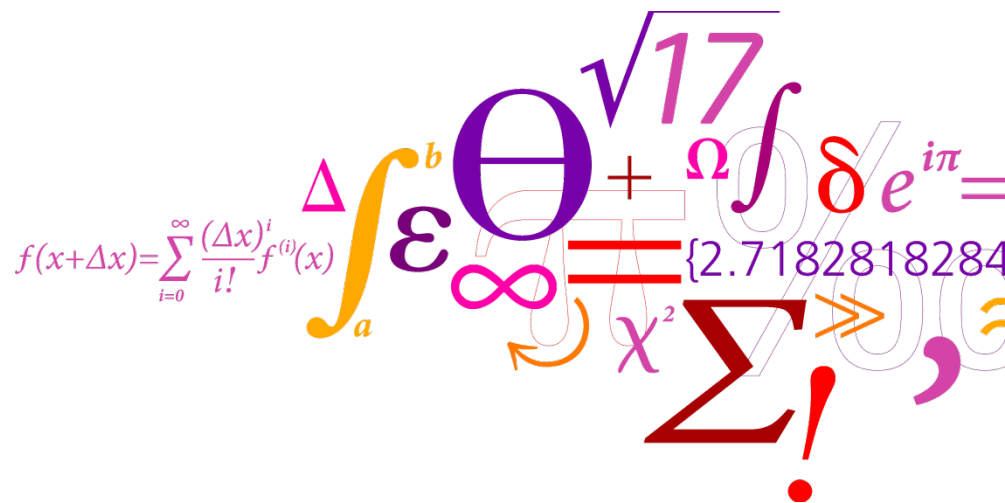


Software Defined Networking from distributed to centralized network control

Angelos Mimidis

PhD student

agmimi@fotonik.dtu.dk

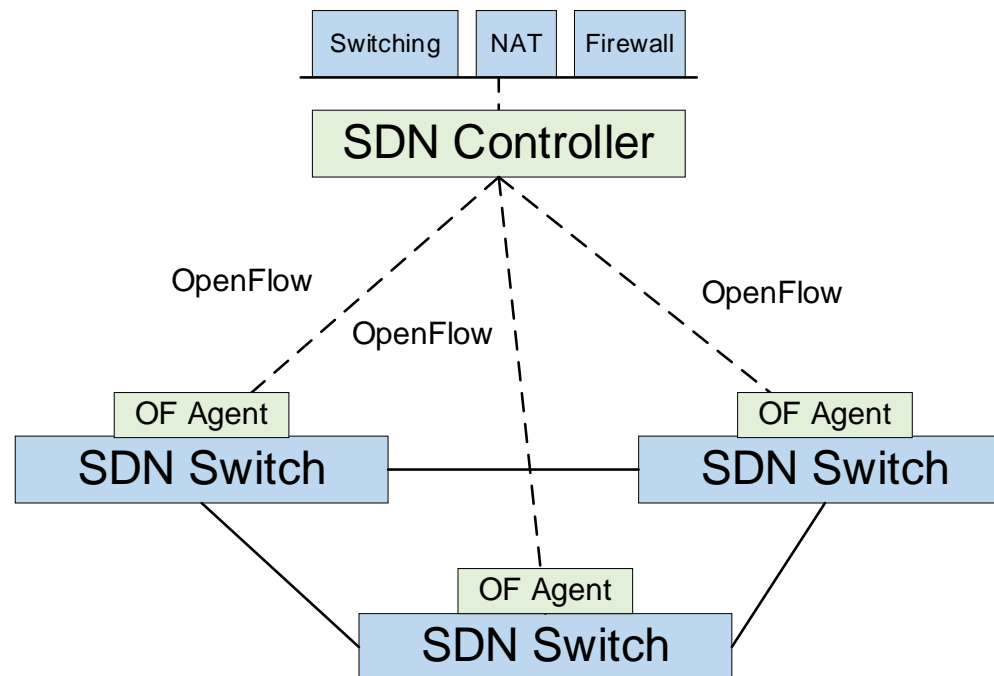


Agenda

- Software Defined Networking (SDN)
- Network Function Virtualization (NFV)

Software Defined Networking in a Nutshell

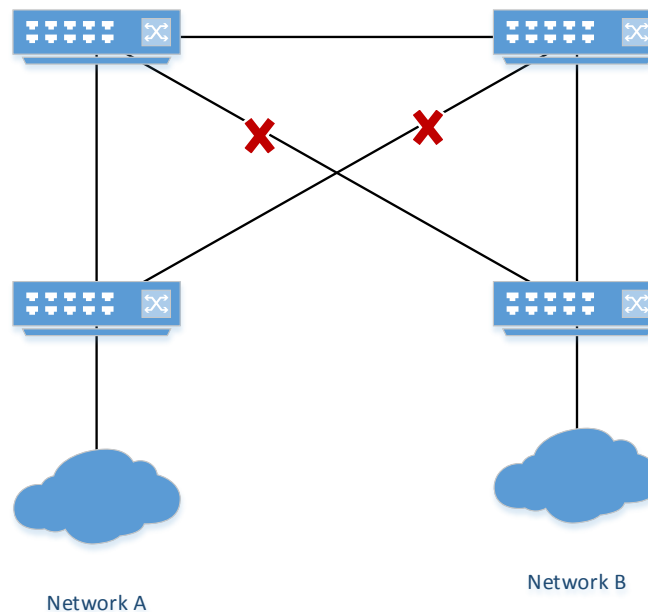
- Software Defined Networking (SDN) is a new networking paradigm which
 - Promotes the decoupling of the network control and data planes.
 - Centralizes the control plane.
 - Promotes innovation and time-to-market through programmability.
 - etc



- SDN was a by-product of the [Ethane](#) project by Stanford University (~2006)

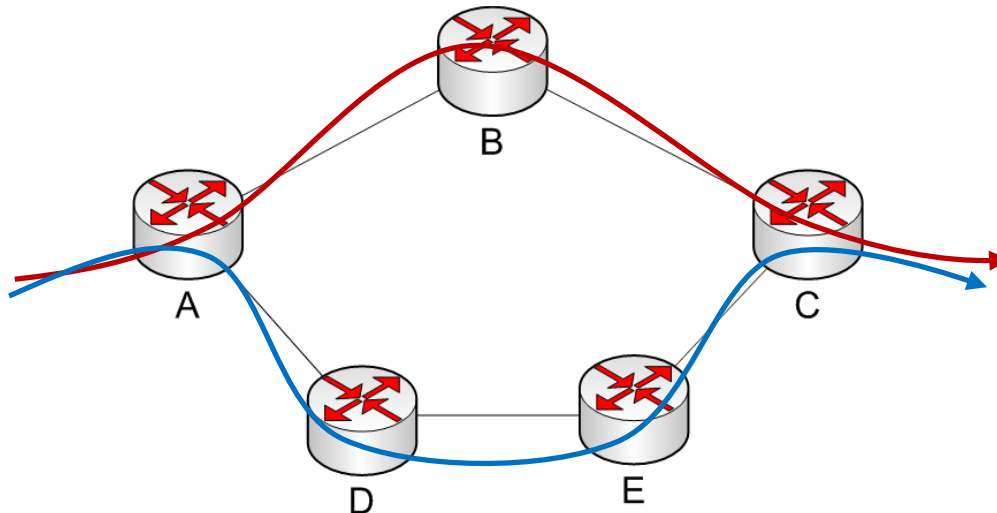
Traditional Networking Drawbacks: Switching

- Ethernet address learning (MAC) does not work when there is a loop.
 - Advertising of MAC addresses is done through flooding.
 - Spanning tree protocol will “prune” links from the network to make a loop free topology → Bad resource utilization



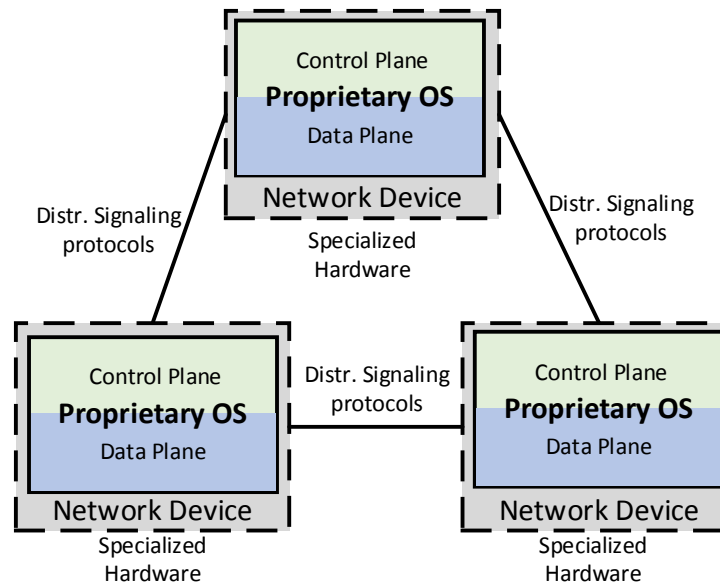
Traditional Networking Drawbacks: Routing

- IP routers perform route computations using simple Shortest Path algorithms.
 - Limited congestion awareness.
 - Bad resource utilization (network resources).
- IP routers perform route computation locally but based on information attained in a distributed manner.
 - Resource intensive computations.
 - Long convergence in case of network changes (e.g. Link down)

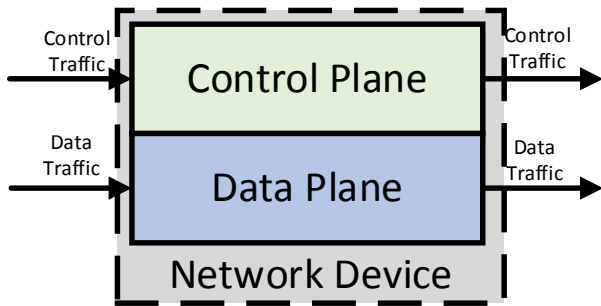


Traditional Networking Drawbacks: Architecture

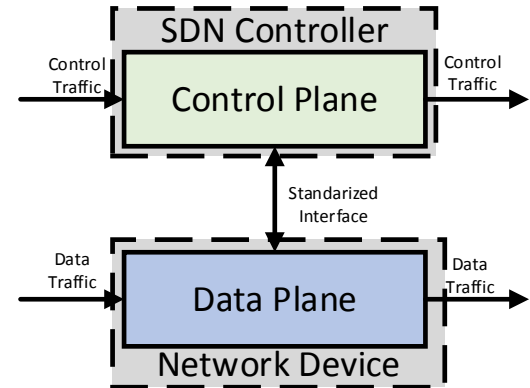
- Specialized design built into a “box” based on proprietary HW/SW.
 - Vendor Lock in
 - Very complicated to add new features
- Control plane **distributed** to every network element.
 - Extra Overhead (network traffic + processing)



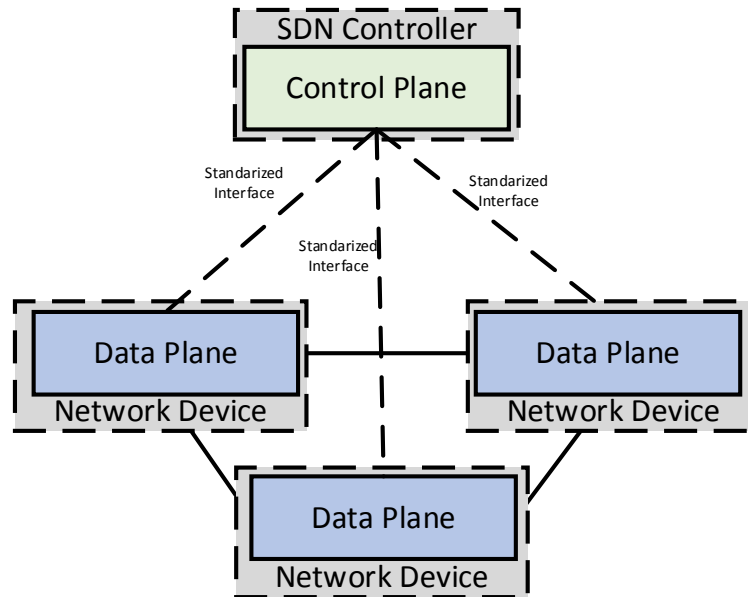
From traditional networking to SDN



Traditional networking



Separation of control & data plane



Centralizing the control plane

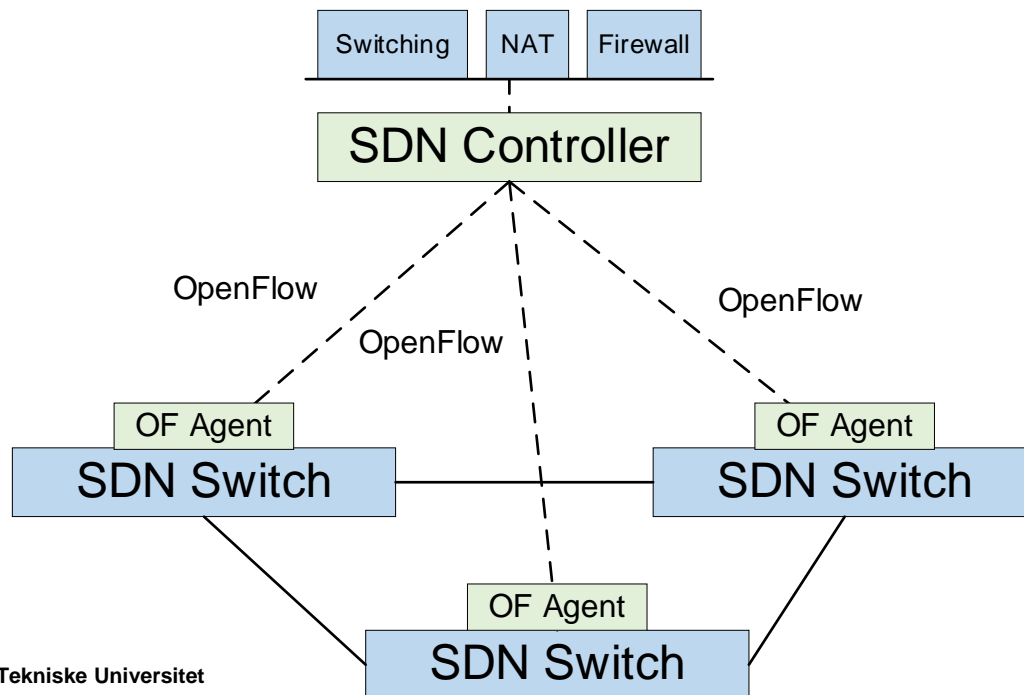
SDN Architecture (Detailed)

Network Elements

- SDN Controller → Controls the data flows in the network via a standardized interface.
- SDN Switches → Perform network actions (forward, drop, etc) as instructed by the SDN controller

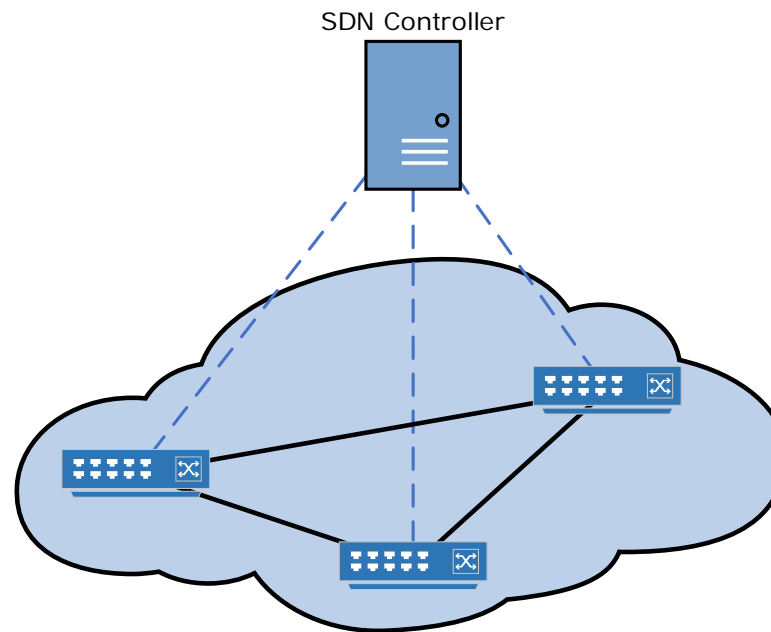
Interfaces

- South Bound → Allows interactions between the SDN controller and the SDN switches (e.g. OpenFlow).
- North Bound → Allows interactions between network apps and the SDN controller (e.g. REST API).



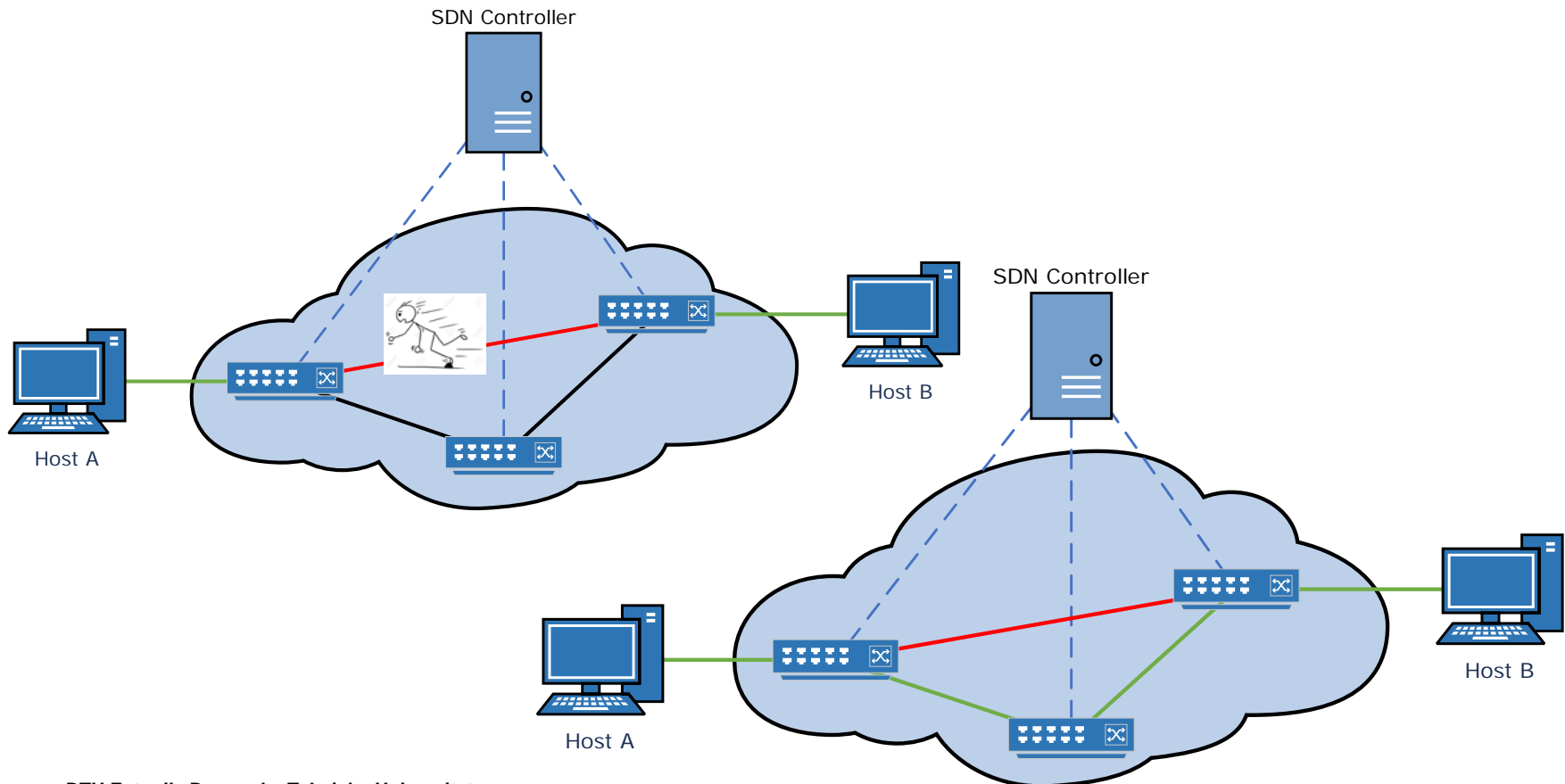
Characteristics of SDN: Centralized Management

- SDN Controller has a global view of the network.
- Easier network administration.
- No need for distributed protocols.
- No need to prune network links, SDNC takes care of loops.



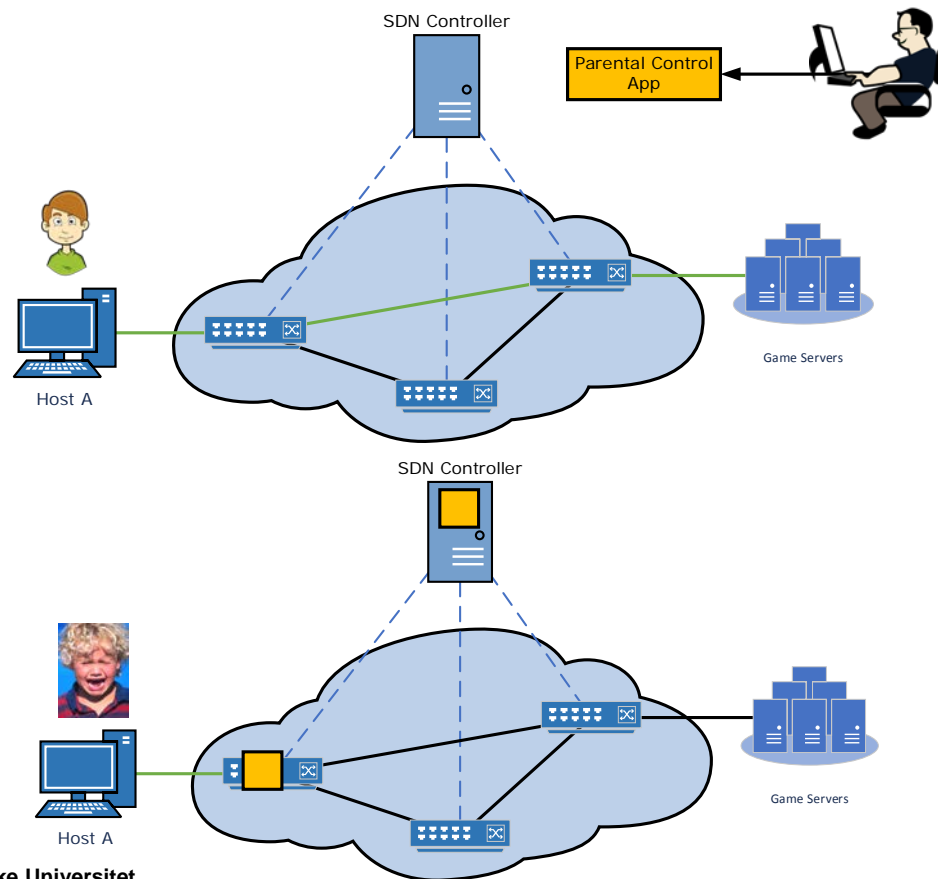
Characteristics of SDN: Dynamic Behavior

- Network can react to changes as $f(\text{net. context})$.
- Faster network convergence (No distributed protocols).



Characteristics of SDN: Programmability, Innovation

- Easy to extend the SDNC with new capabilities.
- Faster time-to-market for new services



SDN technologies and standards

■ SDN Controllers

- ONOS (<https://onosproject.org/>)
- OpenDayLight (<https://www.opendaylight.org/>)
- RYU (<https://osrg.github.io/ryu/>)
- Floodlight (<http://www.projectfloodlight.org/floodlight/>)



■ Interfaces / Standards

- Northbound (A-CPI)
 - REST, Internal APIs, ...
- Southbound (D-CPI)
 - OpenFlow, Netconf, OVSDB, P4-runtime ...

Sources

<https://onosproject.org/images/orange-logo.png>

<https://www.opendaylight.org/wp-content/uploads/sites/14/2017/02/logo.png>

<https://osrg.github.io/ryu/css/images/LogoSet02.png>

http://www.projectfloodlight.org/wp-content/themes/projectfloodlight_v.1.8/images/projectfloodlight-logo-header.png

SDN technologies and standards: OT (I)

- OpenFlow OT extensions
 - https://www.opennetworking.org/images/stories/downloads/sdn-resources/onf-specifications/openflow/Optical_Transport_Protocol_Extensions_V1.0.pdf
 - “ This document specifies a set of recommended extensions to the OpenFlow-Switch protocol to support the requirements for control of optical transport networks and equipment.”



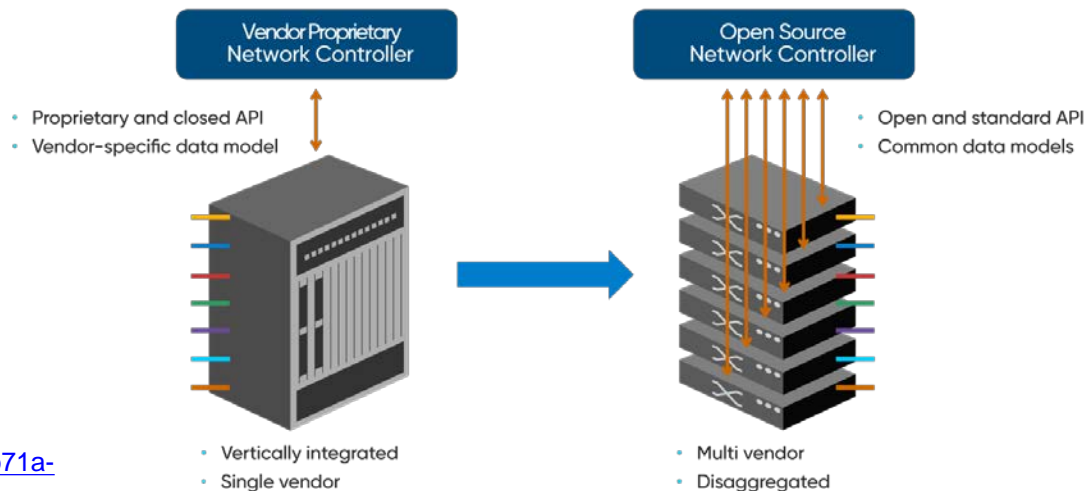
Optical Transport Protocol Extensions

Version 1.0
March 15, 2015

ONF TS-022

SDN technologies and standards OT (II)

- Open and Disaggregated Transport Network (ODTN)
 - <https://www.opennetworking.org/odtn/>
 - <https://wiki.onosproject.org/display/ODTN/ODTN>



Source

<https://3vf60mmveq1g8vzn48q2o71a-wpengine.netdna-ssl.com/wp-content/uploads/2018/03/Current-ODTN-Architecture.png>

- “Open and Disaggregated Transport Network (ODTN) project is an operator-led initiative to build data center interconnects using disaggregated optical equipment, open and common standards, and open source software.”

Agenda

- Software Defined Networking (SDN)
- Network Function Virtualization (NFV)

Virtualization Basics

- **Virtualization:**

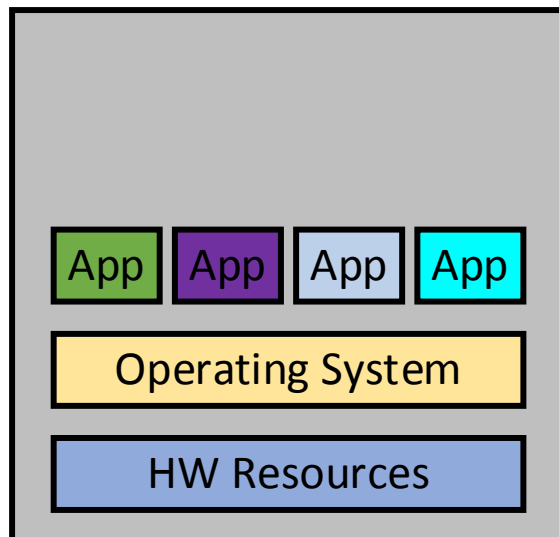
Use software-based representations of components

- Better resource utilization (through multi-tenancy)
- Better flexibility (copy, migrate, start, stop)

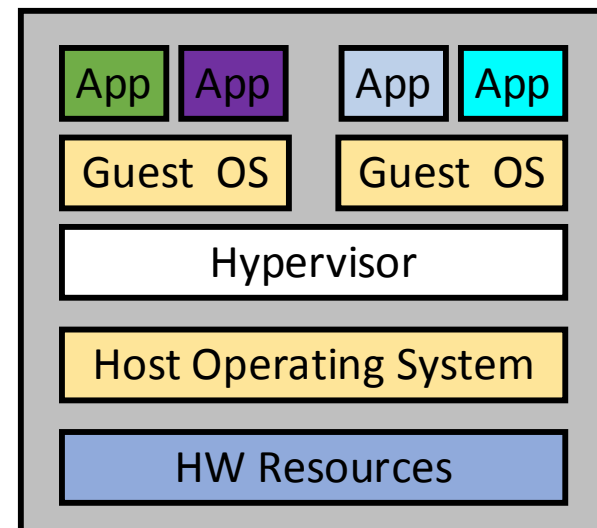
Host → The physical server hosting the Virtual Machines and hypervisor.

Virtual machine → A virtual representation of a physical server.

Hypervisor → Software responsible for managing the virtual machines.



No Virtualization



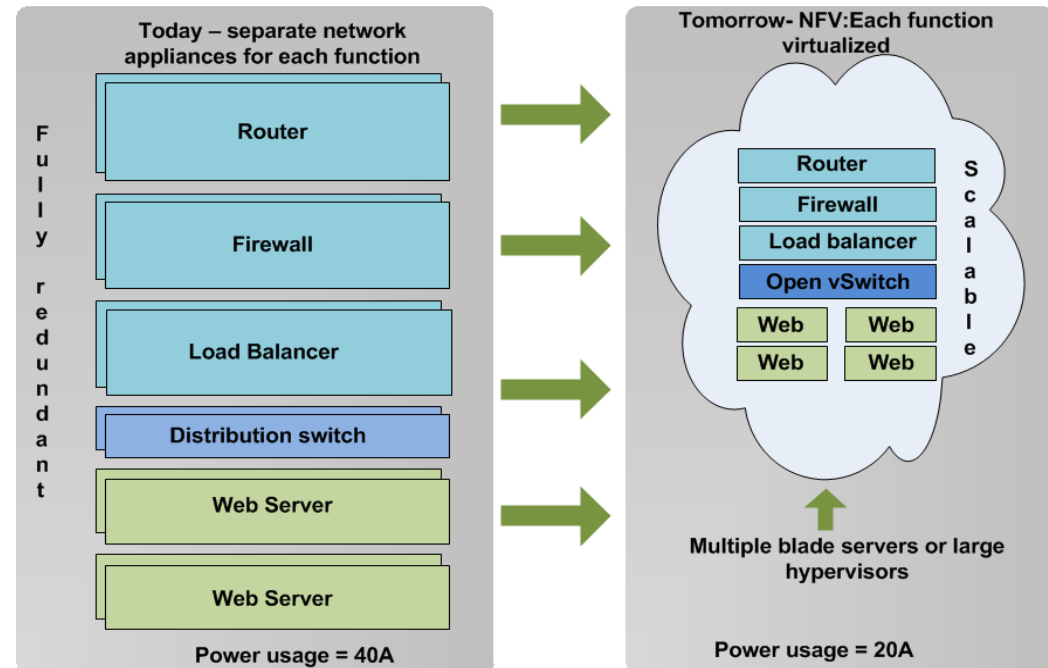
Virtualization

Network Function Virtualization

- Networks consist of many specialized boxes.
 - Firewalls, NATs, Deep Packet Inspection units, Intrusion Detection units etc.

- These boxes are:
 - Hard to manage
 - Proprietary
 - Consume a lot of power
 - Not scalable.

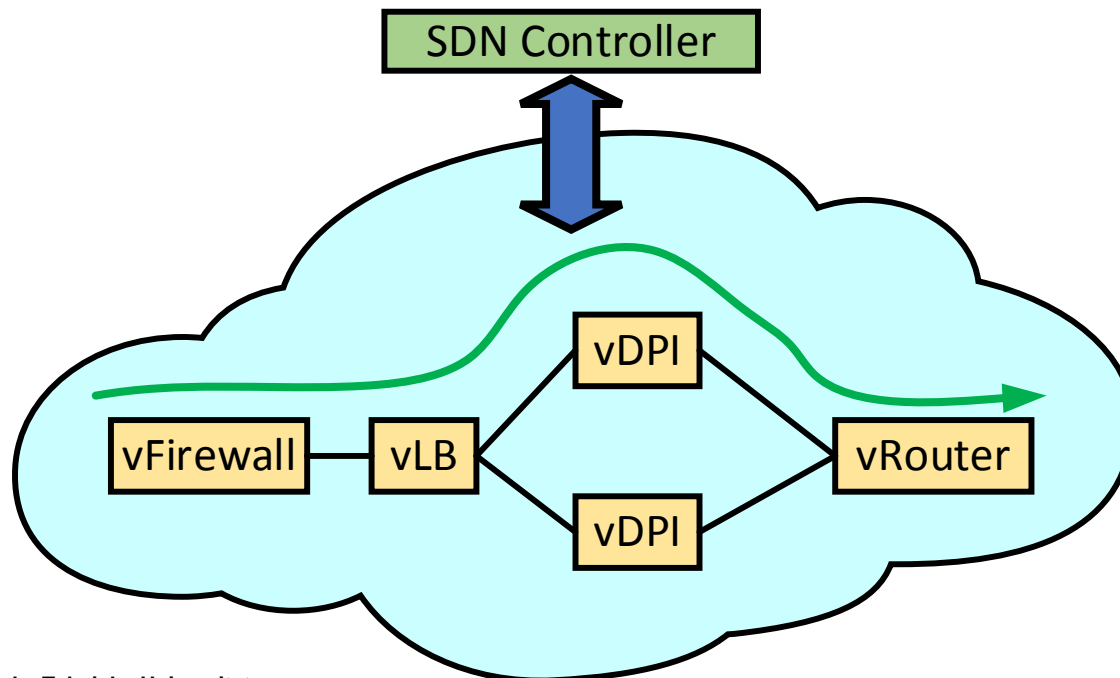
- **NFV** paradigm:
 - Move network functions from hardware to software, using virtualization.



Source: http://wikibon.org/wiki/v/Network_Function_Virtualization_or_NFV_Explained

SDN and NFV: Service Function Chaining

- SDN and NFV are not necessarily inter-dependent.
 - SDN → Programs the control plane.
 - NFV → Processing of traffic flows in the data plane.
- They are however **highly** complementary.
 - Traffic flows need to be routed through VNFs.
 - SDN controller enables the traffic routing.



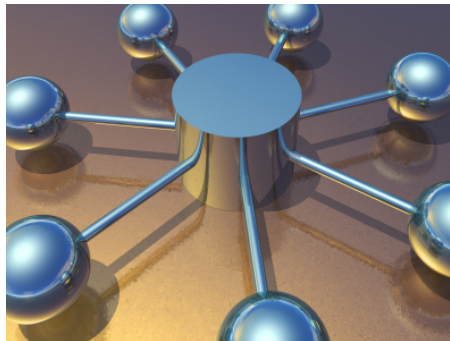
Final Word

- ✓ Want to know more about SDN & get practical experience ?
- ✓ DTU's Course 34359-SDN , spring of 2019!

<http://www.kurser.dtu.dk/34359.aspx?menulanguage=en-gb>

<http://www.dtu.dk/Uddannelse/Efteruddannelse/Kurser>

<http://www.dtu.dk/Uddannelse/Efteruddannelse/Kurser/Kurser-via-tompladsordning>



Source: <http://old.ctcco.com/Wimax/PrivateNetworks.htm>

Questions ?

