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software-defined networking (SDN)

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overview

by 2020 it expected that more than 50 million IOT devices will be connected on the internet .

This devices need to a huge storge this problem will solve be using the cloud storge , and we need also high speed to dealing with devices data but by using the 5th generation wireless systems (5G) the speed will be more faster .

this huge mount of date we can easier dealing by the Big data , and by using IPV6 the problem of the limit IP in IPV4 will be solved .

so now we need a secure ,low cost and strong network infrastructure and the same time be simple with dealing on it , and this will solved by SDN .

So what is the SDN ????

SDN Definition

it is refer to software-defined networking by SDN we can separate between the control plane and the forwarding plane(data plane) .

SDN provide a good soluation to control the network by programming and make abstraction for the applications and network services from the nature of the network topology .

What lead to appear the SDN :

if we take a look to currently network architecture we will face many problem :

1- the first problem that defining the correctness configuration is so hard .

2 – interaction between protocols .

3- every router dealing and exchange the information between only the surrounding routers we don't have top view to the whole network topology

4- difficult to manage the traffic and make the load balance.

5- diffcult to make security .

6- diffcult of dealing with switches ,routers , firewalls and different devices form different vendors .

7- difficult to make new applications and hard to make innovation for networks .

8- Many configurable mechanisms.

9- difficult to discover and diagnose when things go wrong.

10 - difficult to evolve .

Control plane VS Data plane

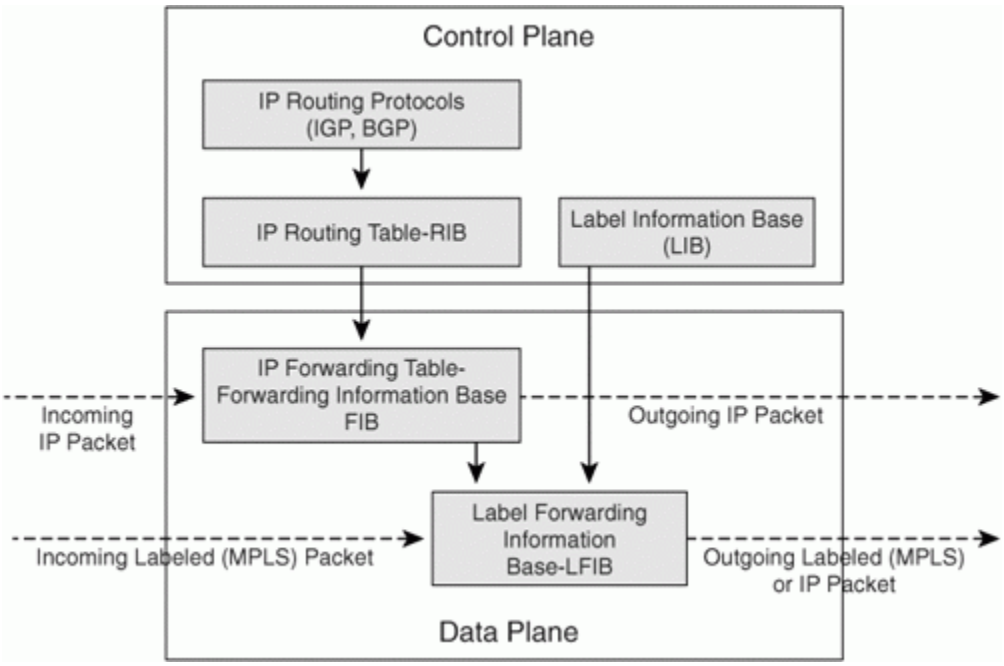
the SDN Introduced a good solution to separate the control and data planes
so what is control and data planes ???

the control plane : Makes decisions about how handling traffic on the network

there are many functions in the control plane such that :

- system configuration .
- system management .
- how routers exchange the routing table information .

The Data plane : forwards traffic according to decisions that made by the control plane



The SDN architecture

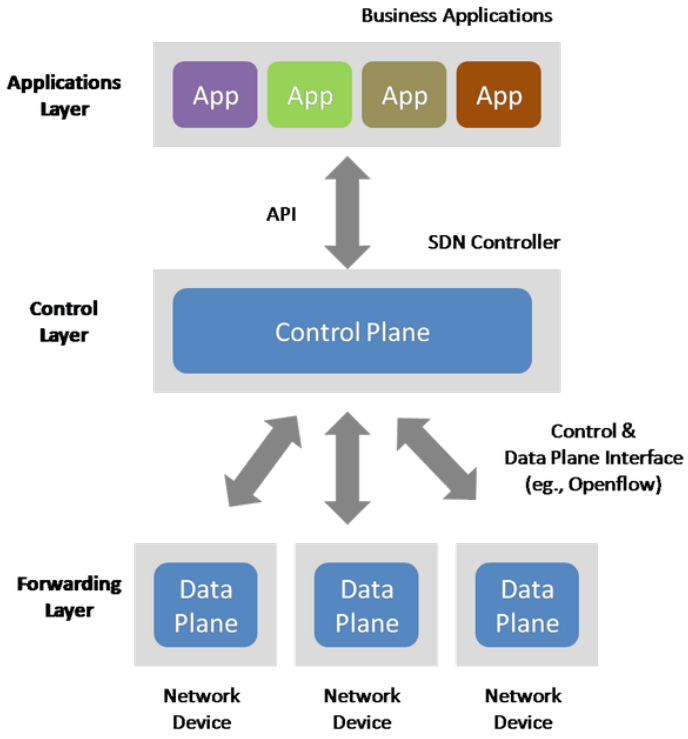
The Controllers: It's consider as th "brains" of the network

SDN Controllers offer a centralized view of the overall network .

the network administrators can to dictate to the underlying systems (like switches and routers) how the forwarding plane should handle network traffic.

Southbound APIs: SDN uses southbound APIs to relay information to the routers and switches ' below ' , and use the Openflow protocal to communicates with this routers and switches

Northbound APIs: SDN uses it to communicates with the applications 'above' ,so the network administrators can easily program the shape traffic and deploy services.



SDN Benefits

1-Centralized Management : it is can be so easily to control and mange the traffic and make Balance loads ,track and debug the errors andmaintenance it .

2- Agility and Flexibility : helps organizations fastly deploy new services , applications,, and infrastructure so quickly meet business goals and objectives.

3- Innovation : help the researchers to develop new applications and services .

4- Indenpendent : develop sofwares that will manage the network independence from the hardware.

5- Research : help to do experments on the network easily and fastly .

6- Security : by centralized control it is can alongside a multi-layered security strategy to deal with increasing threats.

7- Vendor dependence : help to deal with different devices from different vendors .

SDN Applications

1- Data Centers

2- Enterprise Networks

3-Internet Exchange Points (IXPS)

4-Home Networks

SDN & 5G

By network Virtualization will play an important role in laying the groundwork for 5G. Operators will need to to leverage software-defined networking to create network topology that includes multiple hierarchies. The different hierarchies will contain RAN radios of different sizes.

Openflow

- First standard communications protocol that interface defined between the control and forwarding layers of an SDN architecture.

- Openflow protocol enables the SDN Controller to directly interacting with the forwarding behaviors of switches from different vendors on condition these switches provide a API for dealing with openflow protocol .

- When SDN controller make a decision such that change the switch/router flow table Openflow provide a interface from the controller to the switch

Openflow histoy

openflow was created in 2008 at Stanford university

And now the **Open Networking Foundation (ONF)** manage OpenFlow specification and how adopt with SDN

openflow benefits

1-Centralization

- more performance optimization .
-top overview of the whole network topology .

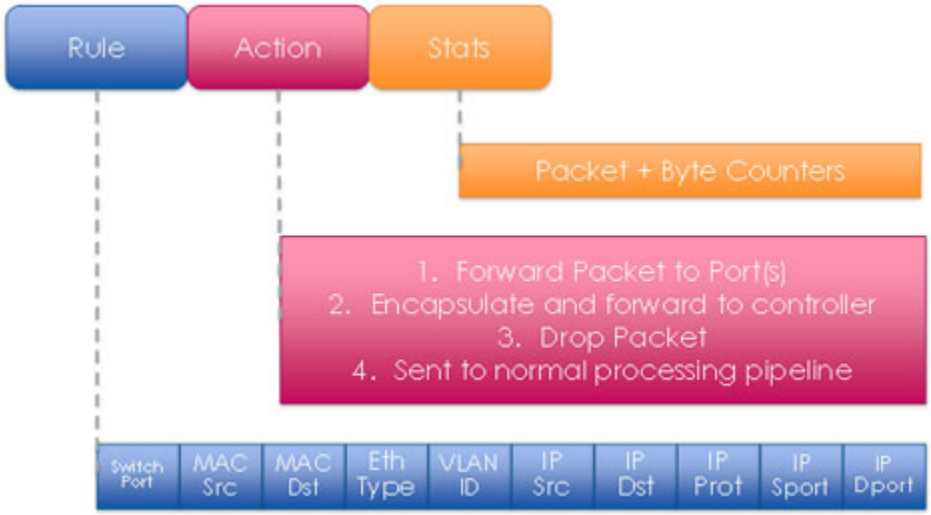
2-Abstraction

- control plane and the data plane .
- software and hardware .
-logical and physical configuration .

3- Programmability

-enable the programers to make more Innovative and different applications in less time .

- administrators don't neet to deal with CLI (commmand line interface) or other configuration interfaces the can directly control the data plane by openflow interface .



SDN Controllers

SDN Controller : a software-defined network (SDN) are the brains of the network. It is the application that acts as strategic control point in the SDN network, manage flow control to the switches/routers ‘below’ (via southbound APIs) and the applications and business logic ‘above’ (via northbound APIs) to deploy intelligent networks .

1- NOX

- It is the first-generation SDN controller
- initially developed by “Nicira Neworks”
- open source
- created in 2008
- there are two edition of NOX
    - -classic NOX : written in c++ and python no longer supported
    - - new NOX : written in c++ anly fast ,stable

2- POX

- python based controller

-supports the same GUI and visualization tools as NOX

pox algorithm for a switch :

1- update address/ ports table

2- if multicast ,flood

3-if no table entry ,flood

4-if source == destination ,drop

5-install flow table entry

3- Floodlight

- Open-source SDN Controller

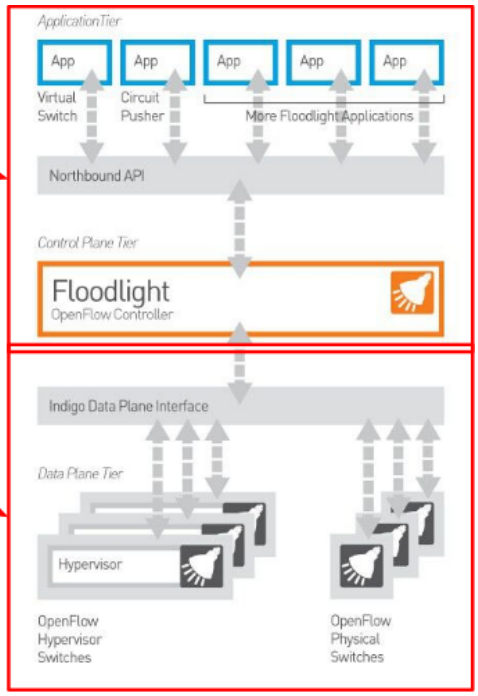
- Java based controller

- Allows developers to create SDN applications

-Supports OpenFlow protocol

-Apache-licensed

- Separation of Control Plane
  - “Brains of the network”
- From Data Plane
  - Routers/Switches



Basic functions :

1- install/Remove forwarding rules on switches
- route flows along the correct path
- Flows are packets with same header

2-Topology Discovery
- know what the network looks like
- Link Layer Discovery Protocol

3-Statistics
- know what is happening in the network and what the traffic is

Flows Rules :

- Flows consist of <match,action>
- Match - routing information
- Action - where to forward the packet

code examples

1- Creating a Match

```
OFMatch match = new OFMatch();
match.setWildcards(Wildcards.FULL.matchOn(Flag.DL_TYPE).matchOn(Flag.NW_DST).
withNwDstMask(24) );
match.setDataLayerType( Ethernet.TYPE_IPv4 );
match.setNetworkSource( IPv4.toIPv4Address("152.3.140.0") );
```

2- Creating a Action

```
ArrayList<OFAction> actions = new ArrayList<OFAction>();
OFActionOutput action = new OFActionOutput().setPort((short) 3);
OFActionNetworkLayerSource ofanls = new OFActionNetworkLayerSource();
ofanls.setNetworkAddress( IPv4.toIPv4Address("8.8.8.8") );
```

The Mininet

-Mininet is a network prototyping tool

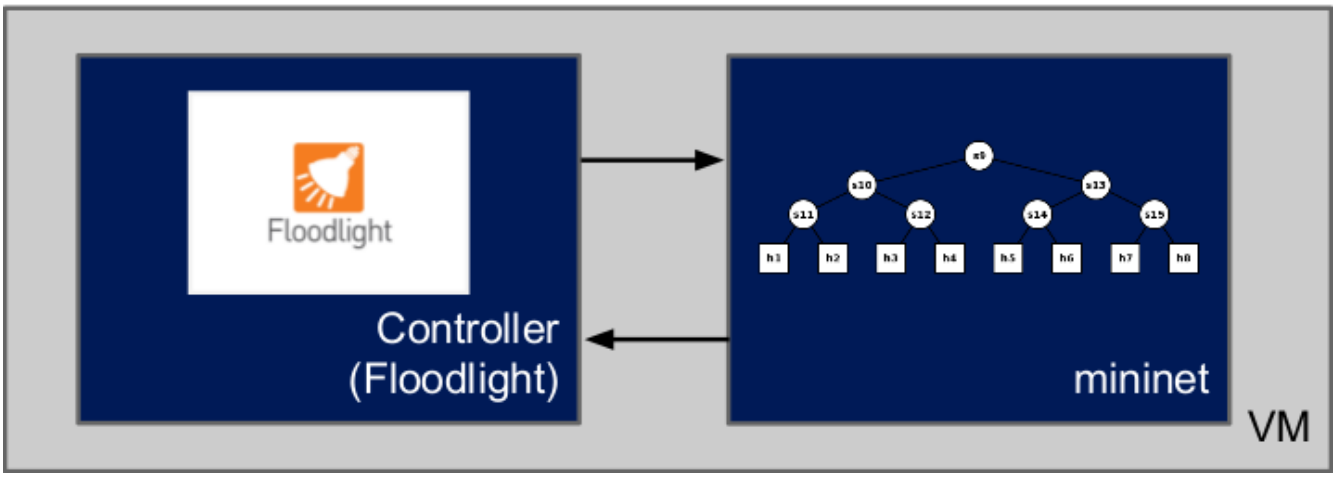
-Simulate an entire network on your pc

-Design network topology

-Testing the topology

mininet is not SDN controller but it is enviroment help you to design and test netork topology

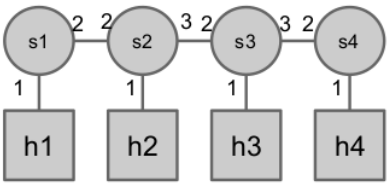
mininet works on data plane



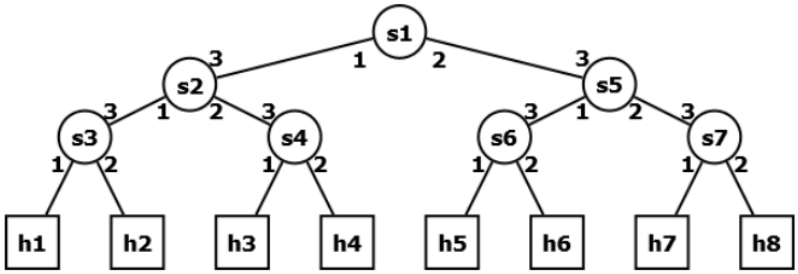
example to ceating topology

we can built in topologies: linear, tree

```
$ sudo mn --topo=linear,4
```




```
$ sudo mn --topo=tree,3
```



Mininet has an API to design your own network topology

Create a switch

```
s = self.addSwitch('s1')
```

Create a host

```
h = self.addHost('h1')
```

Create a link

```
self.addLink(h, s)
```

OpenDaylight Project

- founded by **The Linux Foundation** On April 8, 2013
- written in Java.
- it's goal to accelerate the adoption of software-defined networking (SDN)

-has many releases

-Hydrogen February 2014

- Helium October 2014

-Lithium June 2015

- Beryllium February 2016

-Some of project member

-Cisco Systems

-Dell

-Ericsson

-Fujitsu

-Huawei

-IBM

-Intel

-Red Hat

-AT&T

-Juniper Networks

-Lenovo

-Microsoft

the Index

websites

https://www.opennetworking.org/

https://www.sdxcentral.com/

https://en.wikipedia.org/wiki/OpenDaylight_Project

https://en.wikipedia.org/wiki/Software-defined_networking

http://academy.gns3.com/p/sdn-and-openflow-introduction

http://db.cs.duke.edu/courses/cps214/fall15/FloodlightTutorial.pdf

youtube channels

https://www.youtube.com/user/nfeamster

https://www.youtube.com/user/mahler711

https://www.youtube.com/watch?v=AltMbM2Fyi0