39% said they utilize networking automation and programmability since it conveys agility to perform everyday networking tasks. Furthermore, 43% of respondents said they intend to use, or they already used extensive networking automation and programmatic solutions, and another 47% utilize automation in a constrained manner. Almost 75% of networking vendors hope to accomplish full or noteworthy networking automation products and solutions throughout the following five years.

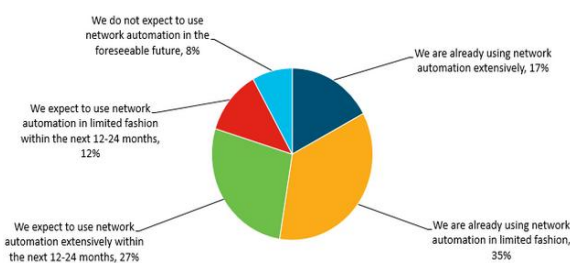


Figure 2 Use of Network automation Technology

Innovative network programmability and automation solutions can provide organizations with great opportunities to become more operational and practical in their business process and can save so much cost in some of the daily tasks. The networking industry has been static and outdated for a long time compared to other technology fields. Network programmability and automation revolution have opened big chances of improvements. Lastly, this new period of IT needs a new set of skills. According to NetBrain's [7] which is one of the leaders in network automation solutions, 53% of network professionals stated they need to know at least one programming language like Python to do their daily tasks as it is a technology that can seamlessly do that and less complex

### 2.1.Similar systems

Many prominent networking vendors have developed solutions based on this concept with different names, and Cisco is one of them. Cisco's way to networking programmability and automation is known by Digital Network Architecture (DNA) Centre in which network engineers can configure networking devices through a centralized management console in an automated way [8]. Also, the solution can provide real-time statistics on network performance and security threats as well as carry out automated troubleshooting for the network.

SolarWinds is another similar system which is an automated network device configuration manager that simplifies the process of setting up networks. The software provides various functions and features. Network engineers can check, keep track, install, deploy, and back up all device configuration in one place or location [9]. This method can decrease downtime caused by failed devices since the network engineer can restore the setting in a device quickly by uploading the backed-up configuration file. The software also can configure multiple devices or update the configuration simultaneously. Also, the software takes a serious concern about security, so it has a vulnerability scanning and reporting functions which help organizations to comply with security

policies and regulations. However, the product is not free and annual fees have to be paid. Our proposed system have been addressed these drawbacks with better performance.

### 3. Research Methodology

Before designing a system, information requirements and specifications must be obtained. The information was collected in the form of interviews. Nine interviews were done with network engineers to get to know their opinion about network automation, problems they face with the traditional and the proposed system along with other questions like if they have used network automation solutions before.

The interviews covered indications along the lines of how frequent they use network automation solution if they were satisfied with the current manual network configuration process, how important is that for a vast network and which features are the most important to add to the proposed system.

Scrum is used as a development methodology. It is a combination of an iterative and incremental process model of system development, and it focuses more on the rapid and fast delivery of the system with complete functional components. Every iteration can take from a week to three weeks and involves all teams to work simultaneously on different aspects like Planning, Requirements Analysis, Design, Coding, Unit Testing, and Acceptance Testing. A working system is delivered to the customer at the end of the iteration.

#### 3.1 Proposed system

The proposed system is designed to perform some of the everyday networking tasks to simplify the process that is involved in carrying them out, such as device configuration and monitoring as well as analysis. The system consists of a tool that handles the automation process, and a web application that stores and display some useful information extracted from the network devices in the network

Setting up networking devices usually is done through a Command Line Interface (CLI), and these devices can be configured by connecting them directly or through a Secure Shell -SSH-connection. Network engineers need to access to the devices then they can pass and write the configuration commands line by line. However, this takes a lot of time when there are several networking devices to be configured.

The proposed system allows network engineers to configure several networking devices in a programmable way by simply pushing a script that consists of the required network configuration for the network devices in one time and eliminate the need to write the configuration commands one by one for every device. The tool will establish an SSH connection to the networking device, and the configuration script is passed once the connection is successful. Besides, the configuration details of every network device are extracted and stored in a database to be used by the web application for monitoring and analysis purposes.

The network administrator should have the correct credentials to establish an SSH connection to one or more routers in the network and the corresponding IP addresses of every device. Once the SSH connection is established, the network engineer can enter the configuration script file's name, and the tool will validate it and push the configuration across all networking devices. Lastly, the complete configuration file is extracted to a database that is connected to a web application for further analysis and monitoring.

Our proposed method in this paper is using different files in this process. A file that consists of commands to each router. A file that the application will use to collect the management IP addresses of the routers and another file that has the credentials to log in. Besides, the feature will verify if these files exist in the directory and check the IP connectivity of each IP. Then it will send all the configuration commands to all routers simultaneously not one by one using threading. Thus, it will ask about the file stores the IP addresses and checks the connectivity of each of



them then send the credentials files and the command file.

The web application function allows network administrators to view the configuration of the networking devices in a table format with some analyzed information like CPU utilization RAM usage, connected ports, IOS image, vendor, etc.

#### 4. Results and Discussion

The results obtained from the interview confirmed that network engineers were not satisfied with the current way of network configuration. They agreed that network automation and programmability play a significant role in the future of the networking industry. It would help them make the process of network configuration simpler as well as reduce the time and cost of the network deployment. Network engineers face some challenges in deploying a complex network as they need to configure each device through CLI commands manually, and sometimes they are required to travel to different places to set up the network. All the interviewees agreed that the proposed system could be helpful for them, and they can overcome some of the common challenges while deploying a network or analyze or maintain it. The web application part of the system can allow them to carry out further analysis of the results of the task are stored in the database and accessed through it. They also mentioned that they would use the proposed system once developed, which shows how vital automation solutions are.

A proper test plan is necessary for any software development to confirm that the system is working as expected with the error-free condition. There are various types of test plans that took place to achieve that, such as unit testing, user acceptance testing, and system testing. The combination of these tests can lead to getting a well-performing system with optimum outputs.

The first type in the test plan is unit testing, which is known as the process of testing each function separately and independently. In other words, it a model in which individual units/ components of a software are tested. The goal of it is to confirm

that each unit of the software performs as designed and developed. Another type of testing is the system testing, which all functions in the system are integrated and tested as a complete system. All functions should work and interact together seamlessly as well as evaluate them with the system requirements. The final testing type of user acceptance testing which guarantees that users have no problems with the system and they can use it without any difficulties. Besides, it allows the developer to get feedback from the end-users and identify any bugs encountered while using it.

#### 5. Conclusions

Network programmability and automation are one of the trending technologies in IT field nowadays. The system aids in network monitoring and analysis as well as to automate and shorten the process of configuring and managing network devices to identify the importance of network programmability and automation and how they can help network engineers and organizations.

While the tool was developed in Python, the web application part was handled by JavaScript. The system fulfilled the requirements that were obtained during the research phase. The set objectives of this study met in that the system provided the required functionality and received encouraging positive reviews from the User Acceptance Testing (UAT).

The proposed system shows outperformance in terms of ease and simplicity as well cost as it is totally free. It has demonstrated that its functionality is beyond excited methods.

##### 5.1. Limitations and future recommendations

The proposed system, likewise, any IT project that involves developing multiple systems over a long time with various functionalities and technologies, flaws, and bugs can happen no matter how experienced the developer is. It can be said that the developed system a few limitations. However, they are not related in anyway to the deliverables at all as they were achieved. One of the limitations is that the

system's automation tool comes only with Command Line Interface and it does not support a Graphical User Interface. Some users believe that GUI is friendlier and make the system function more useful.

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