IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 10, October 2021

DOI: 10.17148/IJARCCE.2021.101023

Multiple Controllers in SDN – A Comprehensive Survey

Mr.M.Ahsan Shariff M.Tech.

Assistant Professor, Dept. of Computer Science and Engineering,

Aalim Muhammed Salegh College of Engineering, Chennai-600055.

Abstract: Software-defined networking technology is an approach that decouples the data plane and control plane providing programmatically efficient network configuration in order to improve network performance and monitoring than traditional network management. The controller is a central unit that controls the SDN model. Through this controller, all the communication takes place. In spite of such capability, one of the difficulties of the SDN controller is a single point of failure hence If the controller fails or is hacked, the entire system will either fail or get corrupted. Multiple controllers help to improving the network reliability because the data plane can continue to operate even if one controller fails. Furthermore, a single SDN controller has many drawbacks on both performance and scalability. Thus, multiple controllers are required and critical for large-scale networks. This paper surveys latest researches on multiple controllers of SDN, benefits and challenges of multiple controllers are discussed after giving an overview of SDN and OpenFlow in the paper. Finally, we conclude this survey paper with some proposed works and suggested open research directions

Keywords: Software Defined Networking (SDN), OpenFlow, Multiple Controllers

I. INTRODUCTION

It is difficult for network administrators to operate and manage when considering dynamic application requirements with traditional network architecture. Hence Software Defined Networking (SDN) has been proposed to solve those problems. SDN separates data plane and control plane by providing the programmability to configure the network. SDN controller is convenient for network operators and researchers by obtaining the global information of the whole network. Unlike traditional network, by decoupling the control plane and data plane in SDN, control planes are merged into a single unit named controller. SDN controller is able to provide Application Programming Interfaces (APIs) to upper applications and allow operators to deploy various network policies based on the requirements. The SDN control plane may take in different forms either single controller or multiple controller architecture. Based on the earlier studies, many medium-sized networks were carried out by a single controller whereas multiple controllers are still required in many circumstances like efficiency, scalability, and availability of the networks. Through load balancing, response latency can be reduced and new controllers can be added dynamically to achieve higher performance with the help of multiple controllers. It also provides redundancy mechanism to avoid single point of failure and improves the various aspects of the control plane like scalability, robustness, consistency and security. OpenFlow is a widely adapted protocol that defines an open standard Application programming interface for Software defined networks. Most Current controllers operations are associated with the OpenFlow protocol like POX, NOX, Beacon and Floodlight. Open Networking Foundation (ONF) manages OpenFlow standards where ONF is dedication and adoption of SDN. OpenFlow proposed that a switch can establish communication with multiple controllers to improve reliability of the control plane.

II. OVERVIEW OF SDN

It describes the basic theories of SDN, including SDN architecture, SDN controllers and a typical southbound interface. SDN breaks the vertical integration by decoupling control plane from data plane. With such separation, switches become simple forwarding devices and the control logic can be implemented in a logically centralized controller. It is responsible for policy enforcement, network configuration, topology management, link discovery, flow table entry and so on. SDN architecture normally contains three layers (i.e., infrastructure layer, control layer and application layer) and two interfaces (i.e., southbound interface and northbound interface). Figure 1 shows a simplified SDN architecture.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 10, October 2021

DOI: 10.17148/IJARCCE.2021.101023

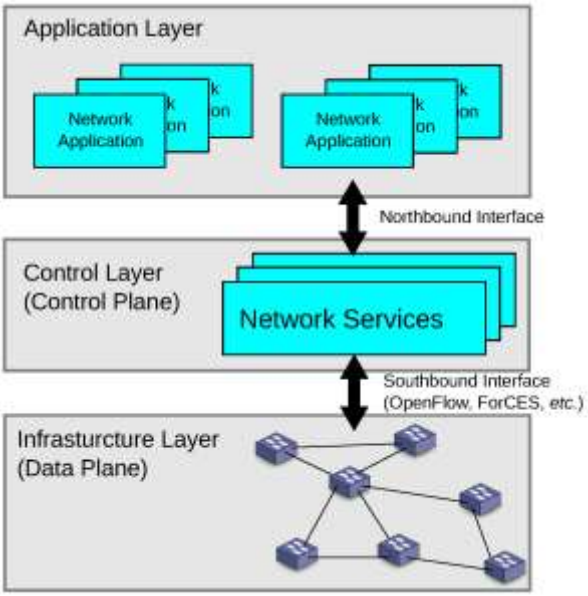

Fig: 1 A Simplified SDN Architecture

• Infrastructure layer is composed of SDN-enabled switches and other network elements (NE). The infrastructure layer provides flow forwarding information to the upper controllers through the data-control plane interface, also known as southbound APIs.
• Southbound APIs are communication interfaces that connect the infrastructure layer and the control layer. The communication between the SDN controllers and the network elements are enabled, in order to determine the network topology, push the flow table and implement the control policies.
• Control layer is the core component of SDN, which is responsible for network management, consisting of one or multiple controllers. Controllers usually have global networks information to determine suitable network policies and then configure switches through a secure channel.
• Northbound APIs are communication interfaces that link the control layer and the application layer. It enables the applications that to easily manage network resources and capabilities.
• Application layer contains SDN applications and services that are designed to meet user requirements. And it also can access and control switches in data plane through the control layer and communicate with the control layer through the northbound APIs

III. MULTIPLE CONTROLLERS: BENEFITS AND CHALLENGES

Motivational, and Benefits:
Having multiple controllers in the network can improve stability, as the switches can continue operating if one controller or controller connection fails. Multiple controllers can be implemented in distributed control plane, which means logically centralized but physically distributed. There are other benefits to use multiple controllers, especially distributed control plane.
• Administration. Efficient administration is a very important motivation for multiple controllers since it is difficult for a single controller to manage a large-scale network with multiple domains structure.
• Scalability. Current OpenFlow approach may lead to heavy load on a single controller, which reduce scalability of the network. Multiple controllers architecture can be a practical solution so that controllers can be added or removed dynamically.
• Latency reduction. If every event is responded by a single controller in successively sequence, it may cause the controller overload and increase response latency. To reduce burst traffic processing latency with multiple controllers, the requests can be load balanced among different controllers or forwarded to the most appropriated one.
• Robustness. SDN architecture with multiple controllers adopts multi-points backup, to avoid single point of failure, and enhance the network robustness. When a controller fails, other controllers can pick up the load with little or no changes so as to maintain network performance and stability. Multiple controllers can reduce the probability of network failures, especially controller faults.

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 10, Issue 10, October 2021
DOI: 10.17148/IJARCCE.2021.101023

Challenges with multiple controllers:

In spite of lots of merits, it also brings some new challenges that need to be resolved. For instance, inconsistency may leads to increase response latency or cause errors. Challenges imposed by multiple controllers are summarized as follows.

• Consistency. Synchronize the network state information among controllers is a critical problem when implementing multiple controllers platform, also known as the controllers consensus problem.

• Placement. Two essential questions need to be taken into consideration when deployment takes place: how many controllers are needed? And where in the topology should they go?

• Scheduling. SDN networks performance can be improved with the help of multiple controllers, but some inevitable issues still exist: how to schedule multiple controllers to prevent one of the controllers overload? And how to make an overload controller balanced as quickly as possible?

IV. SUMMARY

In this section, multiple controllers benefits and challenges are discussed. Multiple controllers provide efficient administration, scalability, latency reduction and robustness. However, several challenges, such as consistency among controllers, controllers placement problem and multiple controllers scheduling need to be resolved.

CONCLUSIONS

SDN improves the network utilization efficiency and realizes the programmability. However, a single controller restricts the scalability and reliability of SDN networks. Multiple controllers architecture is needed in future development of SDN because of its high scalability and availability. In this paper, a comprehensive survey on recent progress of multiple controllers with SDN is conducted.

REFERENCES

[1]. Yuan Zhanga, Lin Cuia,b,∗ , Wei Wangc , Yuxiang Zhanga, –A Survey on Software Defined Networking with Multiple Controllers, Journal of Network and Computer Applications, December 72017.
[2]. R. Braga, E. Mota, and A. Passito, "Lightweight ddos flooding attack detection using nox/openflow," in IEEE Local Computer Network Conference, Oct 2010,.
[3]. H. Farhady, H. Y. Lee, A. Nakao, Software-defined networking: A survey, Computer Networks the International Journal of Computer Telecommunications Networking 81 (C) (2015) 79–95.
[4]. A. Nunes, M. Mendonca, X. N. Nguyen, K. Obraczka, A survey of software-defined networking: Past, present, and future of programmable networks, Communications Surveys Tutorials IEEE 16 (3) (2014).
[5]. R. Masoudi, A. Ghaffari, Software defined networks: A survey, Journal of Network and Computer Applications 67 (2016).
[6]. M. Karakus, A. Durresi, Quality of service (qos) in software defined networking (SDN): a survey, Journal of Network and Computer Applications 80 (2017).
[7]. O. Blial, M. B. Mamoun, R. Benaini, An overview on SDN architectures with multiple controllers, Journal of Computer Networks & Communications 2016 .
[8]. F. X. Wibowo, M. A. Gregory, K. Ahmed, K. M. Gomez, Multi-domain software defined networking: research status and challenges, Journal of Network and Computer Applications 87 (2017).
[9]. SDN architecture Overview, https://www.opennetworking.org/ wp-content/uploads/2013/02/SDN-architecture-overview-1.0. pdf, (Accessed: 2017/09/07) (2014).
[10]. W. Xia, Y. Wen, C. H. Foh, D. Niyato, A survey on software-defined networking, IEEE Communications Surveys & Tutorials 17 (2015).

