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Software Defined Networking:Architecture, Applications and Challenges

Vipin Kumar Rathi
Department of Computer Science
Ramanujan College, New Delhi
vipkrathi2013@gmail.com

Sheetal Singh
Department of Computer Science
Ramanujan College, New Delhi
sheetal.2109@yahoo.in

Ankur
Department of Computer Science
NIT Delhi, New Delhi
ankurbohora@gmail.com

Abstract— Software-defined networking is a new paradigm for building, designing and managing networks that separate the network's data and control planes to optimize better each [1]. Software-defined networking is a wide term that contains various kinds of network technology aimed at making the network as flexible and agile as the storage infrastructure and virtualized server of the modern data center. All SDN models have some version of an SDN Controller, as well as northbound and southbound APIs. Perhaps even more importantly, SDN shifts the focus of networking away from Layers 2 and 3, all the way to Layer 7, creating network functionality based on policy rather than quantitative management-console settings. The traditional (and usually expensive) strategy of simply over-provisioning the network and hoping for the best as traffic demands grow no longer works. SDN helps to detach control plane from data plane which helps the administrator to manage the network centrally and can utilize bandwidth at it maximum, which resulting in great flexibility [2]. The conventional network architecture where data plane and control plane remains in the same device which cannot fulfill these high demands and solution to this problem is Software Defined Network (SDN). The network can be dynamically managed for example whenever there is a change in topology due to loops or any other causes then the network can be managed dynamically. In the context of SDN, administration activities such as configuration, visualization and monitoring is different from traditional network, thus require proper attention.

Keywords- OpenFlow, OpenStack, SDN, Data Center.

I. INTRODUCTION

One of the biggest problems in today's networking is its complexity [3]. Software Defined Networking was introduced in 2008 by separation of control plane and data plane where control plane controls several devices [4]. SDN provide a programmable network protocol that can virtualize whole network infrastructure. Everyday load on networks is increasing, become more complex and should be available to fulfill the high demand. Today network design is not sufficient to fulfill this kind of demand, due to this networks becoming more complex, making the administration of these networks more difficult.

In this sense, SDN reduces some traditional network management problems such as providing support for enhanced network diagnosis and troubleshooting [5]. Therefore we need next generation of networking that can manage such high demand and utilize the bandwidth at it maximum. Due to new trends in computing like a cloud, Big Data, and Internet of Things, a new design is required for networking that is fulfilled by SDN.

The state-of-the-art in SDN has addressed monitoring using the OpenFlow network. SDN promises improve in network efficiency, lowering operating costs, better flow management, making network management easier. Adaptability is a big challenge for SDN as it is a new Paradigm in networking, and this is a transition phase that requires whole new layers of network architecture as shown in the figure.

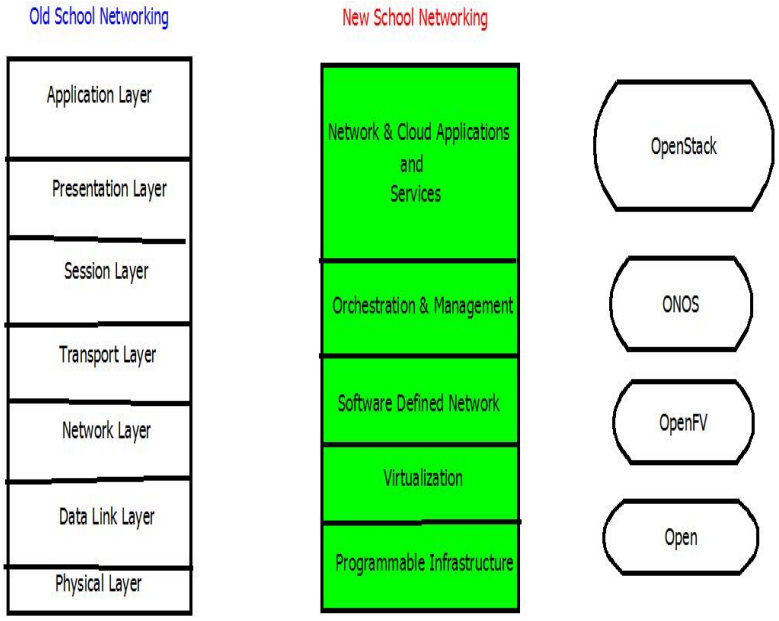

Figure 1: Future of Networking

According to Infonetics Research, Data Center and Enterprise SDN Hardware and Software, Annual Market Size and Forecasts, August 2014 Report SDN Controllers and SDN-capable Ethernet Switches market will grow from $960 million in 2014 to over $ 18 billion by 2018, representing a robust CAGR of 89.4%. Many organizations (Google, Facebook, Cisco, Vmware, NEC, etc.) clubs together and make a foundation named as Open Networking Foundation (ONF) for promotion and adoption of SDN through open standard development.

II. SDN ARCHITECTURE

Software Defined Network has mainly three components that are (i) SDN application, (ii) SDN controller and (iii) Networks Element as shown in the figure [2]. First Component is SDN applications which contain Cloud networking for e.g. Neutron in OpenStack all Tenants Network can be managed in a Centralized Way. These SDN applications contact to Network Controller by North-Bound API (REST/JSON). Network Controller get complete Topology information with the help of Topology module and Link Layer Discovery Protocol it also contains some others module like Path Calculation, Flow Programming, Statistics, etc. Now Network Controller sends a packet to Network Element through South-Bound API, Which contain South–Bound plugins like OpenFlow (OpenFlow is a data flow management protocol for network devices), Ovsdb, NetConF.

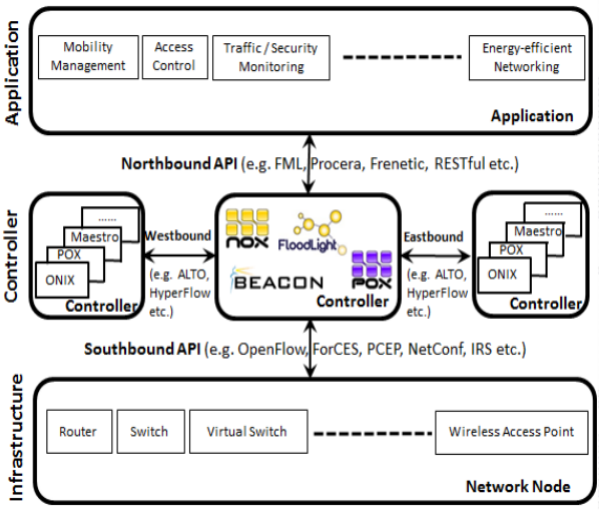

Figure 2: SDN Architecture [6]

III. APPLICATIONS OF SDN

Data Center: Load Balancing, Traffic guiding, Network Virtualization (multi-tenancy traffic isolation, overlays), Service Chaining (with Virtual Network Functions), Automated Network Provisioning, Software-defined Data Center. SDN make network Virtualized and divide different tenants even though these tenants is on the same Compute Node with the help of virtual switches like OVS(Open Virtual Switches) Ovsdb is management protocol for managing OpenvSwitch.

WAN: Traffic Engineering, Network Management, Load Balancing, Bandwidth Provisioning, Service Provisioning, Control and Multi-layer Network Visibility, SLA monitoring. Google uses B4 Network to connect all Google Data centers across different Continents across the globe. At the lowest layer OpenFlow Switches is used, all these switches are connected to SDN Gateway and above that Traffic Engineering Server is used as shown in the figure. Some people use the term SWAN (Software-driven WAN) which provide high utilization and flexible sharing. As shown in fig [3].

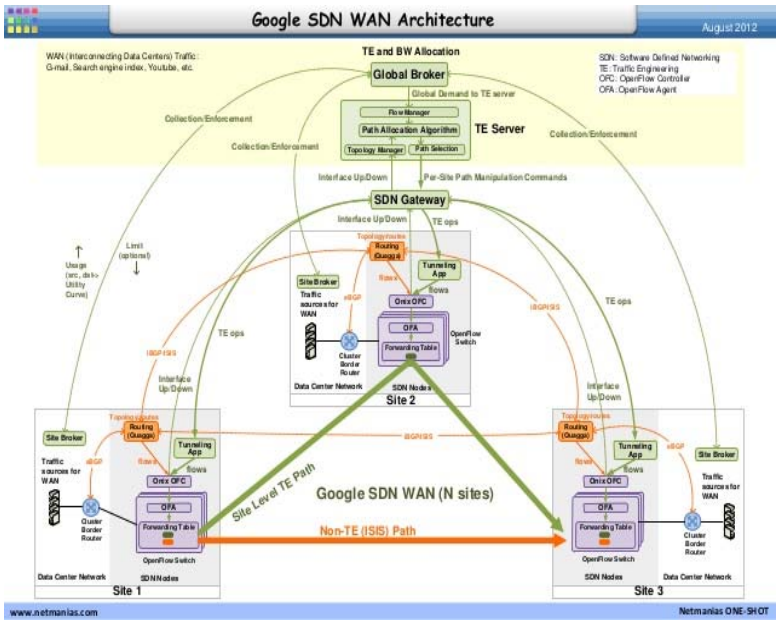

Figure 3: Google WAN Architecture[7]

Campus: Today's campus networks are confronting significant difficulties BYOD (Bring Your Own Device), video, Mobile clients and applications are rapidly changing the network structure. One of the

primary purposes behind these difficulties is that system innovation development is essentially not keeping pace with advancing requests. Software Defined Networking (SDN) can reduce these challenges, offering flexibility and the ability of current solutions to deliver performance, agility quickly and cost-effectively.

Edge: Intrusion detection and prevention, Quality of Service Management, Network Management, Traffic steering, Load balancing, Service chaining (with Virtual Network Functions), Firewall, Service Provisioning and DPI and Big Data applications.

IV. CHALLENGES IN SDN

SDN has many challenges such as Network Debugging, Controller Scalability, Net-work Management, Network Monitoring, quality of service, Load balancing, security, Multicasting, Cloud network management, Adaptability etc. some of the challenges are discussed below:

- Adaptability: SDN is a new Paradigm in networking, and this is a transition phase that requires whole new layers of network architecture.

- Addressing dynamic real-time change: Those Data Centers which are already established has to redesign their architecture, switches should be Open Flow-enabled and in legacy data centers control Plane is distributed whereas in SDN-enabled Data Centers Control Plane is Centralized Management.

- Accommodating rapid on-demand growth: Data is increasing at an exponential rate and handling such big data require whole new infrastructure.

- Single Point of failure: The controller can become a bottleneck and a single point of failure.

- Security of Controller: Controller is the Centralized decision point, so access to Controller needs to be tightly controlled.

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