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Software Specified Network Infrastructure Management

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Abstract: The heart of networking is about change and managing it is a challenge. For operation, maintenance and security of communication network, network operators rely on low level vendor specific configuration to implement complex network policies. The interdependence among the components in a network has led to fear of change in network as change in any part can lead to failure of whole network. This rigidity of underlying network infrastructure presents few possibilities for innovation or improvement. Software Specified Network Infrastructure Management is a paradigm that changes how we design, operate and manage network so that changes to network become practical and reliable. It is implemented by separating data plane and control plane, making network switches as simple packet forwarding devices and leaving the centralized software to logically control behaviour of network. Software Specified Network Infrastructure Management redefines the management and configuration methods of a network. In this paper, we identify the problems of current network configuration and management mechanisms and introduce improved architecture for managing the network.

Keywords: OpenFlow, controller, centralized, ONF, virtual.

I. INTRODUCTION

'Change is the law of life and those who look only to past or present are certain to miss the future' -John. F. Kennedy. The dynamic and complex nature of networks makes configuring and managing them a challenging task. Many types of operation simultaneously occur in large number of switches, routers, firewall and many other networking devices. The implementation of high-level policies and response to network events is the responsibility of a network operator. These high-level policies for their implementation require specification in low-level configuration to perform network configuration which is incredibly difficult. Traditional network has no mechanism for automatically responding to events that may occur.

Network operators are responsible for implementing complex tasks and sophisticated policies with limited number low level policies. This policies being low-level cannot adapt to ever changing network conditions. Network operators have to manually change network configuration depending on network conditions. To overcome this limitations operators use external tools to dynamically reconfigure network devices when events occur. These frequent changes may lead to ill configuration of network.

A. Networking: A traditional approach

In traditional approach, the control plane and data plane are combined into a single network node. The control plane determines the path on which data is to be forwarded. This control information is then passed to data plane in order to carry out the task of data forwarding. As the flow is predefined, the only way to redefine this policy is by reconfiguration of network device. Reconfiguration involves making changes to physical level of a device which is a complicated task. These network devices are vendor-dependent and hence manipulating them is a complex and costlier task. This restricts the use of mobile devices, changing traffic and size of data.

B. Networking: A Software Specified Network Infrastructure Management approach

Software Specified Network Infrastructure Management is an approach comprising of a centralized software program that controls the entire behaviour of network. In Software Specified Network Infrastructure Management, control and data planes are separated from each other. The network nodes become simple data or packet forwarding devices while control logic or behaviour of network is implemented by centralized software. Introduction of centralized controller involves many benefits. First, it is easier to introduce new ideas, changing and manipulating a software program then manipulating a network device at physical level. Second, operator can configure network behaviour by making changes at logically single location, the controller, eventually reducing the effort of configuring all network devices individually. Third, as the application being a software, it is easy to take its backup and hence it redundancy can be increased. Separation of control plane and data plane makes network nodes vendor independent.

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Vendor independence reduces the complexity of configuring the devices and hence eventually reduces the cost.

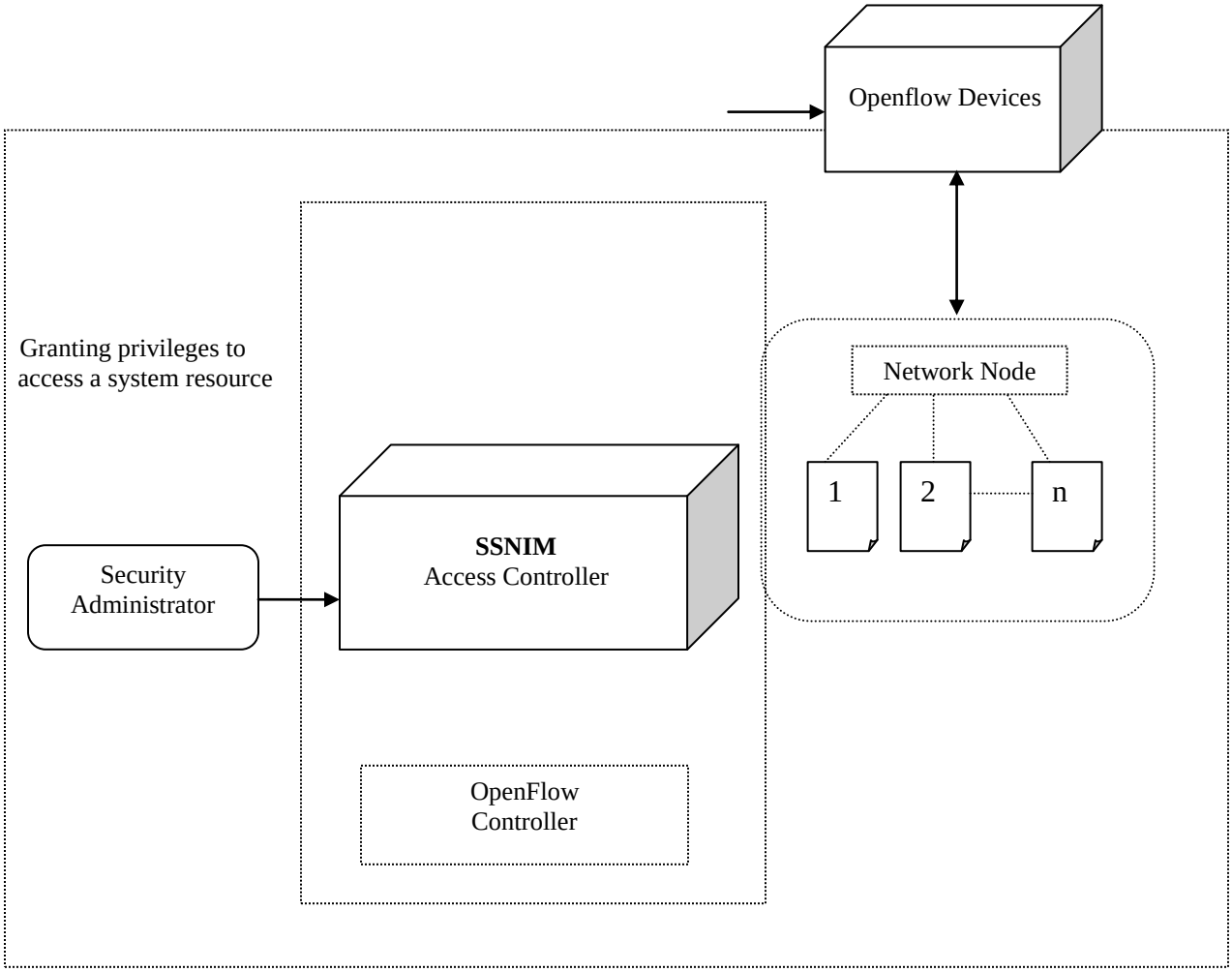

Fig. 1. Architecture Diagram

II. IMPLEMENTATION

The Software Specified Network Infrastructure Management follows a software defined networking paradigm, thus it maintains a low-level policy table inside a controller to make traffic forwarding decisions. The OpenFlow controller forms a connection with all OpenFlow network devices and uses OpenFlow protocol to insert, delete and modify packet forwarding decisions inside a network node. In this article we describe an application that is centrally controlled. This application is used to assign privileges to users that intend to access any system resources. To be precise, it describes an access controller that uses OpenFlow protocols to dynamically manipulate a network.

Software Specified Network Infrastructure Management devices maintain a flow table as shown below. This table is based on the standards defined by Open Networking Foundation (ONF). The table defines MAC address and IP address of source and destination, the action that is to be performed and counts the number packets that have been processed by OpenFlow device.

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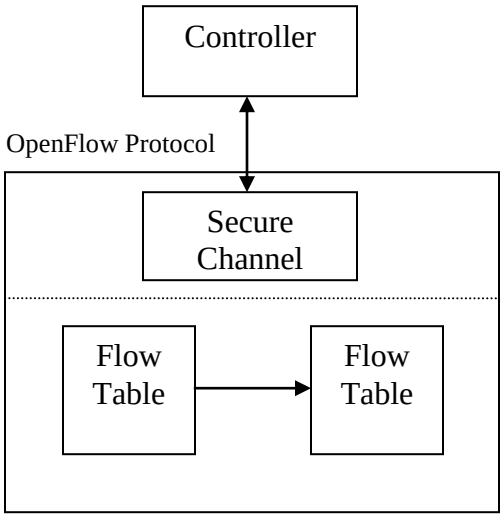
Mininet is a tool used to create virtual network using combination of switches and host.

MAC src	MAC dist	IP Src	IP Dest	Action	Count
*	10.20	*	*	Port1	250
*	*	5.6.7.8	*	Port2	300
*	*	*	*	Port3	350
*	*	*	5.6.7.8	Port4	450
*	*	*	*	Local	350
*	*	*	*	Controller	250

Table 1: Table as per ONF standard

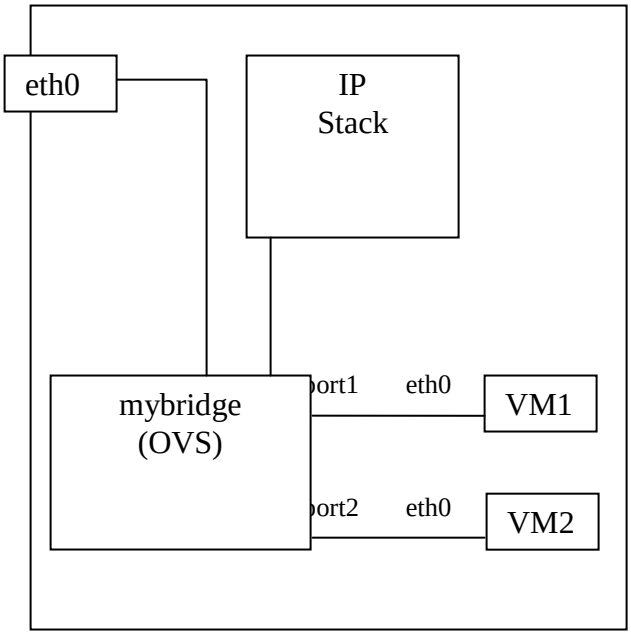
The OpenFlow devices are similar to existing devices and perform a similar task. The only difference is that unlike existing devices, OpenFlow devices do not deal with functionality of operating system and only deal with the flow of packets. These devices are manipulated by a centralized controller that provides settings and configuration to perform a specific function. OpenFlow devices do not consist of a high end operating system and hence these devices have low cost. OpenFlow protocol provides a secure communication between the Controller and any OpenFlow switch.



The incoming packets are matched with the list and sorted depending on their priority. The comparison is done until the match is found from the priority list or the list gets exhausted. If the match is found, appropriate action defined in table is performed over the packet and if match is not found then there is implicit deny at the end.

III. TESTING ENVIRONMENT

We use Mininet to test the performance evaluation scenario of Software Specified Network Infrastructure Management.



Existing system is directly connected to eth0 to IP stack but in this application network traffic is routed from eth0 to IP stack via a virtual bridge. To achieve virtualization it creates virtual ports which are attached to virtual nodes. All virtual node traffic is forwarded to eth0 through a virtual bridge. This virtual bridge supports OpenFlow protocol to notify the controller about the underlying network that is being virtualized.

IV. CONCLUSION

Network configuration is becoming an increasingly complicated task and hence network operators have to perform sophisticated network management tasks. Some reasons for complications in network management tasks are:

- Changing nature of network
- Vendor specific devices
- Low-level network configuration

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Current technologies do not allow operators to configure network policies that respond to low-level networking events. Software Defined Networking allows us to remove the complexity in network configuration and automatically react to changing nature of network.

To overcome these flaws we have designed a Software Specified Network Infrastructure Management application that will allow us to perform access control operations dynamically over a network. We use OpenFlow protocol to communicate between network devices using an SSNIM application. This application is feasible, allows us to dynamically configure a network and thus reduces the complexity of network management.

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