The Real Value of an SD-WAN

Executive Summary

Until recently there has been very little fundamental innovation in terms of how WANs are designed and implemented. Driven by the development of Software-Defined Networking (SDN), that is changing. In the last 18 months, a number of providers started to offer products and services that are often referred to as a Software-Defined WAN (SD-WAN). As described in this white paper, there are tremendous advantages that result from applying SDN concepts in the WAN. To date, however, the discussion of a SD-WAN has focused primarily on one use case. That use case is a hybrid WAN that features dynamic load balancing of traffic over the MPLS and Internet links that connect branch offices to data centers. While that is a very important application of SDN concepts, as discussed in this paper, applying SDN concepts in the WAN can provide far more value than what is possible with just that one use case.

Introduction

In the traditional approach to networking, network functionality is implemented in a dedicated appliance; i.e., switch, router, WAN Optimization Controller. In addition, within the dedicated appliance, most of the functionality is implemented in dedicated hardware such as an ASIC (Application Specific Integrated Circuit). One of the key characteristics of the traditional approach to networking is that, because of its hardware-centric focus, network functionality evolves very slowly. In addition, since each appliance is configured individually, tasks such as provisioning, change management and de-provisioning are very time consuming and error prone.

Networking organizations are constantly under increasing pressure to be more agile and more efficient than is possible with the traditional approach to networking. It's this pressure that drove the development of SDN. The Open Networking Foundation (ONF), which as of April 2016 had over 140 members, is the organization that is most closely associated with the development and standardization of SDN. According to the ONF[1], "Software-Defined Networking (SDN) is an emerging architecture that is dynamic, manageable, cost-effective, and adaptable—making it ideal for the high-bandwidth, dynamic nature of today's applications. This architecture decouples the network control and forwarding functions enabling the network control to become directly programmable and the underlying infrastructure to be abstracted for applications and network services."

SDN fundamentally changes how networks evolve, as well as how they are built and managed in a way that leads to networks being dramatically more agile and more efficient. It changes how they evolve, in part because new functionality will now be developed on a relatively quick software development time frame versus a relatively long hardware development time frame. It also changes how they evolve because now it is possible to programmatically control the network from a central location. SDN changes how networks are built because, as shown in Figure 1, the abstraction that is inherent in SDN enables network services such as end-to-end virtual networks to be abstracted from the underlying infrastructure in a manner similar to how

[1] https://www.opennetworking.org/sdn-resources/sdn-definition

server virtualization enables compute resources to be abstracted from the details of the underlying x86 based servers.[2] One of the ways SDN changes how networks are managed is by enabling tasks such as provisioning, change management, and de-provisioning to be centralized and automated.

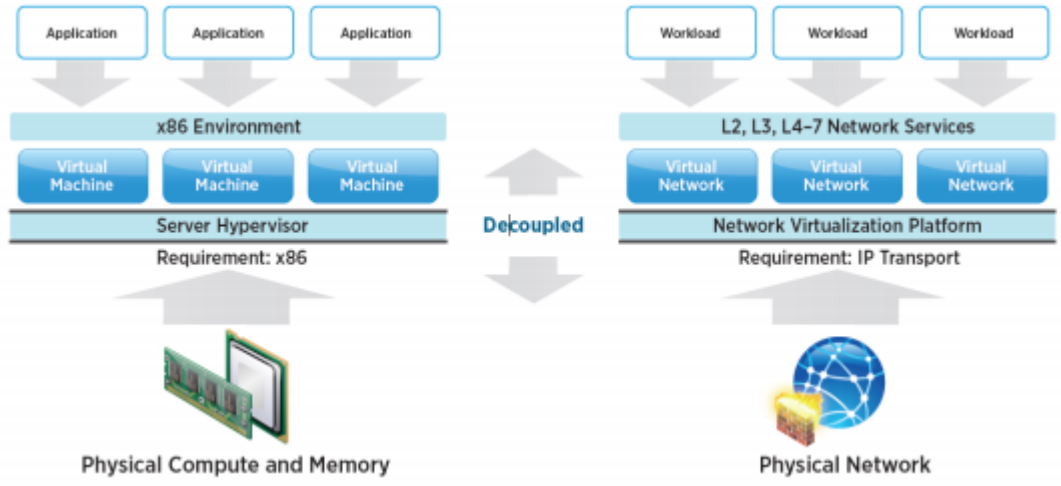

Figure 1: Virtualized Compute and Virtualized Networks

The initial discussion of SDN focused entirely on applying this new architecture to data center networks. However, over the last couple of years there has been growing interest in applying SDN in the WAN as well as in branch and campus networks. That interest was highlighted in *The 2016 Guide to SDN and NFV*[3]*,* which contained the results of a survey in which respondents were asked, "If your organization is likely to implement SDN sometime over the next two years, where are you likely to implement it?" Their responses are shown in Table 1.

Table 1: Focus of SDN Deployment

Focus of SDN Deployment	Percentage
Data Center	51%
WAN	31%
Branch and/or Campus	22%
We are likely to implement a service from a WAN service provider that is based on SDN	20%
Don't know/NA	10%
We are unlikely to implement SDN within the next two years	10%
Other	4%

[2] https://www.vmware.com/files/pdf/products/nsx/vmw-nsx-network-virtualization-design-guide.pdf
[3] http://www.webtorials.com/content/2016/03/the-2016-guide-to-sdn-nfv---complete-guide.html

One observation that can be made from the data in Table 1 is that there is currently as much interest in either implementing SDN in the WAN or using a SDN-based WAN service as there is in implementing SDN in the data center.

SD-WAN Use Cases

As noted, the discussion to date of an SD-WAN has focused primarily on WAN solutions that feature the dynamic load balancing of traffic over a hybrid WAN that connects the branch offices and data centers of large, very sophisticated organizations. While that is an important application of SDN in the WAN, it is only one use case. Described below are three use cases that demonstrate how applying SDN concepts more broadly in the WAN can help all organizations respond to business and societal demands while also responding to changes in the environment, such as those that are brought on by mobility and the Internet of Things (IoT).

One example of a business demand and what SDN can do to help comes from banking. One of the primary ways that people do banking these days is via an ATM. However, performing the troubleshooting, fixing the equipment and installing the upgrades to the network that is required to connect a large number of ATMs is both very expensive and time consuming. To exemplify how a WAN solution based on SDN architectural principles can help, consider a hypothetical organization that has a network of hundreds of ATMs spread over several states. Assume that the organization deploys a WAN solution that features zero-touch deployments; software-defined radio; automation; and simplified, cloud-based management. This solution would allow the organization to replace its legacy wireless networks with modern 4G connections. Some of the benefits of this SD-WAN solution are that it would dramatically reduce the amount of time it takes to do a firmware upgrade and the associated travel costs, and it would significantly reduce the amount of time the organization spends managing and troubleshooting.

An example of a societal demand and what SDN can do to help comes from the world of K-12 education. Consider the situation of a poor K-12 school district in a semi-rural or rural area. Because the school district is in a poor area, the students face a number of challenges that students in more affluent areas do not face. One of these challenges is gaining access to the Internet and all of the tools that are available for connected learning. Providing this access is a key step in offering the students the opportunity to be successful in a world that places a premium on education.

In order to exemplify how a WAN solution based on SDN architectural principles can help, consider a hypothetical school district that has over 100 school buses. Assume that the school district deploys a WAN solution that is partially composed of a piece of hardened, compact equipment that is placed into each school bus. The equipment can provide WiFi access to the students on the bus, and it can connect to the Internet using LTE solutions. When not in use transporting students, the school district can park the buses in the most rural or disadvantaged areas to provide Internet access to students' homes. Further assume that, similar to the preceding example, the solution features zero-touch deployments; software-defined radio; automation; and simplified, cloud-based management. Because the solution has those characteristics, the school district would be able to deploy and manage it in spite of its highly constrained staff. In addition to providing "WiFi on Wheels", this WAN solution can be enhanced to provide additional value.

The adoption of virtualized networks has led to the adoption of a range of virtualized network functions. One way that this could add value to the school district is by having the WAN solution also provide virtualized security services, such as content filtering, which would enable compliance whenever students roam between the underlying 4G networks.

Another societal demand is public safety, and a major piece of that is equipping police officers with the tools they need to do their jobs. This includes providing access to online police records, critical applications, and integration with automatic vehicle location (AVL) systems. Typically this is done by having one or more devices, such as a laptop, in each cruiser, which serves as a mobile data terminal. Similar to what was described for the hypothetical school district, this public safety use case was implemented by placing a piece of hardened, compact equipment into roughly 80 police vehicles. The equipment offers WiFi access inside of the vehicle and connects to the Internet using LTE connectivity.

One of the operational challenges associated with this use case was mentioned in the context of the education use case. That challenge is that the police department could not afford the resources that would be associated with a traditional solution that required them to physically touch each piece of equipment in order to manually configure, provision and maintain it. As a result, the police department selects an SDN-based WAN solution that can be centrally managed from the cloud.

Due to the nature of their work, the officers need to have instant, resilient, secure network connectivity while accessing critical online systems no matter where they are. These requirements create additional operational challenges. One of those challenges comes from the traditional way to implement the necessary network security, which is to set up a VPN between the officer's laptop and the resources they need to access. This approach can be very time consuming, as it typically requires extra hardware and getting a service provider involved when setting up the VPNs. Another operational challenge that occurred when the police department tried to implement this approach using a traditional WAN solution was that the VPNs that connected the officers to the key applications they needed to access were unreliable. One way this issue manifested itself was when officers drove between cell towers, under a bridge or in other areas where the cellular signal would be temporarily lost. In those instances, the VPN connections would drop and communications with critical online systems would be lost.

The police department responded to these challenges by choosing an SDN-based WAN solution that features a virtual overlay network with end-to-end encryption and a private address space that completely isolates it from the public Internet. This solution enables the officers to be automatically authenticated once they turn on the laptop. It also enables the officers to be connected from anywhere.

A View of the Future

In most cases when a new technology is adopted by a network organization, the organization does things the same way it always has, just a little faster and perhaps at a somewhat lower cost. An example of that is the deployment of Ethernet technology at continually faster speeds. SDN is different. SDN is both an architecture and a new way of thinking about networking.

It is important to acknowledge that there is nothing wrong with the traditional approach to networking. It has served the industry well for decades. The traditional approach was, however, designed to solve a different set of challenges. It was, for example, designed to connect a relatively small number of devices, such as computers and servers, in an environment in which neither the devices nor the applications they hosted moved very often. The traditional model was also developed at a time when the size of network organizations was relatively large.

We are now in a world where the users are mobile and they are more likely to access business applications using a smart phone or a tablet than they are by using a desktop or laptop computer. We are also in a world in which the key components of the IT environment, including virtual machines, virtualized network functions (VNFs) and the applications themselves, are also mobile. Today's world is also characterized by the emergence of IoT. Whereas the traditional WAN was designed to connect a relatively small number of devices, many organizations are facing the requirement to connect what can appear to be an unlimited number of devices.

Another key difference between today's world and the world that inspired the traditional approach to networking is the pace at which businesses and applications change. According to Professor Richard Foster of Yale University, the rate of business change, "Is at a faster pace than ever." Plus he predicts that by 2020 more than three-quarters of the S&P 500 will be companies that have not yet been heard from.[4] Whereas the traditional network was designed to support applications that were revised infrequently, the emerging model of application development is one of continuous development and deployment.

The three use cases described in this white paper provide some insight into what is possible today, and what will likely be possible tomorrow, by implementing an SDN-based WAN. One of the aspects of the three use cases that is compelling is that none of the three organizations had a large, sophisticated networking group; i.e., they were not the top 1% of SDN users. The fact that the three organizations represent the 99% of potential SDN users indicates that in the near term many organizations will adopt an SD-WAN in part because of an SD-WAN's key application. That application is the ability to easily set up feature-rich, secure virtual overlay networks that are transport independent.

The pressure that businesses are under to become flexible and agile or suffer the consequences will put pressure on enterprise networks to become continually more agile, but in most cases they will not be allowed to add to the size of the organization. Leveraging a SD-WAN's ability to manage networks from a central location will make these networks more flexible and cost-effective without increasing head count. Further cost savings will come as SD-WAN solutions implement more automation. Additional agility will come in part from the fact that as we move forward, the VNFs that support the WAN by providing functionality such as security and optimization will be updated and deployed on a continuous basis. Additional agility will also come as vendors and enterprise networks develop applications that leverage the ability of the control plane of an SD-WAN to program the data plane.

[4] http://www.bbc.com/news/business-16611040