Network Management in Software-Defined Network: A Survey

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Abstract. SDNs are developed networks that focus on the separation of control aircraft and data. This new model is designed to simplify network management and enable research innovations. It explains the traditional system of SDNs and issues related to the traditional system. This paper explains the background of SDN technology and architecture. At the end of the research, SDN enhances scalability, flexibility, reliability, high availability, security and performance. This paper has tried to simplify and explain every problem with the SDN network and provided an overview of the SDN network general structure, the basics of network management in SDN, and the main challenges in SDN.

Keywords. Software defined network, Network management, SDN challenges, SDN architecture.

1. Introduction

Considering the fast-growing market and following end-to-end communication specifications, software-defined networking is one of the most researched areas. It is a networking paradigm that carries several different skills and addresses the issues of old networking models. The software-defined network is built in a centralized controller to isolate network intelligence, packet swapping devices and network intelligence mixing. This controller then serves as the main brain or main controller responsible for judging routing utilizing protocols called Free Flow" positioned at switches. This technique can be considered one of the beneficial techniques under which intelligent network plane is named the control plane [1]. The data plane and control plane is decoupled for various purposes [2]. This distinction provides tremendous consistency and allows for greater abstraction of the network, easier management of the network, capacity for innovation [3], allowing the control plane to be introduced in an external body named the controller [4]. The data plane remains in packet forwarding components called switches. The free flow protocol [5], [6] is utilized for coordination between the networking components (switches) and controller. The switch cost decreases as the information is transferred from networking components and collected in the external controller. The central controller has all the knowledge regarding the network, so it is easy to handle and operate [7].

The SDN architecture allows for unified management of the data route elements, regardless of the network infrastructure utilized to link these devices from separate suppliers. The unified management integrates all the intelligence and retains the network-wide vision of the elements and connections linking the data path components. This centralized, up-to-date vision renders the Network Operating System (NOS) ideal for network management (NM) functions as well [8].
2. Traditional system verses SND
A modern network pattern aims to eliminate the shortcomings of the current network infrastructures by eliminating the vertical integration paradigm. It also split network control logic separately from routers and switches regardless of managing it inside a network operational system by a centralized logical controller, as seen in Figure 1. Figure 1 demonstrates the SDN design integrating the logic of control from the forwarded hardware and allows middlebox consolidation, easier decision management and new additional features to be consolidated. The solid lines describe the data plane's relations and the dotted lines of the controlling plane's ties. [9]. A more flexible and efficient approach will be possible utilizing real, centralized management planes. An application programming interface (API) between the SDN controller and switches, the optimum example of open Flow will separate power from data planes [3].

![Figure 1. The SDN design integrates the logic control and middlebox consolidation. [9].](image)

3. Drawbacks of the traditional system
In a clustered manner, conventional IP networks pair the controlling and data planes, integrating them in a similar networking unit. While this has certainly contributed to outstanding network efficiency and increasingly growing line speeds and port densities, rigid arrangements that are complicated and challenging to manage have often occurred. In comparison, current network administration depends on expensive patented solutions and advanced skills [3].

4. The general architecture of SDN
It consists of three interfaces and four levels, as demonstrated in Figure 2. It has been observed that the bottom-up architecture approach, as the redirection level, is divided into "physical" and "functional." A functional part is a group of software functions that will be implemented in the redirector apparatus, where the functional part is the main reason for calling this "redirection level" instead of "data level." From our perspective, the functional part holds data and permits the program to be used to perform redirection tasks or use tables, queues, or any other internal data structure. The remaining components at this level are completely physical, including I / O, memory, processor, and storage. The initial control plane aims to aggregate higher-level decisions and force the necessary configurations into the redirection apparatus. Environmental requirements may dictate how this level is designed and
determine the best strategies for locating and distributing items. At the higher level of the SDN architecture, in addition to high-level network services, for example, load balancers and firewalls, are network applications, coordination functions for business, and network logic. This aircraft was rarely featured in early SDN proposals [10]. The management level has been considered an essential part of the architecture to organize the implementation of operations, management, and management (OAM) functions in an SDN. Also, there are two other basic interfaces, a northbound API that summarizes network applications' control plane functions at the top-level [11] and a southbound API that permits the forwarding plane to communicate with the control plane.

![Figure 2. High-level conceptual design. [11].](image)

The authors proposed in [8] that the existing Open Networking Foundations (ONF) SDN architecture actually defines two SDN system specifications, each of which interface the networking devices with the Network Operating System (NOS) describing the unified controlling and management plane. These specifications are Open Flow, utilized to program flow tables in flow and packet time scales, and the new OF-config with the primary task of configuring network components around the network in individual geological timescales. In this article, the SDN concept of the ONF has been extended to the utilization of a network infrastructure that is connected to the internet and distributed by many customers (VNOs), arising from these two requirements. Steps needed to configure and maintain this form of virtualisation SDN, range from bootstrapping devices and networks, configuration of virtual networks, and final transition to VNO. A per-step review of this technique helped us to find vulnerabilities and suggest appropriate modifications to the ONF Model - view in the implementation of network management.

5. Network management in SDN

Network providers have to contend with a low-level resource configuration to enforce high-level, nuanced network policy in order to run, manage, and protect a network. In spite of recent attempts to promote network maintenance, owing to the difficulties of improving the simple architecture, several network management solution strategies have reached the end of downtime. Network management make regular updates to network conditions and requirements, achieving great language setup for network assistance. This adds greater visibility and mission management to the diagnosis and troubleshooting of networks. The (SDN) model defends the data plane isolation and control stage, allowing the network to switch in the basic packet data routers of the data plane and leave a centralized software program to control the whole behavior of the network. It is important to equate
certain benefits to old strategies. First, by apps, it is really simple to incorporate fresh concepts into the network. Using a series of commands in the monopolistic network apparatus makes things easier to process and modify. Second, instead of distributed management, SDN provides the advantages of a centralized solution to network configuration. Operators take network-level redirects in one logical place, culminating without need for operators to manually install all network devices, a controller, SDN offers different possibilities and new approaches to handle network and configuration methods [12]. Table 1 demonstrates the most relevant requirements, taking into account all levels of SDN architecture. This provides a comparison with examples of traditional networks and management activities.

Table 1. Software-defined network management activities versus traditional network management activities, [11].

| No | Management Requirement | Traditional Networks | Software-defined networking |
|----|-------------------------|----------------------|-----------------------------|
| 1  | Bootstrap and configuration | Set well-known protocol parameters, track configuration changes | Configure customized and ever-changing software, set up forwarding and control plane connectivity. |
| 2  | Availability and resilience | Configure alternative routes in case of link failure. | Configure forwarding device behavior in case of failure in connection with the control plane. |
| 3  | Networks programmability | Not required | Control versioning, coordinated deployment, and verification of network software. |
| 4  | Performance and scalability | Bandwidth assignment and reservation, quality of service configuration and enforcement. | Monitor Performance of Networks applications, adjust connection quality between forwarding Control planes |
| 5  | Isolation and security | Control Networks access, prevent intrusion spoofing and Denial Service | Grant Isolation to Network applications, prevent eavesdropping and usurpation of control traffic. |
| 6  | Flexibility and decoupling | Adjust the management of higher-level protocols | Adapt management functions along with management interfaces, coordinate management information within planes or among management systems. |
| 7  | Network planning | Assess capacity and Performance needs, choose a Network topology | Plan the disposition of controlling elements concerning forwarding elements |
| 8  | Monitoring and visualization | Track resource utilization, identify outages and trigger alarms | Track functional parameters of novel applications, visualize the jurisdiction of network controllers. |

6. Research challenges in managing a sustainable development network [11]

6.1. Through high-level functions to network configuration
Reconstructing lost information or translating it into a set of lower- actions level if very high-commands level or functions come from the first SDN structures. Converting high-level bases to low-level confers has become a challenge to handle boot and configuration requirements properly.

6.2. Autonomic and in-network management
The SDN permits the software to dictate the network apparatus behavior. It can put code inside these apparatus to permit interaction with network situations and achieve self-functions management. Independent management methods provide the ability to migrate management functions within the network, typically deployed at the management level, to software running on both the redirection and control aircraft apparatus. Important matters such as autonomy and networks were also essential as they contribute to meeting the SDN availability and flexibility requirements.
6.3. Flexible management through interfaces
Using interfaces in the SDN design leads to management level interaction with other aircraft. While dealing with flexibility and disengagement requirements, the challenge is to find an organized method for defining, using, and developing management interfaces.

6.4. Smart Network Planning
Planning is a challenge when using SDN virtualization to support various networks across a single base layer. The amount of information that a network administrator requirements to process is much greater than a non-virtual network. In terms of asking questions that were not common before the SDN network was created, intelligent planning solutions became necessary to help network administrators.

6.5. Situational Management
Network conditions are more dynamic in SDN due to the frequent and available installation of the software. Like control schemes, there is a risk that it will trigger unintended circumstantial difficulties. For taking the benefits of the knowledge accessible from SDN networks and interfaces to cope with the newly deployed unforeseen and temporary circumstances, funds are provided to construct control applications rapidly. Managing an appropriate position also includes meeting SDN monitoring and visualization requirements [13]. The availability of good services, including such streaming video and availability, has increased over the past years. Providing these networks efficiently is challenging and requires Internet Service Providers (ISPs) to incorporate specific network management processes. The subscriber tunnel is passed into one selection phase, independent of the different categories of networks to which it corresponds, through current broadband network designs. It is simple to handle subscribers in an ISP with one assembly point, providing tremendous expert level capacity and a strong end-to-end opportunity for subscribers. Management of dispersed customers will be the solution, thus complicating the management itself. In [14], the developers suggested a modern traffic management design that would utilize the software-defined network (SDN) definition to expand the Ethernet-based internet infrastructure, enabling the Network provider to handle traffic more efficiently. Using SDN home portals, the ISP can more dynamically customize traffic flows, enhancing network efficiency, particularly for bandwidth-intensive services. Moreover, evidence on applying the conceptual solution is presented to show the total trade-offs of viability and configuration.

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In [2], the author concentrated on the obstacles, possibilities and problems of software-defined network (SDN) science and even on selecting the best available SDN controller to help minimize the size of the network and the expense of network installation and maintenance in any broad organization. Issues and problems of analysis in the paper are listed below:

Major issues are:

1. How to make subjective and conflicting choices using SDN controllers.
2. Characteristics of SDN controllers and their influence on complex problematic decision-making technology.
3. Using AHP technology to select the best SDN controller.
4. Congestion load condition, multi-path dynamic load balancing sharing.
5. Processing a huge amount of data in the network requires a central processing unit and high memory in addition to the control unit so that all requests are processed without delay.
6. How to deal with the number of streams for an SDN controller.
7. Sending the open flush hardware switches decision flow to the SDN controller
8. The controller may cause a delay if it is not properly positioned.
9. In SDN, one of the main issues is the issue of interoperability.
10. ACL access control list for security.

7. Conclusion
SDN is a new network approach, with a logical central control program that separates the network data set from the control level. Many explanations for classic network issues were reviewed utilizing this
structure, and several issues remain challenging. This study is an attempt to simplify and explain all problems of SDN network, provide an overview of the general structure of the SDN network and the basics of network management in SDN, and the main challenges in SDN.

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