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Validation of the NFV SDN Solution for the Efficient Management of MPLS Infrastructures

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Article Info
Volume 83
Page Number: 17516 - 17521
Publication Issue:
May - June 2020

Article History
***Article Received**: 1May 2020*
***Revised**: 11 May 2020*
***Accepted**: 20 May 2020*
***Publication**: 24May 2020*

Abstract

Network virtualization consists of creating tunnels in the existing infrastructure and using a per-flow service. Network function virtualization allows the virtualization of "NFV" network functions from Layer 4 to Layer 7 of the OSI model, and thus NFV allows the creation of virtual functions in the network such as firewalls, intrusion detection and prevention systems, routers. Software-Defined Network " SDN " makes the network programmable and therefore allows a separation of the control plane from the data plane. In this paper we will validate our previously published solution for managing Multi-Protocol Label Switching "MPLS" networks based on an SDN NFV approach. The implementation has been performed in a real environment, the results obtained have shown the efficiency of our approach compared to classical solutions and SDN-only based solutions.

Keywords; *SDN, SDN NFV, MPLS, Management , Qos*

I. INTRODUCTION

Nowadays, virtualization is a movement that mainly concerns different IT disciplines, namely networks, applications, services, servers, and profiles. Virtualization [1] can spread virtually all layers of the OSI model. The value of virtualization is to make the best use of network resources and to make the architecture modular and scalable, supporting new functionality and scalability. NFV (network function virtualization) is a way to reduce costs and accelerate service deployment for network operators by separating functions such as the router or firewall from any dedicated hardware and moving them to virtual servers. Typically, NFV [2] deployments use standard servers to run legacy hardware-based network services software. These software-based services are called Virtual Network Functions (NFV). These VNF services include routing, firewall functions, load balancing, WAN acceleration, and encryption. By virtualizing these network services, providers can offer customers dynamic on-demand services. Network infrastructure virtualization offers several benefits:

- Reduction of costs: Implementing NFV reduces capital (CAPEX) and operational (OPEX) spending on equipment, use of low-cost hardware, sharing of IT resources across functions, and reduced power consumption among a host of other things. Service providers are expected to save significant cost and time through a more efficient network process, NFV.

- Reduce time to market: NFV reduces the time to market for new carrier cycle services through software-based deployment and the rapid introduction of services tailored to customer needs. Reduced time-to-market is also accompanied by operational efficiencies for customers and suppliers.

- Efficient automation: NFV combined with cloud technologies can adopt tools to automate operations and management. Service providers implementing NFV stand to gain from meeting the needs of the

Published by: The Mattingley Publishing Co., Inc.

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communications market through automated scaling of resources, faster service introduction, and optimal use of allocated resources.

The rest of the paper is organized as follows, in section 2 we will discuss the NFV SDN approach to managing MPLS infrastructure. In section 3 we present the simulation environment. In section 4 we present the results obtained. A conclusion will be presented in section 5.

II. NFV SDN FOR MPLS INFRASTRUCTURE MANAGEMENT

The proposed approach [2] is based on three logical layers; the service layer, the orchestration layer, and the physical layer. The service layer provides the set of applications and services that act on the process of establishing the path and routing of MPLS frames. This layer provides the set of graphical interfaces through which the infrastructure administrator can specify the applications to be used, their characteristics, and their QoS constraints. The software layer provides the necessary mechanisms for detecting user activity. The software layer also allows intelligent management of the paths a user must take for a better quality of service. The Hardware layer allows the instantiation of several VRFs within the same gateway that respond to the routing policies adapted to the user. It allows the definition of different classes and QoS policies within the gateways, adapted to a user within a given architecture (MPLS, MPLS VPN, or traditional IP). Figure 1 illustrates the architecture of the proposed solution.

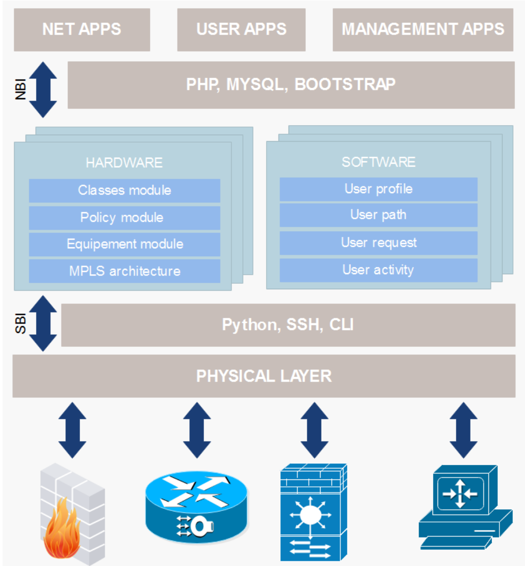

Figure 1.The architecture of the proposed solution.

III. PERFORMANCE EVALUATION

Performance evaluation is generally concerned with measuring the quantitative parameters of an architecture to deduce its effectiveness. This evaluation will allow us to measure the response time of our solution for MPLS VPN management [3] .

Before proceeding with the evaluation, we must first set up an experimental model in which the criteria must be well defined. These criteria are :

- **Process:** They represent the set of elements to be evaluated. In our case these processes are the SPLM infrastructures to be evaluated.
- **Inputs:** They represent the variables on the basis of which the model will be evaluated. In our experiment we will focus on the number of MPLS equipments in an infrastructure.
- **Outputs:** They represent the ends of the experiment. Our model will be evaluated by the time needed to set up the MPLS network taking into account the QoS.
- **Controllable factors:** represent the technical choices of the experiment. In our simulation we have used the IOS of real routers.
- **Uncontrollable factors:** these are the factors that vary independently of the technical choice of

Published by: The Mattingley Publishing Co., Inc.

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the experiment, for example the state of the server and its memory.

Figure 2 illustrates the experimental model on which our simulations are based.

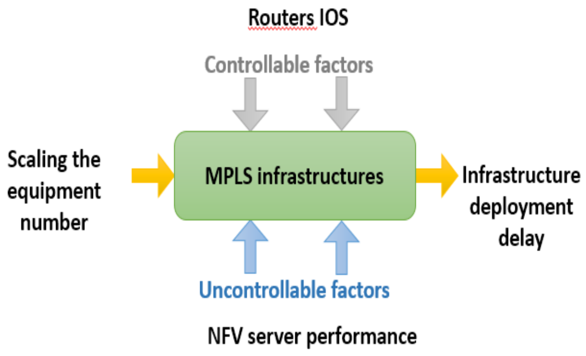

Figure 2. The experimental model

IV. OBTAINED RESULTS

4.1 Objectif de l'évaluation :

Figure 3. The loss rate

Figure 3 illustrates the loss rate of different VoIP, http, FTP, and TFTP applications by adopting the FIFO, RSVP MPLS strategy and our solution. It is very clear that the loss rate using FIFO is very high making the applications virtually unused. The RSVP MPLS model offers a relatively low loss rate at FIFO, which is justified by the fact that the RSVP signaling protocol traces the path according to its capabilities and the QoS requirements of the applications being transported. That said, the RSVP protocol consumes a considerable amount of channel bandwidth and is based on an active metrology, thus consuming a considerable amount of channel bandwidth, in addition this protocol leads to link stress. Our solution offers very low rates, a 70.58% reduction in http traffic compared to RSVP MPLS and 91.22% compared to FIFO. For VoIP traffic, our approach proposes a 72% decrease compared to RSVP MPLS and a 92.85% decrease compared to FIFO.

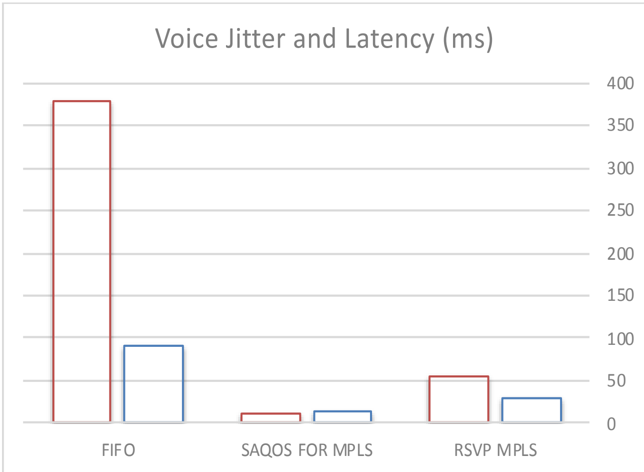

Figure 4. VoIP jitter and latency

Figure 4 illustrates VoIP jitter and latency. Latency and jitter are two important indicators for evaluating VoIP performance. Both depend on the state of the router port queue. A good model is one that processes the waiting packets as quickly as possible to avoid congestion. The results obtained showed the efficiency of our model compared to FIFO and RSVP MPLS. Indeed our model does not exceed the thresholds defined by IUT concerning VoIP QoS; 50 msec for jitter and 150 for latency.

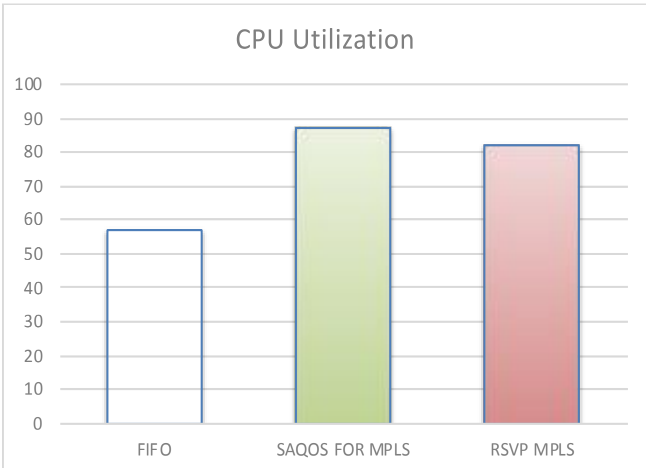

Figure 5. CPU utilization rate

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ISSN: 0193-4120 Page No. 17516 - 17521

We cannot ignore the fact that every solution has a cost to pay, the cost of our solution is imperceptible on the CPU performance of NFV servers. Indeed, our solution consumes more CPU performance compared to FIFO and RSVP MPLS and this is due to the intelligence mechanisms provided by our solution. However, the performances of RSVP solutions and ours are almost identical, so if we make a compromise between infrastructure improvement and consumed performances, our solution remains the best.

Figure 6.Infrastructure setup time.

One of the innovations of our solution is to reconfigure the infrastructure to better serve the flow and achieve high QoS levels. Figure 6 shows how long it takes to generate the configurations and deliver them to the network nodes. RSVP MPLS makes a reservation per bandwidth request, thus exploiting existing paths without modifying the network. Our solution is practically effective in terms of routing, forwarding and quality of service and therefore requires almost twice the time to generate configurations and deliver them.

4.2Evaluation subjective:

As part of the effectiveness of our model, we conducted an evaluation of the quality of experience of our approach. The QoE test measures the quality of service as experienced by the end user. The set of criteria we used to measure user satisfaction are shown in Table 1.

Table 1: Attributes of Quality of Experience Assessment.

Attribute	Definition
Reliability	Refers to user expectations of the solution presented. This attribute makes it possible to evaluate the overall performance of the solution in terms of managing dense infrastructures without failure or degradation of system performance.
Availability	The functionalities of the solution were accessible to users without restrictions. This attribute determines whether the tool performs its appropriate tasks in a very short time in the first attempt.
Flexibility	Flexibility in the use of the tool's functionalities. This attribute is used to check the effectiveness of the tool's interface design. Normally a well-designed tool taking into account the desirable technical aspects should be handled by the user without difficulties.
Features	Support of all the technical parameters desired by the user, either in the definition of the infrastructure, the application, the transition method or the duplication.

The evaluation was based on the scores in Table 2.

Score	Definition
5	Very satisfied, this score can be given if no errors or latencies were perceived during the customization and infrastructure management

Published by: The Mattingley Publishing Co., Inc.

May – June 2020
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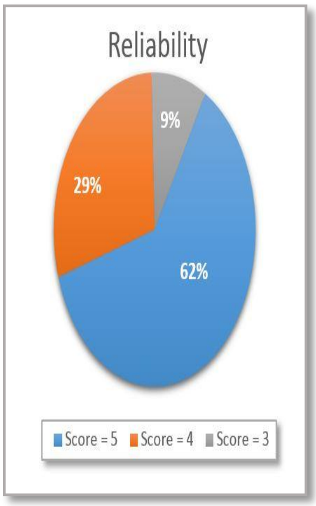
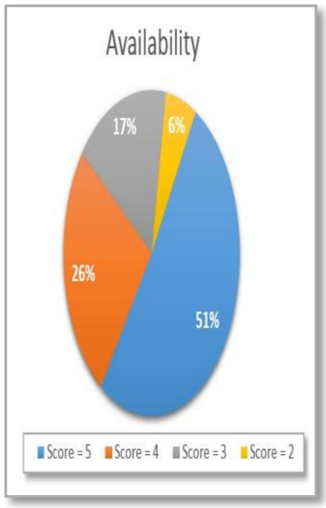
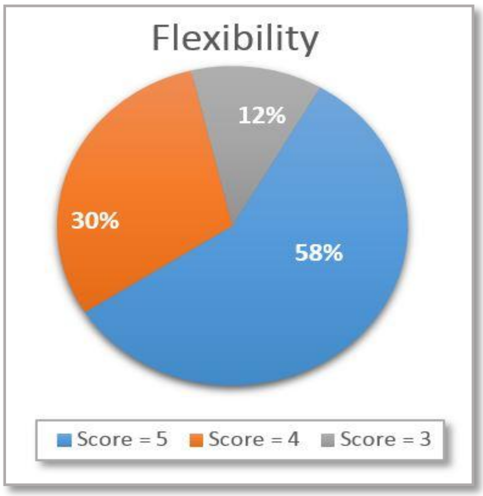
	phases. The user can assign this score if he finds that the desired functionality is supported by the system. However, the user proposes to include other functionalities in the system.
4	Satisfied, this score can be awarded if no errors or latencies were perceived during the customization and management phases. However, the user proposes to include other functionalities in the system.
3	Neutral, this score can be given if the user encounters some difficulties when customizing their infrastructure, and notices a slow response from the system. The user insists on including other functionalities in the system.
2	Dissatisfied, this score can be given if the user manages to manage his infrastructure but after several attempts and errors of response on the system side. This score can also be given if the user does not like either the developed platform or the project generation procedure.
1	Very unsatisfied, this score means that the solution lacks reliability, flexibility, availability and poor functionality.

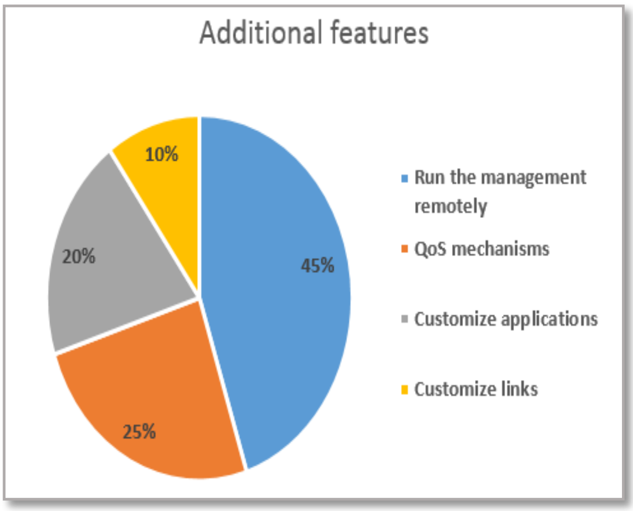
The evaluation was carried out on 34 individuals: 15 IT experts, 10 administrators and 9 network and telecommunications engineers. The results obtained from the quality of experience are shown in Figure 7.





(a) Reliability Results **(b) Availability results**





(c) Flexibility results.(d) Functionality results

Fig 7. Quality of Experience Results: Reliability, Availability, Flexibility and Functionality

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TEST Engineering & Management

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ISSN: 0193-4120 Page No. 17516 - 17521

The results obtained from the Quality of Experience Evaluation Survey show that the vast majority of users are satisfied with our solution. 62% of users were very satisfied with the reliability of our solution, 51% with the availability and 58% with the flexibility. However, 2 out of 34 people were not satisfied with the availability of the solution. 20% of the users needed to customize applications not present in our solution.

V. CONCLUSION

In this paper we evaluated the performance of our model for managing MPLS infrastructures by adopting NFV and MPLS approaches. The evaluation was based on the subjective and objective part. The objective part evaluates the performance of the architecture by exploiting applications (VoIP, ftp, tftp, and http). The results obtained from this part showed that our solution offers a good indicator of QoS in terms of loss rate, jitter, latency, configuration time. The subjective part measures the satisfaction of the users who tested our approach. The survey conducted on 34 individuals showed the high acceptance of our approach among the IT administrators and experts' community.

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