**Software Defined Networks**

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1. **Introduction/What is SDN**

SDN or software-defined networking gives the operator the ability to manage their entire network consistently and holistically by controlling the network in an intelligent and certain way. We can program the behavior of networks using SDN. SDN allows a simple interface to the complex data center so that the data center network operator can see clearly what is going on in the network of that data center. (TechsavvyProductions, 2022)

1. **The Basics of SDN**

In a SDN, the software is separated from the hardware. The software takes the responsibility for the control plane, which controls the traffic of the data. The hardware takes responsibility for the data plane, which is responsible for forwarding the data (“What is software-defined networking (SDN)?”, VMWare, 2022).

The three basic parts of SDN are (“What is software-defined networking (SDN)?”, VMWARE, 2022):

+ Application: which is used for sending resource request and information about the network

+ Controllers: which controls how data packets are being routed by using the information from the application.

+ Networking devices: which controls how to move the data packets by using the information from the controllers.

1. **The Fundamentals of SDN**

The five fundamentals of SDN are (Kifayat Ullah, 2021):

* Plane separation.
* Simple Device.
* Centralized control.
* Network automation and virtualization.
* Openness.

1. **Some Characteristics of SDN (“What is Software-Defined Networking (SDN)?”, 2022)**

4.1) Network programmability.

SDN allows control of network behavior by software outside of the network devices that provide the physical connection. As a result, network operators can tailor the behavior of their networks to support new services and even individual customers. By separating hardware from software, operators can quickly introduce innovative, differentiated new services - unconstrained by proprietary and closed platforms).

4.2) Logically centralize intelligence and control.

SDN is built on logical centralized network topology, allowing intelligent control and management of network resources. Traditional network control methods are distributed. The devices operate automatically with limited awareness of the state of the network. With the kind of centralized control that SDN-based networking provides, bandwidth management, recovery, security, and policies can be very intelligent and optimized — and an organization has a big picture. about the network.

4.3) Abstraction of the network.

Services and applications that run on SDN technology are abstracted from the underlying technologies and hardware that provide the physical connection from the network controller. Applications will interact with the network through APIs, rather than management interfaces that are tightly coupled to the hardware.

4.4) Openness.

The SDN architecture ushers in a new era of openness — enabling cross-vendor interoperability and fostering a vendor-neutral ecosystem. The openness comes from the SDN approach itself. Open APIs support a wide variety of applications, including cloud orchestration, OSS/BSS, SaaS, and business-critical network applications. In addition, intelligent software can control hardware from multiple vendors with open programming interfaces such as OpenFlow. Finally, from within the SDN, smart network applications and services can run in a shared software environment.

1. **Advantage of SDN and Its Differences from Traditional Networks**

The main difference between a traditional network and a SDN is in the infrastructure. In a traditional network, everything relies on the physical hardwares to function. From controlling and forwarding data. On the other hand, SDN’s control plane is controlled by software and the forwarding of data is controlled by the data plane of the hardware (“What is software-defined networking (SDN)?”, 2022).

Because of this difference, SDNs have advantages that traditional networks do not have (Cole, 2020):

* More Reliable: since they can be configured to automatically reroute packages around areas that are down.
* More Efficient to manage: since SDN can provide real time analysis of the network.
* More Cost-Effective: SDN are easier to upgrade because you only need to upgrade the software and maybe the hardwares.
* Faster Scalability: a SDN can be upscaled and downscaled more easily than a traditional network.

1. **Different Models of SDNs (“What is software-defined networking (SDN)?”, 2022)**

There are five different SDN models. They are:

* + Open SDN: which uses OpenFlow to operate the virtual and physical switches at the data plane.
  + APIs SDN: which uses application programming interfaces to control the flow of data through the devices.
  + SDN overlay model: which runs a virtual network on top of an already existing hardware infrastructure.
  + Hybrid SDN: is where SDN and traditional network protocols are incorporated in one environment.

1. **Security Fundamentals of SDN and its Principles (“SDxCentral Studios”, 2013).**

Some of the things needed to be paid attention in SDN to ensure security. Secure the controller: since the controller is the center of SDN, traffic around it needs to be secure.

1. Protect the controller: If the controller were to be attacked and taken down, then the entire network would also go down. So it is important to protect the controller.
2. Establish trust: this means that the SDN controller, the loaded programs and the hardware that are being operated are trusted; making sure that they are working properly.
3. Create a robust framework: there needs to be a list of checks and requirements for the SDN controller, to make sure the SDN controllers are working properly.
4. Conduct forensic investigation and restoration: whenever an attack happens, there needs to be a vigorous investigation and try to repair and upgrade the system.

There are many ways to implement a security system in an SDN, but they need to be:

* Simple: to implement, upgrade and maintain.
* Cost effective: this to make sure the security can be implemented across the network.
* Secure.

1. **Apply of SDN In Real Life (TechsavvyProductions, 2022)**

* A home network may need changes to their router/switch once per device replacement.
* A small need their switches and routers to change their configurations may be once a year.

1. **Conclusion**

In conclusion, SDN, or Software Defined Network, is an alternative way for networking. It works by separating the network into two parts, software, and hardware. It has its own characteristics and fundamentals. Because of that, it has its own advantages over traditional network. Along with those advantages, there are certain challenges that comes along with SDN. Especially about security. If we can understand the advantages and disadvantages properly, then we can apply them to many different networks efficiently.

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