SDN: A New Approach to Networking Technology

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Abstract - *In an era where Information Technology is in complete boom, we have multiple technologies working together to provide solutions and services. The basis of their interconnection being Networks. It is not possible to use the traditional networks for their connection as it has many drawbacks such as high cost, no flexibility, manual configuration is compulsorily etc. Hence, here we can see the evolution and a drift in the hardware perspective i.e moving to software in terms of functioning of networks(SDN). The expectation from today's networks is the implementation of virtualization of as many devices possible combined with the concept of programmability, to create efficient networks which are in their evolving stages.*
One such Network is the SDN wherein we eliminate as many hardware connections and replace it with softwares which are quick in reconfiguration and very efficient.

Key Terms: Virtualization Network, FlowVisor, Network Function Virtualization(NFV), Software Defined Networks(SDN)

I. Introduction

In the world of exponentially growing information technology where communication plays a critical role, we can see the rapid evolution of programmable network configuration and management. This is implemented by combining the concepts of Software Defined Networks (SDNs) and Network Virtualization to cater flexible networks which can be easily re-configured [1].

The concept of Network Function Virtualization is also introduced here which is the elevation of Network Virtualization, here the aim is to virtualize those functions of the network that are typically implemented by dedicated hardware devices like routers, firewalls and load balancers.

The main design aspect of a Software Defined Networks (SDNs) is to separate the control and the data panel in the networking devices to enhance the ability to program the network [1].

An exhaustive study of the benefits of the SDN network and the threats that can be expected while using SDN is mentioned in [2]. The concept of SDN is not completely novel, rather it has evolved in three phases in the history of Networks First of all we had the active Networks which allowed programmability by the implementation of open interfaces in each node of a Network. Next we have the separation of the control plane from the data plan and lastly we have the OpenFlow protocol[9] and Network Operative System(NOS). OpenFlow is the basic element for the solutions pertaining SDN. It is an open standard that allows researchers to execute experimental protocols in the campus Networks that we use on a daily basis.

With regards to the hardware components every time a new function is required, these are carried out in the hardware environment. NFV is a new approach which is established on the concept of Virtualized Network Function (VNFs) whose target is to reduce the cost related to the deployment and management of all the new network applications. NFV depends upon traditional server virtualization but also differs from it. Virtual Network Platform may compose of one or more VM'S running different softwares and processes which runs on top of standard high-volume servers, switches and storage devices or even cloud computing framework rather than having custom hardware devices for each Network function. The implementation of partition of control plane and data plane can be carried out by a well illustrated interface between the switches and the SDN controller.

In the current times, devices such as load balancers and firewall are carried out in a hardware environment; NFV's main aim is to move these functions to the software surroundings. This would result in the reduced expenses in the provisioning and management of telecom services. NFV and SDN are two different terminologies which go hand in hand, whose relationship would be seen further in this paper.

II. Related Work

Virtualisation Network: The very first

Virtualization is quiet an old concept, wherein the first device to be virtualized was memory. In today's time it is even possible to virtualize the OS, storage capabilities and even the computer hardware and networks [1]. Virtualization is basically the abstraction of logical assets from the physical assets [2]. In this particular sense, Network Virtualization allows multiple simultaneous Virtual Networks on top of a physical network as shown in Fig.1.

Some Technologies use the concept of virtualization within the network. For example we have the VLAN. VLAN is a logical network which is created by a group of hosts in a single domain, here the logical architecture is different from the physical architecture. VLAN opens new doors for management, recognition and isolation of the network. Virtual Private Network is a VN that aids in the communication of multiple sites by the means of a secure tunnel over a public network. There are different types of VPN's: layer 1 VPN, layer 2 VPN, layer 3 VPN and VPN over multi protocol label switching(MPLS). There are also other approaches such as Open vSwitch, , a multi-layer, open source virtual switch for all major hypervisor platforms [4]. Communication of VM's can take place through these switches.

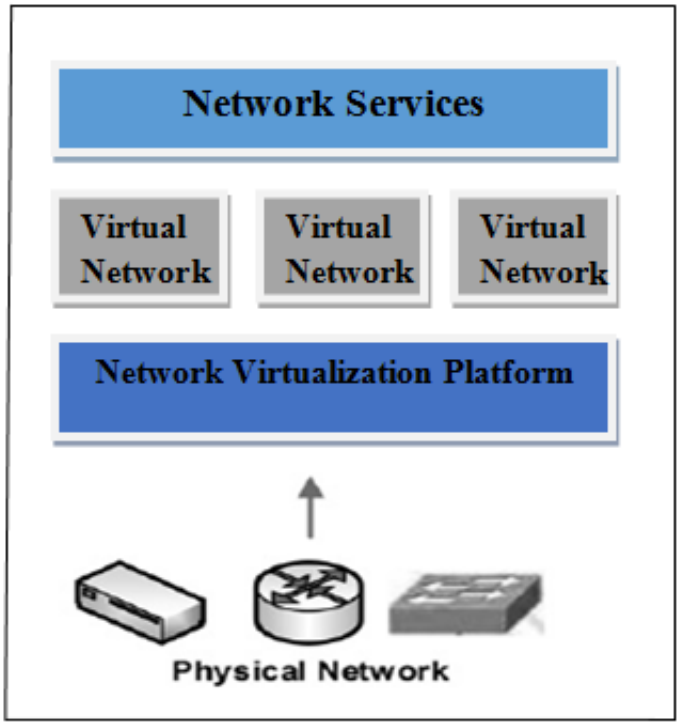

Fig 1: Network Virtualiztion

FlowVisor

FlowVisor is a model that slices the production network as described by Sherwood et al. in [5]. This is an approach to Switch Vitualization wherein the same hardware forwarding plane can be shared among several multiple logical networks, each with a unique forwarding logic. Using the Switch level Virtualization we are able to build a research platform which lets multiple network observation to run parallely with network traffic while still providing solitude and hardware forwarding. We can also notice that this approach goes along with commodity switching chipsets and does not need the use of programmable hardware such as FPGA's or network processing. Network Virtualization which is similar to computer Virtualization promises to improve resource allocation, allows network operators to change their network settings and also allows to share the same resources in a controlled and isolated fashion.

FlowVisor is placed between the underlying physical hardware and the software that controls it. FlowVisor uses the OpenFlow protocol to control the underlying physical network. OpenFlow is exposed to programming entity which can be seen by forwarding control of a switch's packet.

FlowVisor slices the network into five dimensions with the following features:

- FlowVisor describes a slice or a set of flows running on an architecture of switches
- FlowVisor is placed between each OpenFlow controller and switches, which ensures that a guest controller can make observations and control the switches assigned to it.
- FlowVisor divides the link by assigning a data rate to a set of flows which makes up a slice
- FlowVisor also partitions the flow table in each switch by keeping account of which entries in the table belong to guest controller
- FlowVisor is executed as OpenFlow proxy that intercepts messages between OpenFlow enabled switches and controller.

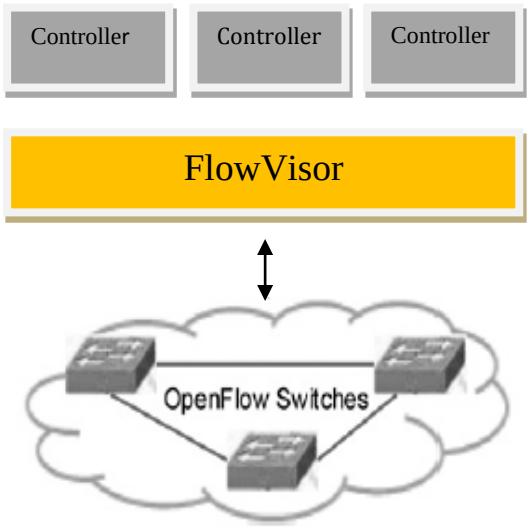

Fig 2: FlowVisor

Network Function Virtualization

NFV is an enterprise of main Telecommunication Service Providers and European Telcoms Standard Institute(ETSI) which came into existence in 2012 [3]. One of the main problems of network providers these

days is the need for new devices as and when new services are added. Often these devices are fixed hardware and cannot be used by other network providers. Taking into consideration the short life cycle of the devices, lack of space and complexity of the systems, the hardware would not represent enough revenues. NFV would be of help in solving this issue

through the virtualization of Network functions, these functions can run on storage or standard switches or high volume servers. To put in across in simple terms, it can be said that it's a new way to define, create and manage network devices by replacing dedicated network devices with software automation. NFV would also come to use in the following areas: to accelerate the deployment of new servers, Network functions reduce the consumption of energy, capacity of multi-tenancy and multi-version and finally the deployment and management of infrastructure and network services.

The advantages of NFV branches from the fact that it is implemented on general purpose servers in Virtual Machines or containers and is built with standard Open APIs. NFV counts on Open source Development and offers wide range of networking capabilities adaptively and dynamically. In a generic sense the aim of NFV is to provide agility, simplicity and flexibility.

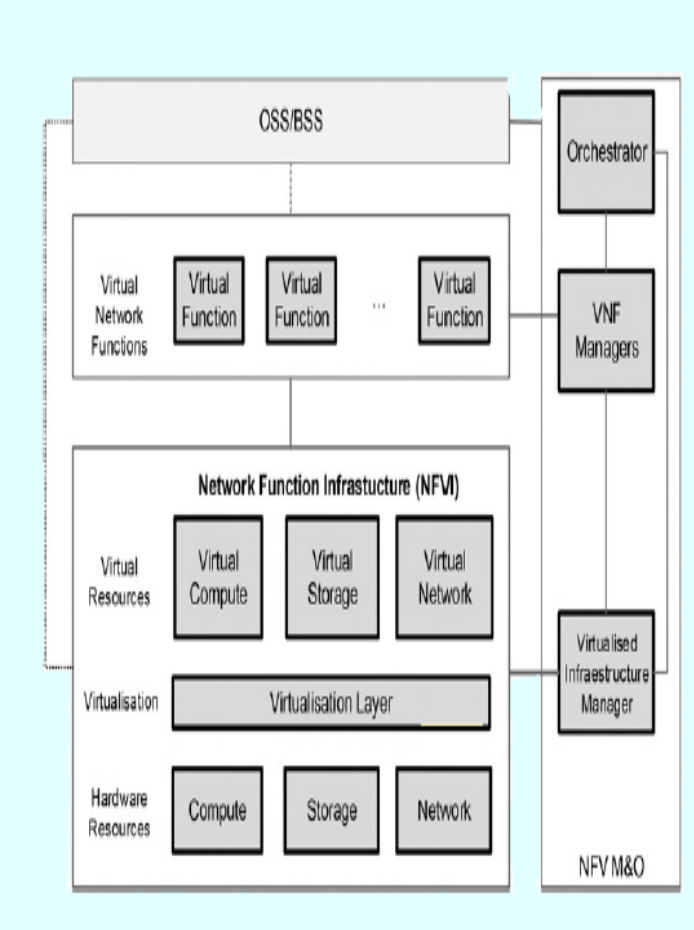

Fig 3: NFV Architecture [6]

Software Defined Networks(SDN)

Emerging mega trend setting technologies such as Big Data, IoT, Machine Learning and Cloud Computing impose new challenges to future internet for which global acceptability, high bandwidth and dynamic management are vital as presented in [7]. The problem with traditional networks is that the manual configurations for universal devices are inconvenient and error prone due to which they cannot completely utilize the capacity of physical network infrastructure. More recently Software Defined Networks(SDN) has been acclaimed as one of the most assuring solutions for future internet. In paper [8] we can see that an organization called Open Networking Foundation(ONF) has provided the most precise and received definition of SDN as "An emerging network architecture where network control is decoupled from forwarding plane and is directly programmable". SDN is identified by it's two distinguishing features, which includes the decoupling of the control plane from the data plane and providing an interface for programming the network applications. As a result of which SDN provides for better performance, efficient configuration and higher flexibility to hold ingenious network designs. Figure 4 gives the architecture of SDN as specified by the ONF.

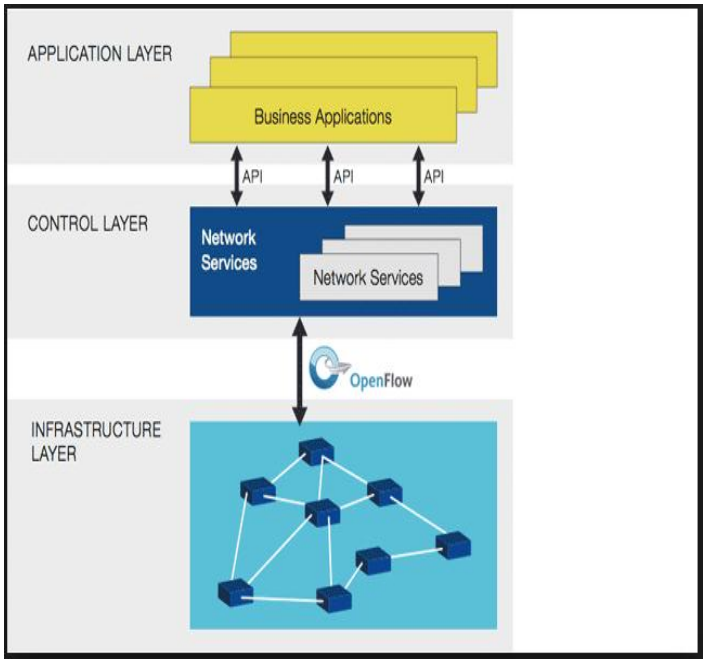

Fig 4: SDN Architecture

The architecture of SDN contains three layers as shown in the figure. The infrastructure layer consists of all the physical devices such as the switches and the routers which are a part of the data plane. The switching devices i.e the switches and the routers have two primary

functions: firstly they collect the current position or the status of the network and stores it temporarily in local devices and then passes it on to the controller. The current position includes information such as network topology, network usage and statistics. Secondly they are culpable to take action on the packets based on the regulations given by the controller.

The control layer acts as a platform between the application layer and the infrastructure layer. For interaction with the infrastructure layer it uses the South Bound Interface. It enumerates functions for the controllers so that it can connect to the functions provided by the switching devices. Functions may cover announcing of the current status of the network and transport the packet forwarding rules. Interactions between control layer and the application layer uses North Bound Interface. Here it adds service access points in different modes such as API. Application layer can access the current status of network that has been recorded from the infrastructure layer through these API.

The application layer contains all the SDN applications designed to provide services to the users, via the programmable podium given by switching devices at the infrastructure layer. Some of the examples of SDN applications are dynamic access control, Server load balancing, Network Virtualization, mobility and migration.

III. Advantages of SDN

- Centralizing network furnishing: SDN provides for a central view of the entire network. The key aspects of management and provisioning becomes a central operation with the aid of SDN.
- Practical Savings: Networks do not need manual administration, since SDN is responsible for providing better server utilization, better discipline of virtualizaion and other gains should result in operational savings.
- Flexibility: SDN provides resilience in how the network is made use of and how it is managed. Resellers can now write their own set of network services using standard development tools.
- Improved implementation time: By disposing of the manual intervention, we can reduce the errors in the configuration and deployment which would have a huge impact on the network.
- Hardware savings and condensed fundamental expenditures: Separating the control plane from the data plane separates the switching from the forwarding plane which therefore results in reduces hardware resources.
- Cloud Absorption: Cloud Computing is the latest trend setter technology which is going to stay for a long time. By absorbing cloud resources using SDN, it's easier to unify cloud resources. The networking components that make up massive data centre platforms can all be managed from the SDN controller. The networking components that make up massive data centre platforms can all be managed from the SDN controller.

IV. Relationship between SDN and NFV

Both SDN and NFV are not constituent basically. They have similar goals with extending technologies. SDN has emerged in association with two contrasting problems. Firstly, building and administering large IP/Ethernet networks was becoming increasingly convoluted. The overall opinion for traffic management and operational efficiency could be enhanced by exploiting the central control over the forwarding plane. Secondly, with the advent of Cloud Computing it enables a new model for application deployment where tenants need to share a public infrastructure. Whereas Network Function Virtualization is a carrier-driven initiative to virtualize NF's(Network Functions) and immigrate them from purpose built devices to generic devices. The main aim of NFV is to minimize the distribution cost of services by lowering the dependence on proprietary devices and upgrading the flexibility of services. SDN controller could be carried out as a virtual function, which would make it comply to both SDN and NFV. It may take some time until NFV plays a part in SDN architecture and vice versa, we could see the change by the network overlays in NFV will create an intersection of the technologies in a briefer term. The relationship between SDN and NFV can be depicted as in figure 5. NFV could also bring together the two models of SDN infrastructure i.e the centralized and distributed with the aid of network overlays. If it is possible for SDN to manage accumulated routes better than the respective individual flows it would then be more scalable.

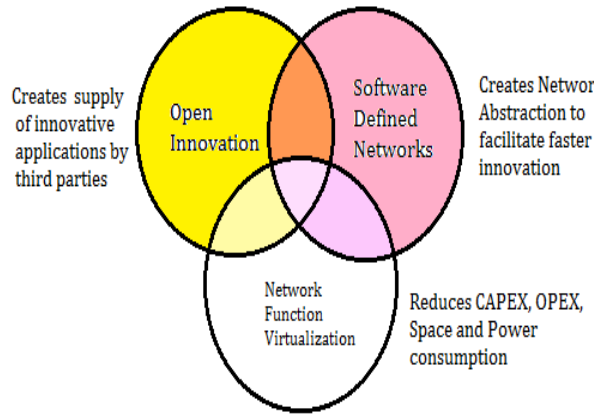

Fig 5: Relationship of NFV with SDN

V. Conclusion

It can be seen that SDN dominates the field of Networking in the current day scenario. The main challenge in the implementation is that the network must co-exist with the current devices, for this SDN must provide additional improvements. The functioning of data intensive applications such as Artificial Intelligence, Cloud Computing, Machine Learning, Big Data etc. Requires rapidly configurable and highly flexible networks to which SDN's provide a solution. We need to leverage the features of SDN i.e decoupling of control plane and data plane and programming capability of applications. There is a need for rapid evolution of networks in order that the sensitive applications function smoothly and data transfer is efficient. With the many advantages that SDN has in it's name and the astounding energy of the industry, SDN is on its way to become the latest approach to networking.

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