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New Networking Era: Software Defined Networking

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Abstract: *The fundamental problem with traditional network architecture is that it is static. Users don't have much controlling power and it is just trying to accommodate current networking needs of the user. Therefore which means window for innovation is too narrow with respect to network controlling, virtualization, automation, scalability, programmability and fault tolerance. A revolutionize network technology which can put all the above aspects into practice in future networks is Software Defined Networking. In the study we review a brief history of Software Defined Networking that can help to provide evidential clarity with respect to the understanding of the new technology and more significantly, in understanding the motive that why we need Software Defined Networking.*

Keywords: *Software Defined Networking, SDN, SDN models, Control Plane, Data Plane, OpenFlow.*

I. Introduction

Networking a field of vast interests and studies. Yet not mature enough due to no hardcore principles like other computer science domains. Today networks and internet are far more developed than ever before but we can clearly see all new dimensions for future networking and internet, yet not functional enough on large scale. Current or in-practice network architectures don't match to the actual demands of today's network users and businesses. Closeness to "abstraction" principle is becoming popular idea behind why users need a new network architecture which revolutionize this field and concentrate on abstraction rather complexity. For instance, today networks are huge and they support many services from simple text messages to various multi-media services in parallel to several network users opting for same service at a time. This creates traffic within a traffic and add more complexity to network architecture hence things look messy in the end and hard to handle at some point of time. The present network architecture is consisting of various hardware like firewalls, routers and switches and we can see all of them together as large complex system and thus a minute change at any level can cause network failure. This gives researchers a motive to move to such an architecture which has centralize control, dynamic, easy to manage, and highly scalable. The answer to the above is Software Defined-Networking which has all essences to revolutionize and to take networking to completely different environment.

A. Contributions

The following are the contributions of this literature survey:

- The study answers why there is a need to move to a different networking architecture from the traditional one.
- The study tried to establish the facts why SDN is far better than the current network architecture. This is achieved by studying what exactly SDN offers us.

II. Traditional Networks

Data flow is controlled by routers and switches in traditional networks. Current network architecture is static if compared to SDN. Users don't have any control over packets. Generally this job is done by switches whereas in SDN, user can shape his own traffic because of the centralize control mechanism. In the study [16], [17] comparison of traditional networks and SDN are done. Furthermore in this new design user can change and introduce his own traffic policies over the network which is lacking in traditional approach. This is accomplished with help of SDN provided software interface. This is cost effective too as now we are not much dependent on costly switches and their vendors [4], [6]. Traditional networks are being over used to their limit. The design principles behind them is not matching today's astronomical data growth, bandwidth, speed, security and scalability issues. In general networking devices consist of control plane. The control plane is an important part of a router. The duty of it is to concentrate on how that one individual box communicates with neighbors and what the state exchange. Data plane whose task is to consult the forwarding table. The network device uses forwarding table to decide where they have to send the packets. Both resides on networking hardware devices [5]. User can't put his innovation in practice with traditional networks due to the design limitations of it but this is possible by software Defined networking. A traditional network architecture consists of a data plane which carries data physically in form of packets from one node to the other by following certain protocols, control plane which consist of logic that devices are using therefore to forward packets over the network then comes Management plane which behave as an administrator [14]. The basic fundamental protocols behind the design of internet is still a success. If we see carefully the initial architecture of the network is same as before. But the new application points out new requirements which the network is not able to satisfy in an efficient manner, it is just accommodating it currently. Therefore reviewing the network architecture is a need of hour [9].

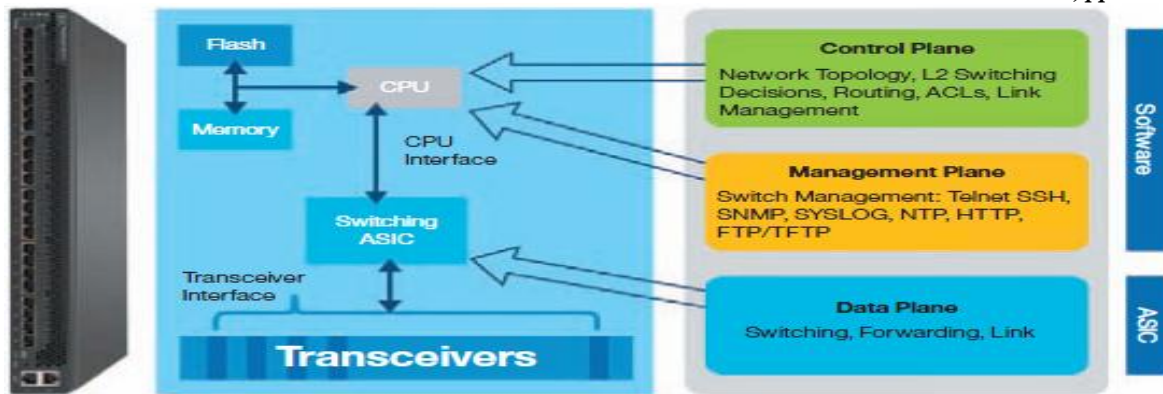


Figure 1. Traditional Switch Architecture. Source: IBM Systems and Technology Thought Leadership white paper

III. Software Defined Networking

What SDN is all about? The basic idea of SDN is the separation of control plane and packet forwarding plane [1], [2]. In SDN control plane is programmable hence giving rise to innovation [13]. Software Defined Networking (SDN) assure to strikingly minimize the current complex networking environment and its management. Innovation feature is making the networking environment more attractive to work on. User can differentiate between the service providers because of various dimensions which are not there in traditional networks. This will help drastically to maximize the network ability to deliver to the best and more efficiently. SDN is seen as area of attraction for researchers and hardware manufacturers in recent times. For example Ericsson, Net-gear, Nokia Siemens Networks and Verizon are in the list of current members of Open Networking Foundation (ONF). Along with what discussed above, various opportunities which should be trapped with help of implementing the SDN to wireless infrastructure-less networks are stated in the study [3]. SDN is based on abstraction. Separation between control plane and forwarding plane is done. An interactive application environment is provided with control plane. Network topology information plays critical role with the help of which decision can be changed, modified and designed in completely new manner with help of SDN application interface [7]. Control plane can also be termed as the operating system of the network. Refer Figure.2 for more detailed SDN design concept.

What are the architectural Models available for SDN? A very critical task is to select a SDN model or models SDN can support. Basically there are three types of models which are network virtualization model, evolutionary model and the OpenFlow model of SDN. The most important goal of network virtualization is to get rid of restrictions on LAN partitioning that resides in Ethernet Virtual LAN standards and solve the issues like scalability & multicasting in the network architectures. One highly popular advantage of network virtualization is that it is affirmative towards multi-tenant clouds without making any change in the network but the most significant negative of virtualization is that it adds complexity and extra overheads. Evolutionary model objective is to maximize software control within the boundaries of network topologies. Integration of standards in the devices by vendors is a major problem in this model. Some do it some won't there compatibility issue arises. Last one is OpenFlow is the model, on which the basic idea on SDN is built [8]. The paper [20] concentrated on three problems in networks. Firstly, there must be a mechanism for frequent changes to a network. These change will be both in conditions and network state. Secondly, there must be a high level language for network configuration support. Lastly, there must be better visibility and control on network troubleshooting tasks as well as on its diagnosis. For the solution a wide range of high level language network policies and correct scan of network problem. Later study explained how SDN can help is efficient network management.

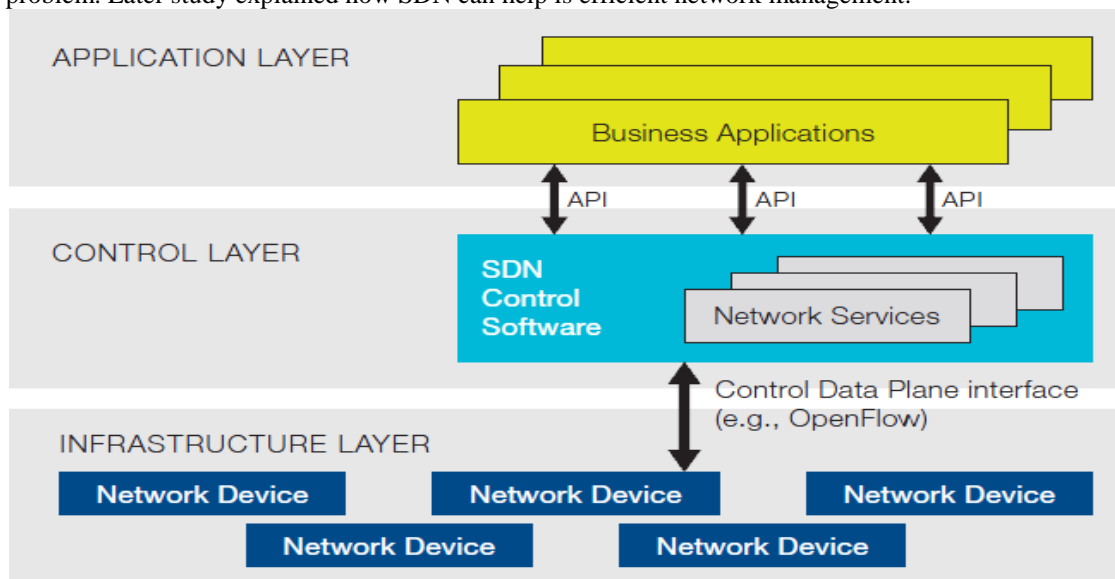


Figure 2. SDN Layered Architecture. Source: ONF White Paper

One of the major output in giving future Internet design is Software Defined Networking (SDN) [1], [10]. With the help of SDN user can design and defined network protocols that can be tested on production systems. OpenFlow, with the objective of implementing innovation in computer science networking field is the major advances [11]. What OpenFlow does is to make differentiation by creating separation among the control plane and data plane. SDN represents a great opportunity to the scientist and engineers to rethink networks with the view point of separating the software that controls the network from the individual network entities. OpenFlow concentrated on Ethernet technologies but its functional ability with wireless and optical networks is still in question yet works are going on in this area because it will open a wide environment for SDN [9]. In study [12] authors stated that one of the motive of SDN based architecture is to give programming capability whereas in ICN gaining popularity among the computer science experts who wants to change present IP based layer with a complete new idea. With emergence of Information Centric Networking (ICN) and SDN as one of topics of research communities also attracting corporate businesses and investments to gain from it. It's too important how ICN and SDN will combined in parallel, implemented and tested.

IV. Cutting Edge Feature of Software Defined Networking

Software Defined Networking (SDN) provides very interesting features which will revolutionize the future networks like centralize control mechanism [33], cost efficiency, innovation, programmability, scalability [21],[26], security, virtualization, cloud support, automation, reliability [26] and efficient environment to support Big-Data. In paper [15] what SDN offers us is stated. It gives us a centralized control mechanism of various networking hardware devices from multiple vendors, further network automation is greatly improved with the help of APIs which are used to abstract network details. One of the main objective of SDN is to provide innovation over the internet or the network, this ensure very less vendor dependence. Programmability by operators is feature of Software Defined Networking which helps to put innovation into practice. Security and reliability are the major issues in today's networks, SDN enhance these two aspects to the maximum. Simple operation and cost efficiency are key factors with openness to design and invent in SDN. Yet this openness with respect to APIs not yet fully explored but in study [13] this aspect has been studied. SDN makes it easy to share resources in an efficient manner with the feature of network intelligence. Further paper stated SDN is helpful in service aware networking too. With SDN, Network Management has improved vastly which also give it cutting edge on traditional networking architecture [27] and important determinant in future works.

Networks based on Software Defined Networking are being implemented both on testbed and production networks. Fault tolerance property is a key for the production networks and a most desirable & a must for SDN networks. It is noted that with respect to fault tolerance in SDN there are not much researches. In the paper [18] CORONET, a SDN fault-tolerant system is discussed. A fault tolerance SDN architecture is stated which quickly recover from the occurred faults and can work on highly scalable networks. The architecture describes the recovery from multiple links failures. SDN based networks are more and more been deployed both on testbed and production networking environments. For example, Google exhibit its deployment of OpenFlow and the most famous SDN protocol, On April 2012 at the OpenFlow Networking summit [19].

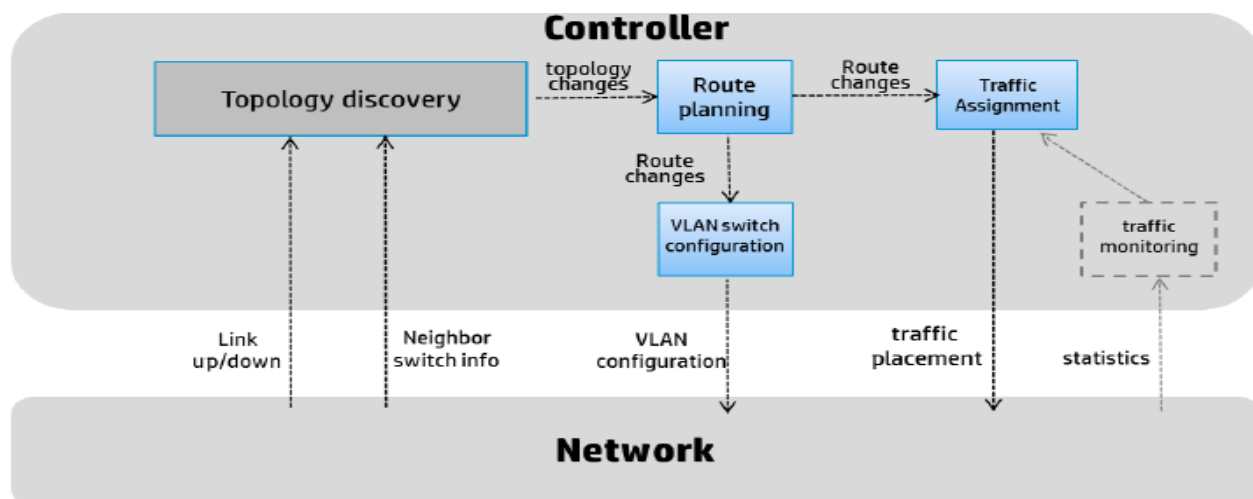


Figure 3. CORONET Architecture. Source:[18]

V. SDN Concept to Enhance Big-Data management and Optical Networks

Databases are now real-time and distributed with parallelism, they support thousands of queries at a time. The data volume in various engineering and science disciplines is assumed to be increase by a factor of 10 or even more in coming years [22], [23]. Companies are moving from SQL databases to No-SQL databases. We have seen amazing data production over internet and by many other science projects like Large Hadron Collider. All this has given birth to Big-data concept which means processing of large variety of data in huge volume with high velocity. Current networks are lacking in providing efficient support for this purpose but SDN is seen as an answer to this problem. With the architectural idea of Software-Defined networking a Research Sandbox demonstrator has been implemented in paper [24] where virtual switch network abstraction is studied with combination to SDN. This is taken as an example of adaptable

networks according to demand and requirements. Internet is becoming important part of our everyday life. There is a necessity of providing disaster resilient wide area networks which is reliable [26]. SDN or OpenFlow is maturing technologies in this respect which tends to solve several problems of operation management in WANs. The study [25] represent a disaster resilient WAN system. SDN based networks are also getting popular among wireless and optical networks and hence shown bright prospects for future work in this area. Enabling high bandwidth, flexibility, efficient resource utilization, error control, data security and efficient traffic management requirements of wireless and optical networks are achieved with SDN based wireless and optical networks. Complex issues like traffic grooming can be efficiently handle with SDN. Further it will be a cost efficient and highly reliable solution for these networks [28], [29], [30], [31] and [32].

VI. Conclusion

The traditional networking architecture can't accommodate the advance user requirements efficiently. Increase of mobile devices, virtualization, high automation & security, efficient Big-Data management and high quality with variety of services, SDN is a promising architecture. For sure current network is not dynamic if compared to SDN. Though yet SDN, needs some time to mature and industry also need time to synchronize the devices according to it. SDN can also manage optical and wireless networks fruitfully. To understand why SDN will play a critical role in future in shaping various technologies, we have to think what actually SDN providing us apart from all technical advances? SDN gives user or operator a feel of nearness to the network. He won't feel that he is a distinct entity when operating on SDN based networks. Hence it is true to say that future networks will revolve around SDN based networking.

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