SOFTWARE DEFINED NETWORK

Vaishali Sharma[1]
Sagitech Solution
California, USA
vaishali.sharma@sjsu.edu

Vipul Pratap Rai[2]
San Jose University
California, USA
vipul.rai@sjsu.edu

Dr. K K Sharma[3]
Lingaya's University
Faridabad, Haryana
kksharma@lingayasuniversity.edu.in

Abstract— As the network traffic increasing daily, the consumption of resources increasing with the same rate. Cloud computing data centers are becoming gradually popular and important for provisioning the computer networking resources. In the past, it has been observed that a lot of importance was given to the resources that could be employed using Virtualization technology. But recently, the focus is moving from the data center for LAN and WAN to Cloud computing as the core system infrastructure. The requirements for such implementations depend on computer resources, storage and networking which in a way is becoming Software Defined Network (SDN). Instead of limiting the need for physical infrastructure and applications, the precisely defined network in virtual environment is the future. Software Defined Network plays an important role in providing the common platform to all the possible applications, innovations, operators, vendors and hardware components. The main objective of this literature review is to do research work and describes the ongoing efforts to address the thought-provoking issues.

Index Terms— *Cloud Computing; Virtualization; Software-Defined Networking; OpenFlow; Quality of Service; Load Balancing; Security; Scalability.*

1 INTRODUCTION

With many evolutionary changes, Ethernet networks have evolved significantly since the late 1980s. Switching has been introduced as a unique category, LAN and WAN, with high speed of 10Gbps, 40Gbps, and now 100Gbps peer to peer switching. While these traditional switching features have been serving from the last three decades of progression among hardware and software technology evolution, every time any new feature arises, it increases cost overhead as equipment are vendor specific and need to be replaced. This extensive requirement can now have managed resources that will comprise of software APIs, network and data center storage using Software Defined Network which is the emerging technology, which is replacing the hefty hardware overhead in computer networking with easier and more user friendly software approach. SDN can be defined as the technology that separates the control plane (brain) and data plane (muscle) [1, 2]. SDN is a centralized system which originated from OpenFlow which is a programmable protocol of network that helps in managing and designing the traffic among routers and switches. The decoupling of traffic route and traffic destination is possible using SDN. Today, many engineers are working on this new immersion technology which is considered innovative in the field of computer networking. This has received a lot of recognition and attention in the last 5 years which promises to resolve the long-standing challenges in networking. During the last decade, the computer network industry has been changed tremendously in hardware as well as software implementation of new services and application. In this literature review of the scholarly articles and proceedings, the importance of SDN and changing face of engineering industry was observed. The most relevant and significant articles were selected and studied on the topic of Software Defined Network and processed to prepare a meaningful literature review. After reading thoroughly many articles on SDN, it has been observed in most that even after study for many years, the definition of SDN varies from writer to writer. As well as, the implementation of technology depending on different operators or developers is unique for all. Although SDN has many advantages over traditional network, it has a few challenges as well. As per literature review, it has been found that SDN has research related challenges including Load Balancing (LB), Quality of Service (QoS), Scalability and Security [2,3].

This gives rise to the research question: How *can one single tool change the future of our present conventional network and how secure is it?*

2 LITERATURE REVIEW CATEGORIES

Even after this noticeable progression in network speed, the significant improvements are 1) Load balancing in SDN 2) QoS 3) Scalability, and 4) Security. The main influences of this review are dependable on challenging issues in SDN, its identification and classification. The ongoing research efforts to solve the identified challenging issues using the survey conducted by the active researchers who are actively contributing to the field [3]. The paper also reflects the comparison of presented techniques and focusing on their features related to Load balancing, QoS, Scalability and Security as referred to Fig. 1.

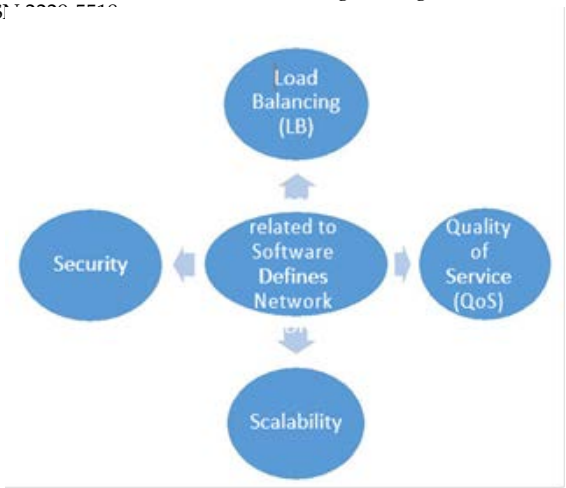

Fig. 1. Major Research Issues

3 Load Balancing

In Software-Defined Networking (SDN), to identify the awareness about congestion in the switches, Load-balancing is used. To improve the availability and scalability of applications it is an essential entity based on network environment as shown in Figure 2 which is imposed in a way to achieve the minimal response time of the applications. SDN has introduced many different methods to implement the reliable load balancing techniques [4].

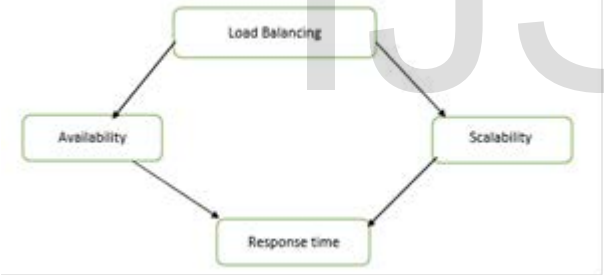

Fig. 2. Load Balancing in SDN

4 OpenFlow Based Server Load Balancing

Many researchers worked on this method of achieving load balancing in SDN. After reading through a lot of research work written, Richard Wang et al. [5] suggested a much optimized method of installing the wildcard rules in the switches itself for redirecting the requests in a proactive manner in the network. This is achieved by partitioning algorithms to generate the wildcard rules in load balancing architecture to change one set of rules to another as per the requirements without changing anything about the hardware nodes connected to the network. To determine the global optimal rules for wildcard, these algorithm methods are centralized to control the flow. It divides the client traffic and distributes it as per the calculated values and defines the IP prefixes, where each node containing that IP prefix and those are close enough to attach the same IP segments. The proposed topology work can be implemented and evaluated by using tools like OpenDayLight, NOX, POX, Ryu, Floodlight and MiniNet [5].

5 ASTERX

The proposed load balancer is different from the one discussed above in the purpose of implementing the load balancing in the network. How it is different is reflected in the article by Nikhil Handigol et al. [5] who proposed the load balancer named Aster *x. The load balancer could consider single request or multiple requests as flow. Asterx is logically centralized and flexible in working nature. The decisions made by the load balancer vary in many ways depending upon the individual versus aggregated requests, static and dynamic, and proactive versus reactive at the time of arrival of request. This method works on GENI infrastructure that is hosted by PlanetLab nodes connected through OpenFlow based on networking hardware devices [6].

6 Quality of Service

Quality of Service (QoS) [3] is performance achieved by the service in other words, it defines the degree to achieve a service. It is a critical and essential property of network and it is very hard to achieve the desired QoS parameter for a longer duration of time. The critical QoS parameters to be obtained and achieved in the network are insuring bandwidth, reducing delay, and minimizing packet loss and congestion control. This article brings into light some of the research work done in the field of solving problems related to QoS in the SDN based networking. We have different controllers dealing with different QoS, OpenQoS controller provide end-to-end Quality of Service (QoS) for multimedia based applications. In OpenFlow based network environment QoS management is provided by QoSFlow. In Cloud environment it is important to provide dedicated bandwidth to the virtual machine which depends on different data centers so VDC (Virtual Data Center) provides the guaranteed bandwidth QoS here. Network coverage is one of the critical areas these days to support the traffic multiple applications on the single network which is obtained under the QoS control frame work for the automation and management of converged network traffic [7].

7 SCALABILITY

Scalability is one of the most important factors of SDN which is based on network environment and is divided between three levels which can be shown in Table 1.

S. No.	Scalability Level	Description
1.	Level 1	The number of switches that can be handle by an SDN based controller
2.	Level 2	Describes the flow table entries that occur for each flow in the network
3.	Level 3	The switches which are spanned at multiple sites can be represent how SDN controller handles it

TABLE 1. Scalability Issues in SDN

To represent the scalability architecture, there are different methods available namely, DIFANE, Maestro, and DevoFlow. To implement the DIFANE [8] architecture, the change needs to be implemented only on control plane not on data plane. The findings of DIFANE architectures show considerable increase in lower delay, better scalability and higher throughput. Maestro architecture works on TCP connections by enabling parallelism. Maestro is implemented with four applications namely Discovery, IntradomainRouting, Authentication and Routeflow. It shows better performance compared to NOX controller. Devoflow [9] stands for Devolved OpenFlow. The main motivation behind this architecture is to develop a simple and cost effective hardware. It is implemented by two mechanisms namely, rule cloning and local routing actions. The scalability was improved by using sFlow [10] based sampling technique and reports.

8. Security

Security is one of the major threats faced by SDN networks as SDN is still in a developing phase to be completely reliable and threat free. As the data plane is controlled by control plane only, in that sense SDN needs to protect it. The other security concerns that come in the scenario with SDN are Distributed Denial of Service (DDoS) attacks, Intrusion Prevention and SQL injection. SDN researchers have tried to implement the security features. Ye Wang et al. [11] projected a mechanism named NetFuse that lies between the controller plane and switches to protect cloud based data centers. NetFuse controls and modifies the flow rules for the switches. NetFuse has provided the improved scalability of the system by implementing the features like delay injection and packet blocking. Next, Fresco is developed by OpenFlow security application by Seungwon Shin et al. [12]. The application layer enables the service of security which used python and is also available in NOX and security enforcement at kernel level.

9. CONCLUSION

Resources of cloud such as compute, network and storage become worthy for infrastructure, data storage, hosting network based application and computation. Software Defined Network (SDN) is used to resolve the complexity of the conventional networking and virtualization by meeting the user's application constraints and effectively using the resources from the network. In this review we find out the art of Software Defined Networking in the areas: Network Quality of Service (QoS), Load Balancing, Scalability and Security and in our review we conclude that there is no specific architecture or solution for all the issues mentioned above. It depends on the users application requirements. So the future prospective is broad open and lot of work has to be done in the focused development of Software Defined Networking (SND) platform.

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