OPTIMIZATION OF NETWORK TRAFFIC IN SOFTWARE-DEFINED DATA CENTER NETWORKS

[1]Swati Dewangan, [2]Anup Kumar Sharma
[1]M.Tech. Scholar, Computer Networks, Bhilai Institute of Technology, Durg, India
[2]M.Tech. Scholar, Computer Networks, Bhilai Institute of Technology, Durg, India

ABSTRACT: The Internet has led to the creation of a digital society, where almost everything is connected and is accessible from anywhere. Despite its widespread adoption, traditional IP networks are complex and very hard to manage. It is both difficult to configure the network according to predefined policies, and to reconfigure it to respond to faults, loads and changes. The traditional network architecture is static and the window for innovation is too narrow with respect to network controlling, virtualization, automation, scalability, programmability and fault tolerance. A revolutionized network technology which can put all the above aspects into practice in current networking is Software Defined Networking (SDN). Existing Data Centers interact with the network in complex ways, compelling administrators to run multiple traffic handling operations to manage the network system. This paper reviews the benefits of SDN in Data Center Networks and exposes related challenges in traffic engineering that can help to provide evidential clarity with respect to the understanding of the new technology that offers a simple and expressive programming framework for the network and service administrators.

Keywords: Data Center, Network Virtualization, Open Flow Protocol, Software Defined Networking, Software Defined Data Centers.

1. INTRODUCTION

Today networks are huge and they support many services in parallel to serve several network users opting for same service at a time. These create traffic within traffic and add more complexity to network architecture. The present network architecture consists of various hardware like firewalls, routers and switches which is a large complex system and thus a minute change at any level can cause network failure. Virtualization, cloud computing, Big Data, and mobility offers significant business benefits, but these initiatives are pushing data centers to their limits. This gives a motive to move to such an architecture which has centralized control and is dynamic, easy to manage, and highly scalable. The answer to the above is SDN which has all essence to take networking into a complete different environment. To overcome the issues of rising demand for more storage space, computing power, resource pooling, simplification in networking and overall management of data centers; innovators have come up with the concept of Software Defined Data Centers (SDDC). This concept helps traditional data center users to scale up their existing infrastructure seamlessly, thereby resulting in reduced overheads for enterprises and service providers in managing their existing data centers and networks.

2. DOMAIN KNOWLEDGE

The traditional network architecture consists of a data plane which carries data physically in the form of packets from one node to another by following certain protocols. The control plane consists of logic that devices use to forward packets over the network then comes Management plane which behaves as an administrator who doesn't have any control over packets rather the data flow is controlled by routers and switches. SDN promises to change this state of affairs, by separating the network's control logic from the underlying routers and switches, by logical centralization of network control, and introducing the ability to program the network. By breaking the network control problem into tractable pieces user can change and introduce his own traffic policies over the network traffic because of the centralized control mechanism which is lacking in traditional approach [1].

3. THE ASSESSMENT ENVIRONMENT

All elements of the infrastructure – logical computing, networking, storage and security are virtualized and delivered as a service in SDDC. Deployment, provisioning and operation of the entire infrastructure is abstracted from hardware and implemented through software and are dynamically configured based on workload requirements. The SDDC comprises of three operational parts: Computing, Storage and Networking. First, Network Virtualization by combining the available resources and splitting the available bandwidth into channels which can be assigned (or reassigned) to a particular server in real time. Second, Storage Virtualization by maintaining pool of physical storage from different network storage devices into single storage device and managing from a central console and last Server Virtualization by masking the resources of server from users such as the number and identity of individual physical servers, processors, and operating systems. [2].

4. TRAFFIC ON DATA CENTERS

Today's applications access different databases and servers, creating a huge machine-to-machine traffic before returning data to the end user. With explosion of mobile devices, server virtualization, and increase of cloud services, traffic engineering on a traditional routing infrastructure becomes more expensive and complex. Many enterprise data center's managers are ruminating towards a computing model, which might include a private cloud, public cloud, or both, resulting in additional traffic across the wide area network. Network loads that once ran on static, dedicated servers are today hosted by dynamic, virtualized server environments that can be scaled and shaped to meet increasing demand. But the transformation is incomplete to transport traffic between servers in the data center.

5. OPTIMIZING TRAFFIC

The control plane and management plane serve the data plane, which bears the traffic that the network exists to carry. Moving the control plane to software allows dynamic access by which a network administrator can shape traffic from a centralized control console and can change any network switch's rules when necessary by prioritizing, de-prioritizing or even blocking various types of packets with a very granular level of control [3].

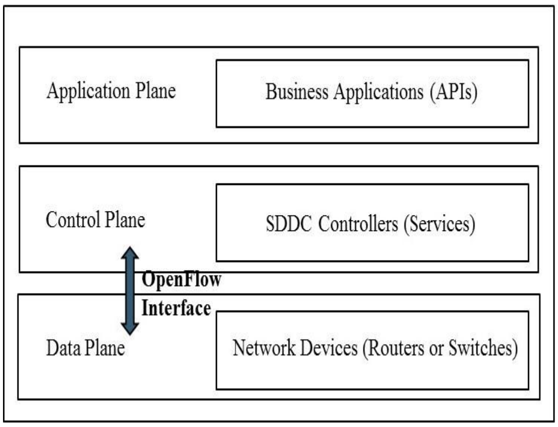

Figure-1: SDDC Network

5.1 SOFTWARE CONTROL PLANE

The control plane carries signaling traffic and is responsible for routing packets originated from or are destined to a router. It establishes the local data set used to create the forwarding table entries, which are used by the data plane to forward traffic. The data set used to store the network topology is the routing information base (RIB) which is often kept consistent i.e. loop-free by the exchange of information between other instances of control planes within the network. Forwarding table entries are commonly called as forwarding information base (FIB) and are often placed between the control and the data planes of a device. The FIB is programmed once the RIB is kept consistent and stable. To perform this task, the control program has to develop a view of the network topology that satisfies certain constraints.

5.2 NETWORK DATA PLANE

The data plane carries the user traffic. It handles incoming packets (on the wire, fiber, or in wireless media) through a series of link-level operations that collect the packets and perform basic security check. A well-formed packet is processed in the data plane by performing lookup in FIB table that are programmed earlier by the control plane. The FIB in the IP model has undergone many optimizations of both structure and traversal (lookup) algorithm.

5.2.1. Time Convergence

It is the time when a network element introduces a change in reachability of a destination due to a network event to when this change is seen and instantiated by all other relevant network elements. One of the components of convergence is the propagation delay of a specific update. This is normally a function of the average distance from the site of first change measured in the number of intervening nodes that have to re-advertise the update. To optimize convergence processing at the protocol level, as well as the propagation (flooding) mechanism, each protocol has a different internal timer that is used to generate various types of events for that protocol.

5.2.2. Network Evaluation

Although there are non-equal cost paths different purposes, Load balancing is normally applied to equal cost paths. The efficiency of a load balancing algorithm depends upon both the computation of algorithm and the potential imbalances in flow size. The primary advantage of a centralized control plane is the view of the network it can provide to an application and the simplification of programming control [4]. To achieve an end-to-end change in a large network to balance load, the application no longer has to know of or directly touch the individual elements, but interacts with a few control points that take care of these details.

6. OPENFLOW PROTOCOL

An Open, defined industry standard communication protocol which provides access to the forwarding plane of a network switch or router, facilitates more advanced traffic management. Applications use APIs on the OpenFlow controller to implement network policy. It enables network platforms of various types to communicate with a common distributed control plane called a controller, which runs on external servers. The controller uses the OpenFlow protocol to communicate over the network with network agents such as switches and routers. In an OpenFlow flow entry table, the entire packets are available for matching and modifying actions. Entries in the table can be prioritized (in case of overlapping entries) and has a expiry time (setting a drop results for flows in controller loss scenarios). OpenFlow is designed to support policy-based flow management within Data Centers by pushing predefined policies to implement network segmentation [4].

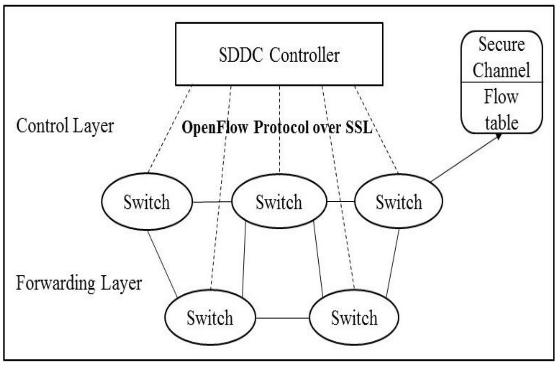

Figure-2: Network Overview

7. SDDC CONTROLLER

The SDDC controller cluster provides a logically centralized control plane for all of the network devices within its domain. It is automation software that controls physical and virtual switches directly via the industry-standard OpenFlow protocol. Policies defined by the network manager are distributed across a large number of devices. Introducing programmability controllers allow users to make use of libraries of predefined policies [7]. An SDDC controller abstracts the details of storage control path from the underlying hardware so that access and management of storage infrastructures can be centrally executed in software.

8. RESULTS AND DISCUSSIONS

Rapid innovation through the network services SDDC enables virtualization of the enterprise Data Center networks by making network components programmable for newer traffic engineering models, distributed access control and scalability. . Pooling of network resources can be automatically applied to relieve bottlenecks and enable application reactivity. In an SDDC, all network hardware in the data center is responsive to a central authority, which automates network provisioning based on predefined rules and procedures. The intelligent abstraction of hardware enables provisioning of resources through policy-based automation, while ensuring that performance, security and changing requirements. Automation tools reduce operational overhead, thus decreases network instability introduced by operator’s error, and support emerging IT-as-a-Service. Self-service provisioning model enables dynamic management of workloads in the Data Center Networks.

9. CONCLUSION

To support network workloads, and to reduce the complexity of the network in the Data Centers and allow automation and service-orientation of network configurations, programmable networks are employed to manage the high degree of change necessary on the network. Through the use of programmatic control of virtualized topologies and software computing SDDC enables organizations to simplify the transition from multiple data centers to a single multitenant architecture. SDDC eliminates the need to manipulate servers, networks and storage hardware in response to a specified request. Rather, provisioning takes place automatically within the framework of defined rules, policies and service level agreements, passed via application programming interface (API). The future of networking will rely more and more on software, which will accelerate the steady step of innovation for networks as it has in the computing and storage domains.

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