UNIVERSITY OF LEEDS

Faculty of Engineering

Institute of Communication and Power Networks
School of Electronic and Electrical Engineering

SDN – preface and hands-on

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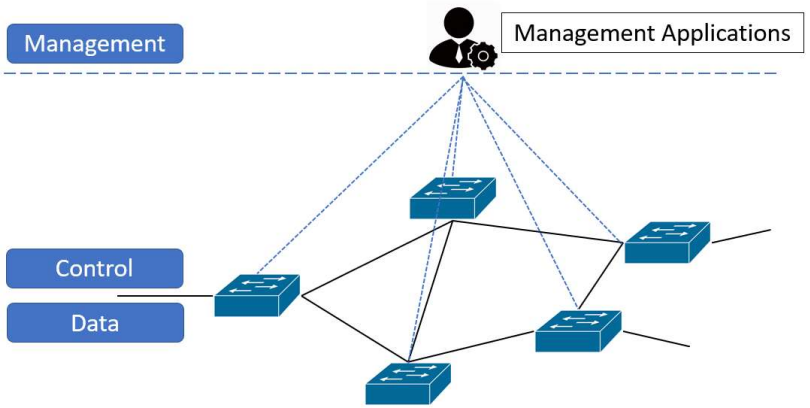
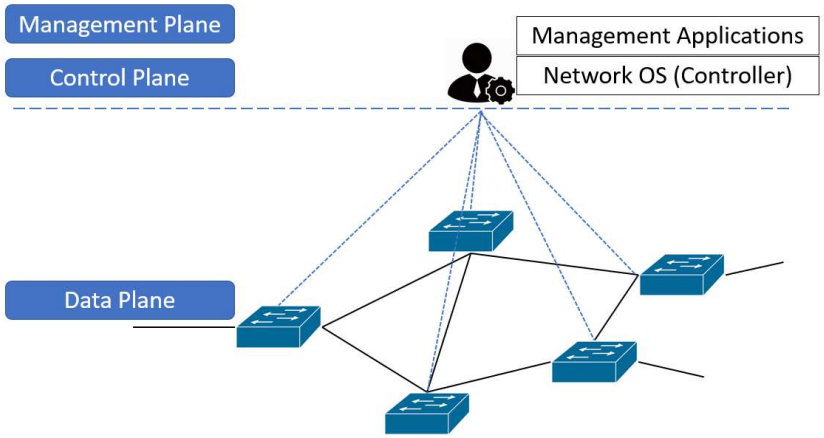
Traditional Network Management

- Network operator configure network devices such as switches, routers, firewall and load balancer to realize network management tasks.
- The packet processing in network devices can be modelled as match-action processing where the network devices match on certain patterns of packet headers.
- Policies change over time, needs to reconfigure network devices in face of various network events such as traffic shifts, cyber-attacks, device failures, host mobility and others.
- In today's network, the control plane is coupled with the data plane. Since the control plane is distributed on the devices, it does not have a global view of the network and cannot make good network-wide decisions.



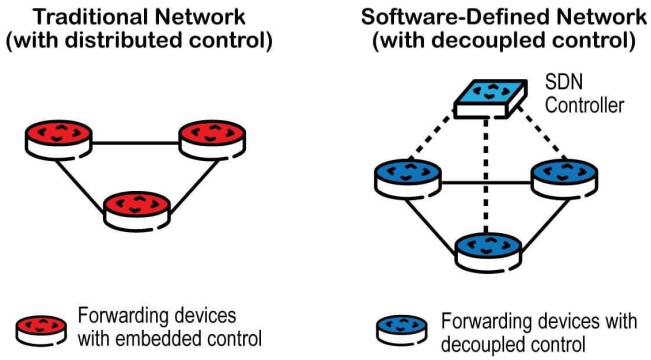
SDN Network Management

- Emerging trends like network densification and service differentiation are commanding new challenges to future network architecture. Owing to its simplified and dynamic management, high flexibility and improved performance, SDN has drawn considerable attention in recent years.
- The typical three-layer model of SDN as shown. The interface between the control plane and the data plane is open and used open standard such as OpenFlow.
- SDN can offer logical centralization of network management over distributed switching devices and introduce programmability, which opens new approaches to control functions in the application layer.

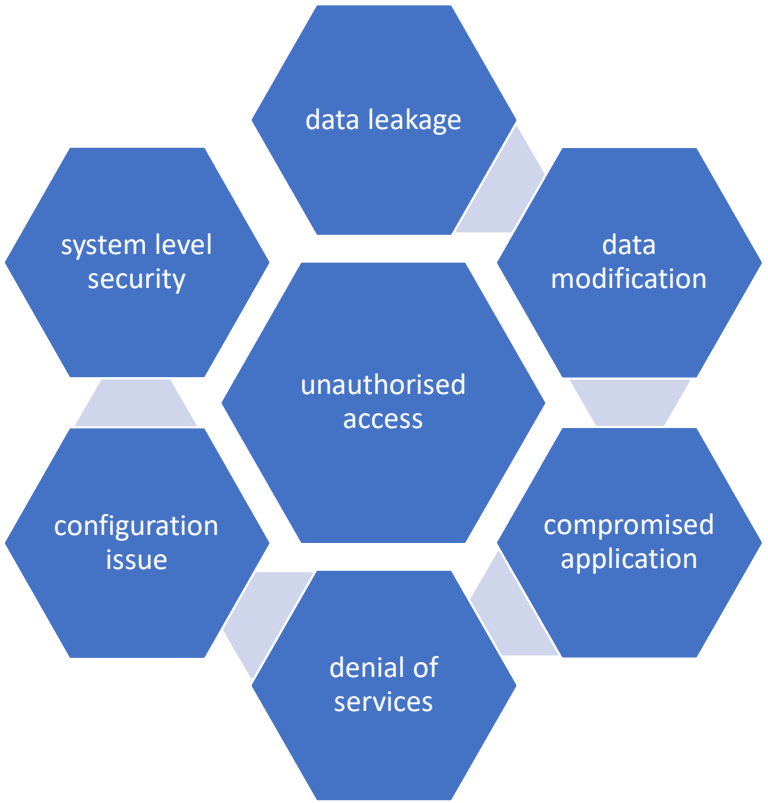


SDN Introduction

- SDN decouples the data and control planes, while maintaining a centralised and global view of the whole network.



How SDN is Fixing Existing Network Bottlenecks With More Hardware at the Edge. [Photograph]. Retrieved from https://www.lanner-america.com/blog/sdn-fixing-existing-network-bottlenecks-hardware-edge/



SDN Plane

The **Management Plane** is the set of applications that leverage the functions offered by the northbound interface to implement network control and operation logic. Essentially, a management application defines the policies, which are ultimately translated to southbound-specific instructions that program the behaviour of the forwarding devices.

The **Control Plane** is responsible for the network management with the aid of SDN controllers. The SDN controller serves as a logically centralised intelligence in the SDN structure. Thus, the SDN controller has a global view of the entire network. Thanks to programmability, the SDN controller also can control the various functions in the application layer individually and dynamically.

Data Plane is generally responsible for forwarding the traffic flow between switching devices based on the rules that are provided by the control plane. The switching devices are also responsible for collecting the network state information and reporting to the control plane.

SDN Features

i. Dynamic flow control

Network application can control network flows dynamically. This feature is highlighted with network applications for flow control such as dynamic load balancing and network management application.

ii. Network-wide visibility with centralized control

All data planes are connected to a centralized control plane to receive control messages. In addition, the control plane collects network status information from each data plane by sending a statistics query message. Therefore, a network application running on the control plane naturally has a view of all connected data plane and it can control all data plane in a centralized way.

SDN Features

iii. Network programmability

Since all data planes in an SDN network can be controlled by a network application program, SDN provides a strong capability to program enable new network functions. This is similar to programming a smartphone application like using Android to enable unlimited creativity of functionalities. To empower this feature, several network programming languages such Frenetic have been proposed so far and help to program network functions easily.

iv. Simplified data plane

SDN architecture separates the data plane from the control plane and thus the data plane only has relatively simple logic. This simplified data plane gives us possibility of adding new features and introduced better modification.

SDN Controller

- The SDN controller is the central entity of the SDN environment. It acts as the brain of the SDN network, managing flow control between the switches and applications. Open Virtual Switches are unable to perform any actions without programmed by the controller.
- It typically contains a collection of pluggable modules that are used to accomplish different tasks in the network. The controller also supports the addition of extensions that can be inserted to extend the functionality for more advanced configurations. The controller uses the OpenFlow protocol to communicate with the switches under its domain.

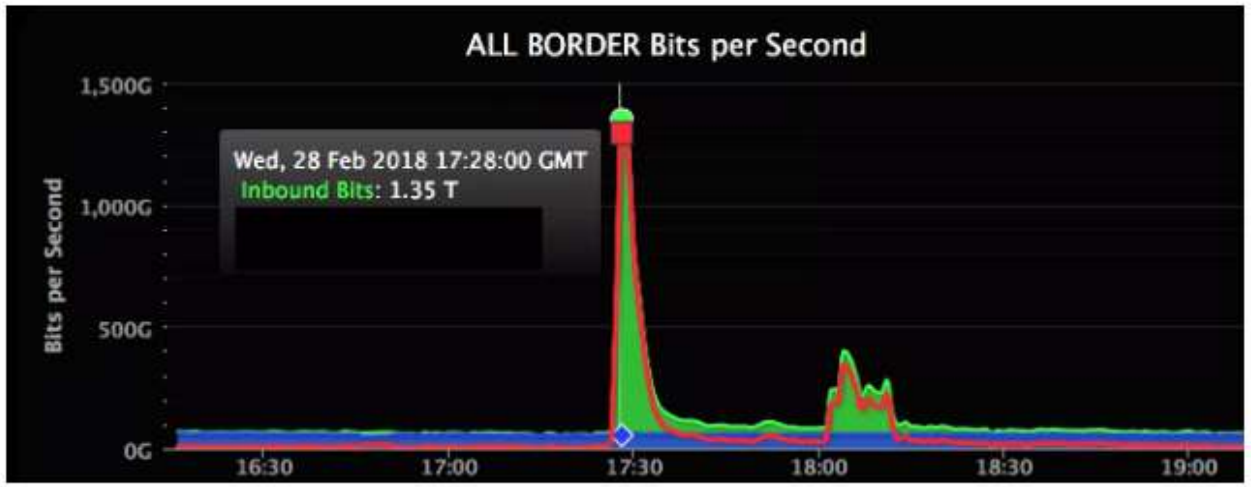
Name 5 SDN controller that you know…

1.
2.
3.
4.
5.

Attack Cases

- DDoS attack on February 28, 2018. Attackers exploited vulnerability of Memcrashed and deploy amplification attack from UDP port 1211. Catastrophic attack by 1.35 tbps of traffic as shown.
- With the ever-increasing volume of attack recorded, it is a vital sign that the problem long-lasting exists and some solutions need to be in place to handle or mitigate it.

DDoS attack on Github

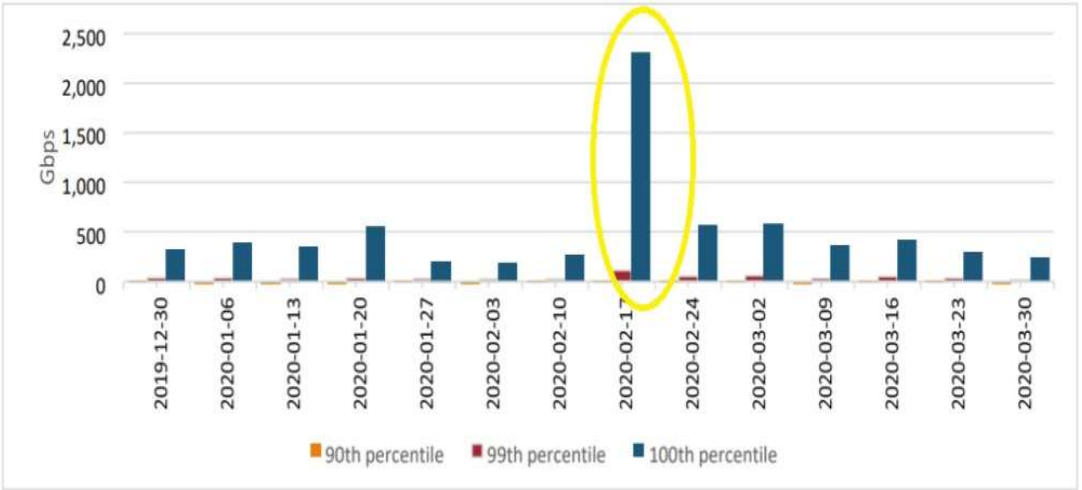


Mohit Kumar. *Biggest-Ever DDoS Attack (1.35 Tbs) Hits Github Website.* [Photograph]. Retrieved from https://thehackernews.com/2018/03/biggest-ddos-attack-github.html

Attack Cases

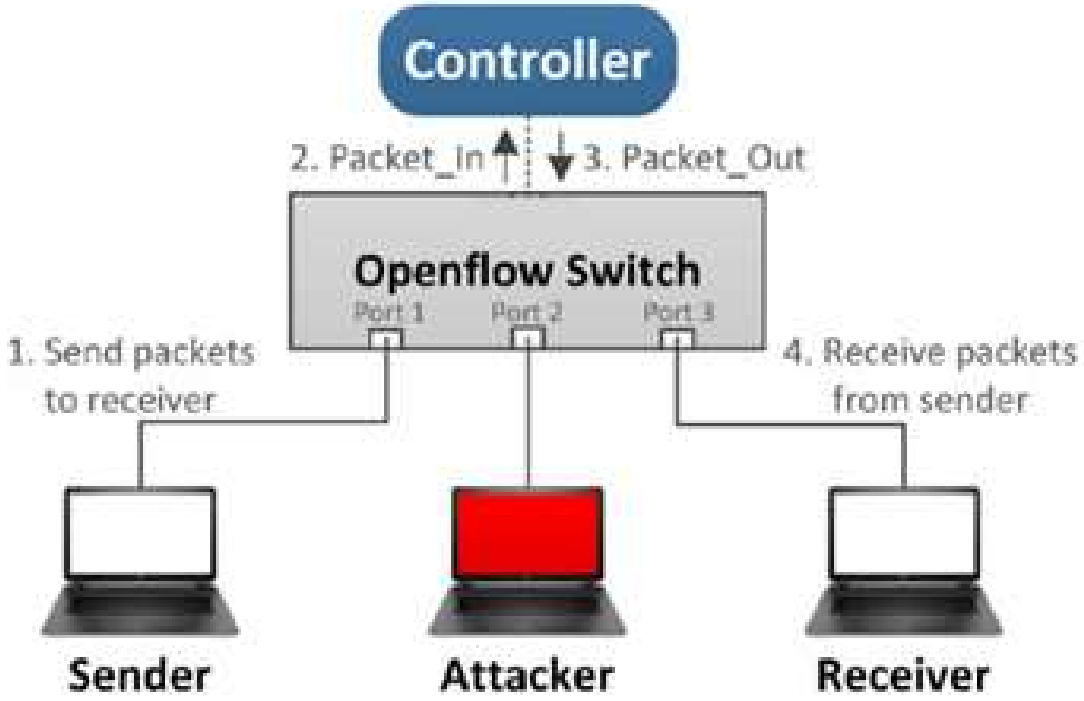
- Close almost double terabits per second of attack also occurred as shown, hitting Amazon Web Services in February 2020

DDoS attack on AWS



Conclusion

- SDN promises to transform today's static network into flexible, scalable, programmable, self defined platforms with the intelligence of dynamic resources allocation.
- Expected advantages and astonishing industry support and momentum, SDN is on the way to become the next approach for networking domain.
- Let's the journey begins…



HANDS-ON

Virtuallization
- Oracle VM

Guest Operating System
- Ubuntu 20.04

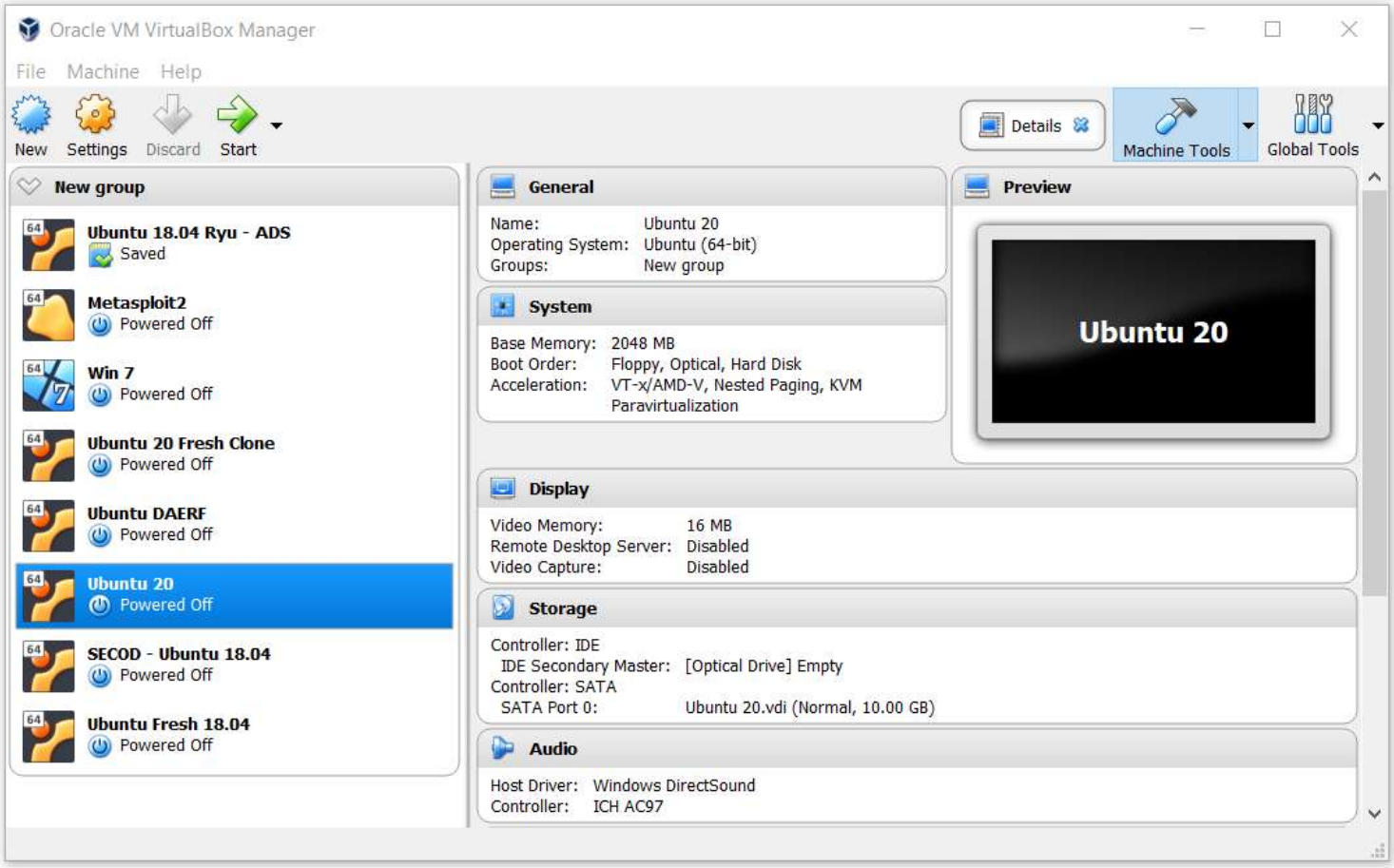
SDN Environment
- Mininet

Controller
- Ryu Controller

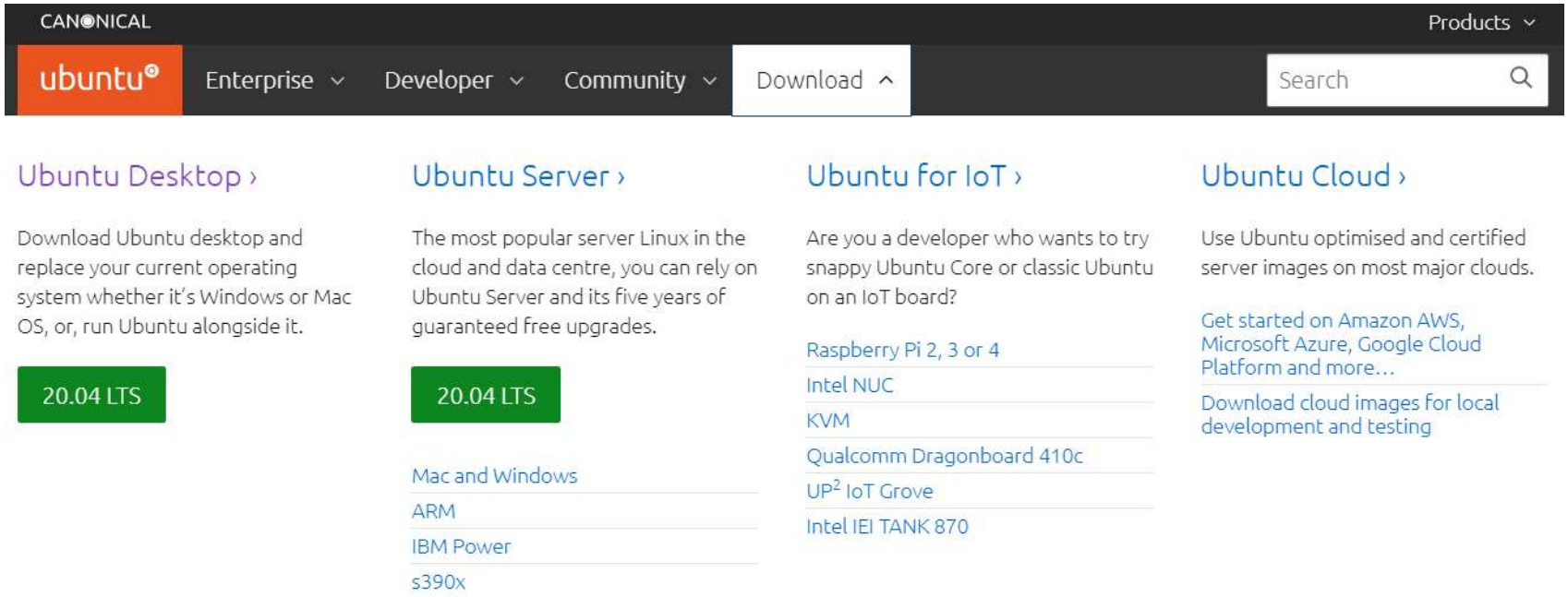
SDN Switch
- OVS

Programming
- Python

Oracle Virtualbox Manager



Ubuntu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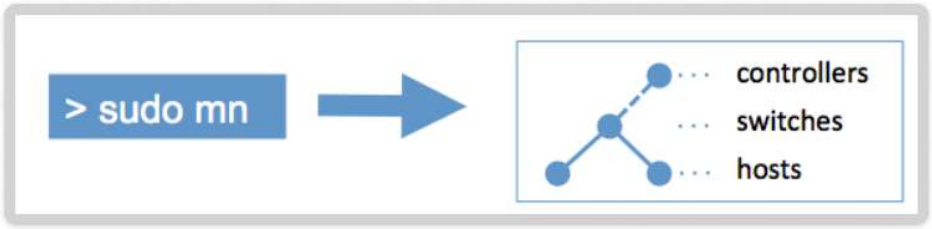
Ubuntu Server ›
The most popular server Linux in the cloud and data centre, you can rely on Ubuntu Server and its five years of guaranteed free upgrades.
20.04 LTS
Mac and Windows
ARM
IBM Power
s390x
Ubuntu for IoT ›
Are you a developer who wants to try snappy Ubuntu Core or classic Ubuntu on an IoT board?
Raspberry Pi 2, 3 or 4
Intel NUC
KVM
Qualcomm Dragonboard 410c
UP² IoT Grove
Intel IEI TANK 870
Ubuntu Cloud ›
Use Ubuntu optimised and certified server images on most major clouds.
Get started on Amazon AWS, Microsoft Azure, Google Cloud Platform and more…
Download cloud images for local development and testing

Mininet

Mininet

An Instant Virtual Network on your Laptop (or other PC)

Mininet creates a **realistic virtual network**, running **real kernel, switch and application code**, on a single machine (VM, cloud or native), in seconds, with a single command:

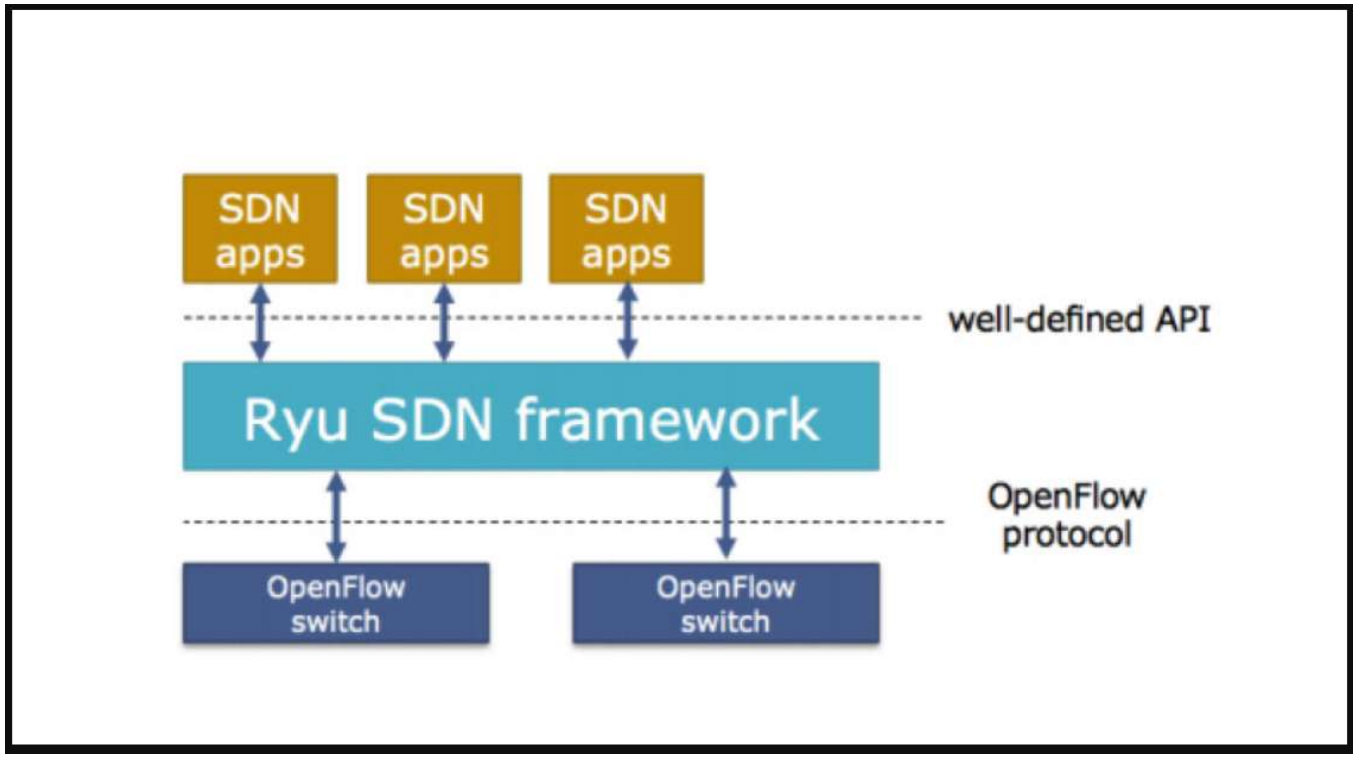


Because you can easily interact with your network using the Mininet CLI (and API), customize it, share it with others, or deploy it on real hardware, Mininet is useful for development, teaching, and research.

Mininet is also a great way to develop, share, and experiment with OpenFlow and Software-Defined Networking systems.

Mininet is actively developed and supported, and is released under a permissive BSD Open Source license. We encourage you to contribute code, bug reports/fixes, documentation, and anything else that can improve the system!

Ryu Controller



Thank you