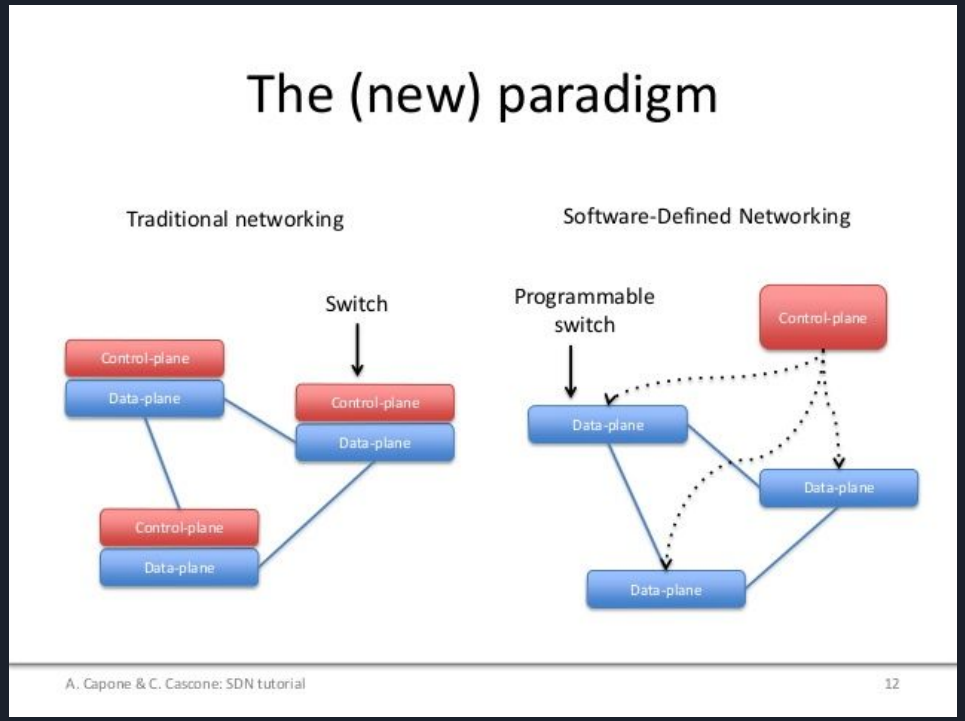
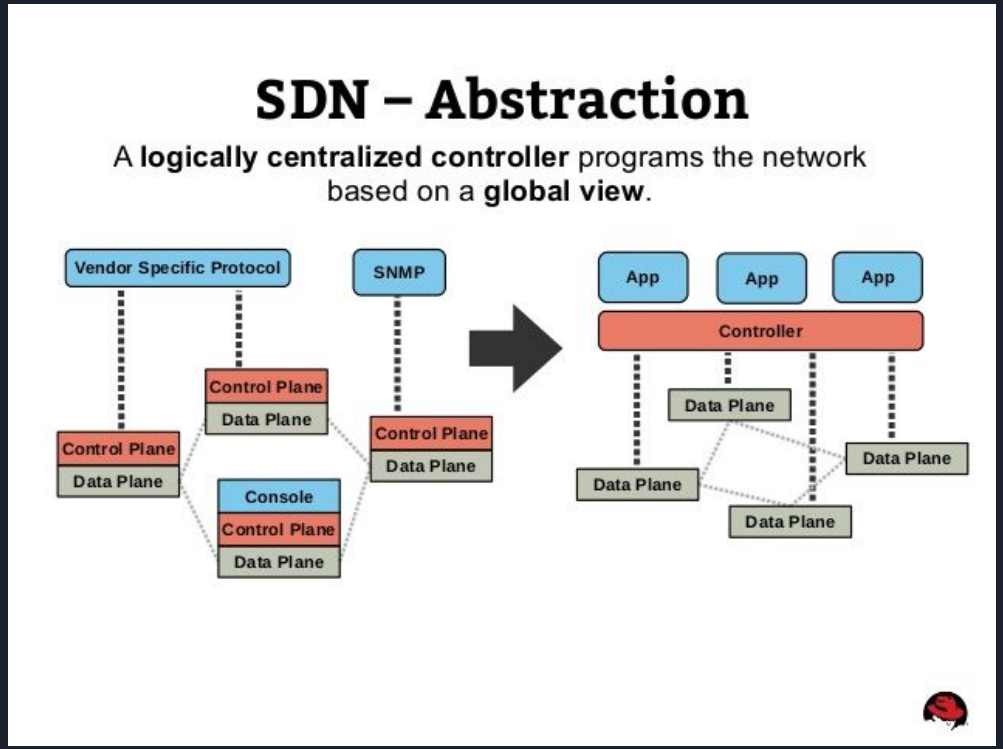
Software Defined Network

What is SDN ?


The (new) paradigm
Traditional networking
Switch
Control-plane
Data-plane
Control-plane
Data-plane
Control-plane
Data-plane
Software-Defined Networking
Programmable switch
Control-plane
Data-plane
Data-plane
Data-plane
A. Capone & C. Cascone: SDN tutorial
12

What is SDN ?


SDN – Abstraction
A logically centralized controller programs the network based on a global view.
Vendor Specific Protocol
SNMP
Control Plane
Data Plane
Control Plane
Data Plane
Console
Control Plane
Data Plane
Control Plane
Data Plane
App
App
App
Controller
Data Plane
Data Plane
Data Plane
Data Plane

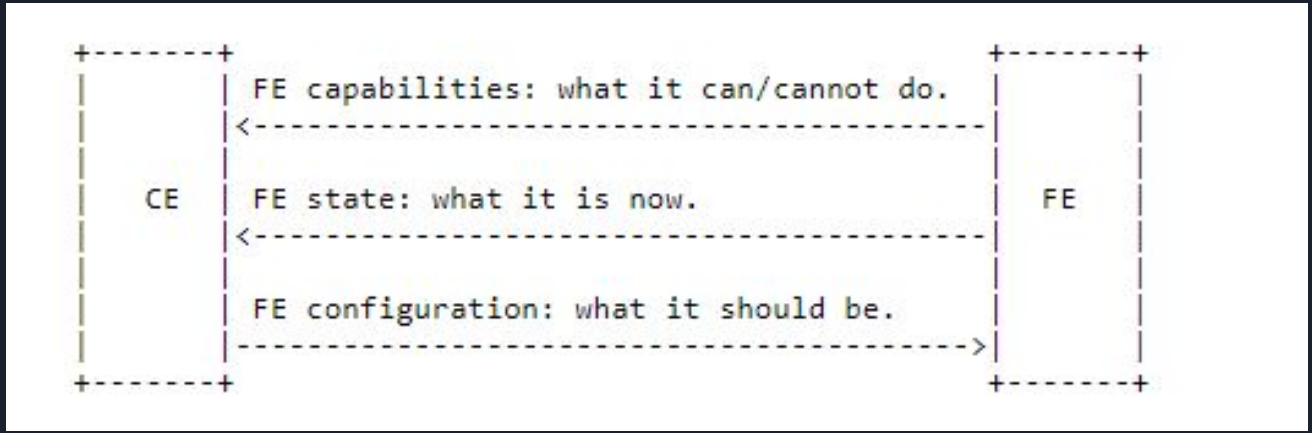
What is SDN ?

- Separate the forwarding hardware and control decisions
- Centralized in software-based controllers (the control plane)
- Network devices = packet forwarding devices (the data plane)
- Common SDN architecture (ForCES, OpenFlow)

SDN Architectures

- ForCES
- OpenFlow
- OpenFlow is overwhelmingly more common
- OpenFlow has hardware support from networking companies

ForCES

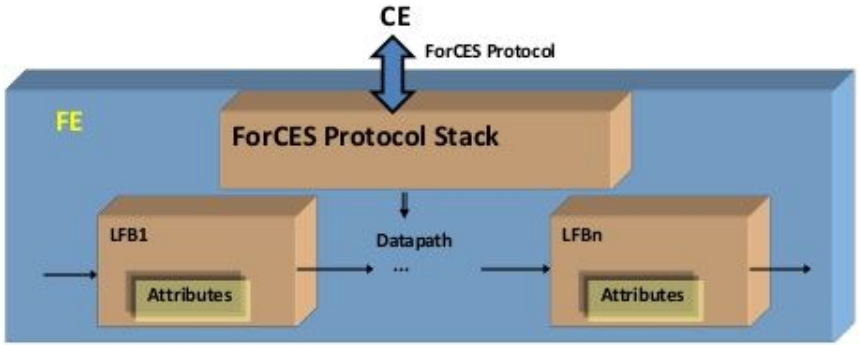


- The control element(CE)
- The forwarding element(FE)

ForCES

ForCES Architecture - FE

FE Model



- ForCES Protocol
  - To provide a universal standardized control interface for FEs
- LFB – Logical Functional Block
  - e.g., Classifier LFB, IPv4 LPF LFB, IPv6 LPF LFB, Scheduler LFB
- Datapath
  - Can configure dynamically LFB topology for supporting various over IP services

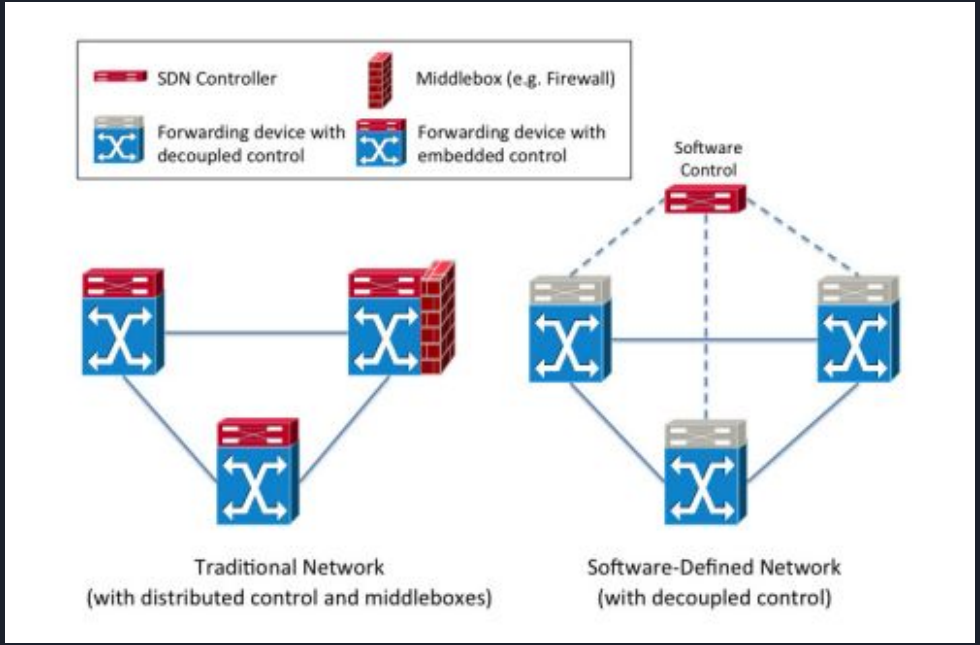
ForCES

- The control element(CE) separate from the forwarding element(FE)
- The FEs use hardware to handle packet
- The CEs execute control and signaling function + instruct the FEs
- The Logical Function Block(LFB) enables the CEs to control the FEs (Configuration + process)

Openflow

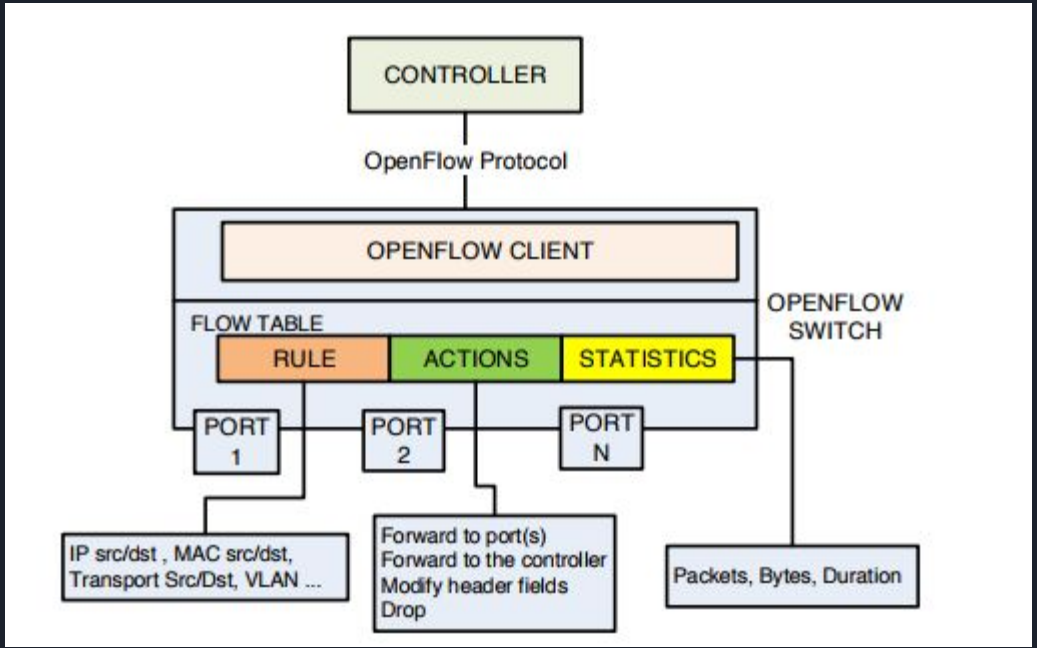
The control plane device

The data plane device



Openflow

1) Controller
2) Openflow switch
   - Abstract Layer
   - Flow table
     - Match Field (Rule)
     - Set of Instructions
     - Counter



ForCES vs OpenFlow: What are the differences?

- ForCES uses Logical Function Blocks (LFBs) while OpenFlow uses flow tables
- Every router in ForCES has both the control plane and the data plane
- In OpenFlow however, there are separate control devices and forwarding devices
- Both can be “programmed” to achieve the same task

Forwarding Devices

- Computational tasks are offloaded to the controller
- Forwarding devices are called just “switches”
- Forwarding devices still need to process OpenFlow rules
  - General-purpose CPU or special network acceleration card can be added
- Forwarding devices have small memory
  - OpenFlow rules are more complex than traditional IP rules
  - Many solutions by multiple groups exist as extensions to OpenFlow

The Controller

- Usually a computer running control software
- Applications interact with controllers using REST API and can be developed in any languages
- Control Scalability
  - Modern and upcoming controllers can support many flow requests and switches now
  - Greatly impacted by Control models
- Control models
  - Can be centralized or distributed
  - Flow decisions take time, should never consider each packet separately
  - Flows should be grouped whenever possible
  - Some policies should be pushed to the switches

Communications

- Controller-Switch (Southbound)
  - Must be secure as the protocol (OpenFlow) is open source
    - OpenFlow 1.3.0 has TLS support and (some) support for certificate exchange
    - No fine-grained (permission control) specified yet by the standard
- Controller-Service and Controller-Controller (Northbound)
  - No standards defined yet as of now

SDN Development tools

Simulation tool

Mininet

Native SDN Switches

Software Switch Platforms

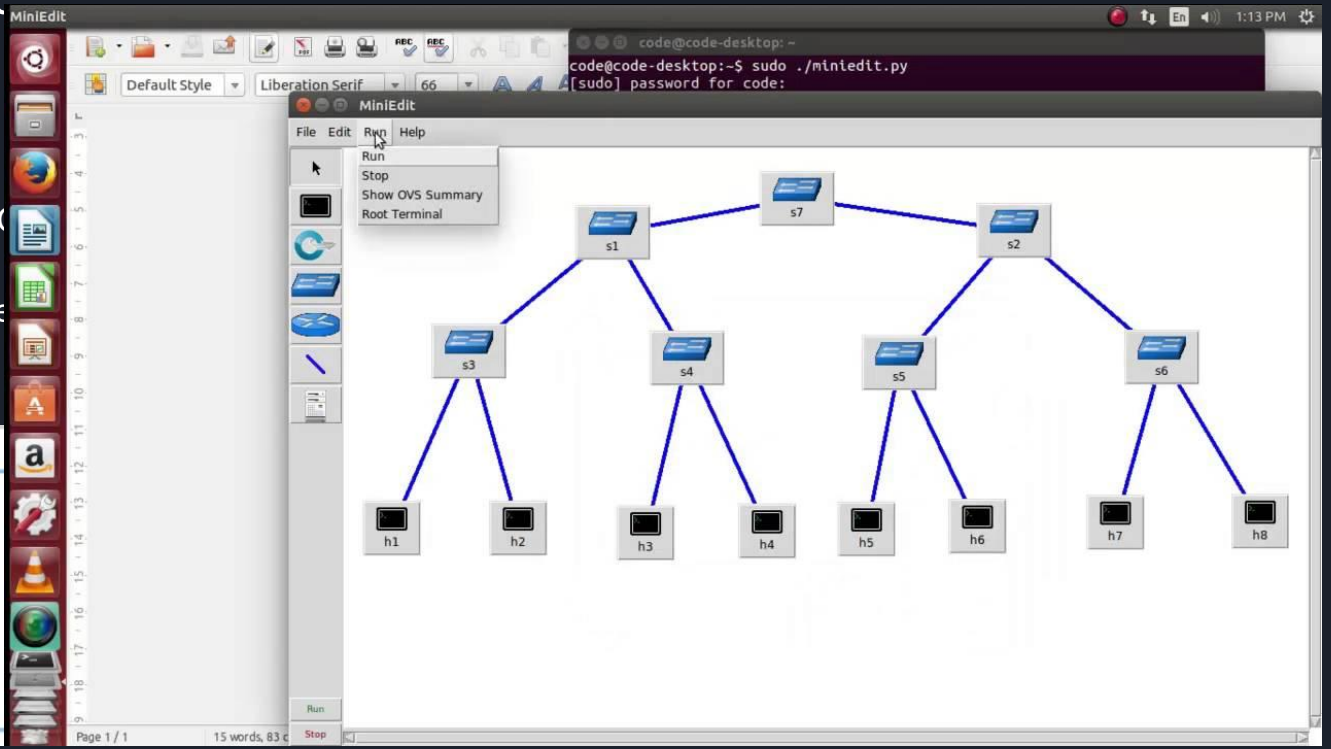
OvS

Open vSwitch

Mininet

Emulate entire C

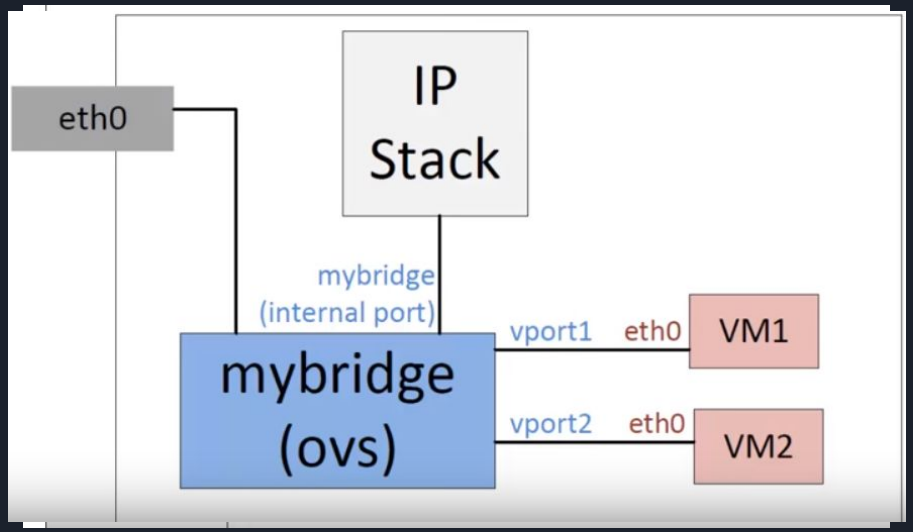
Support switche



Open vSwitch

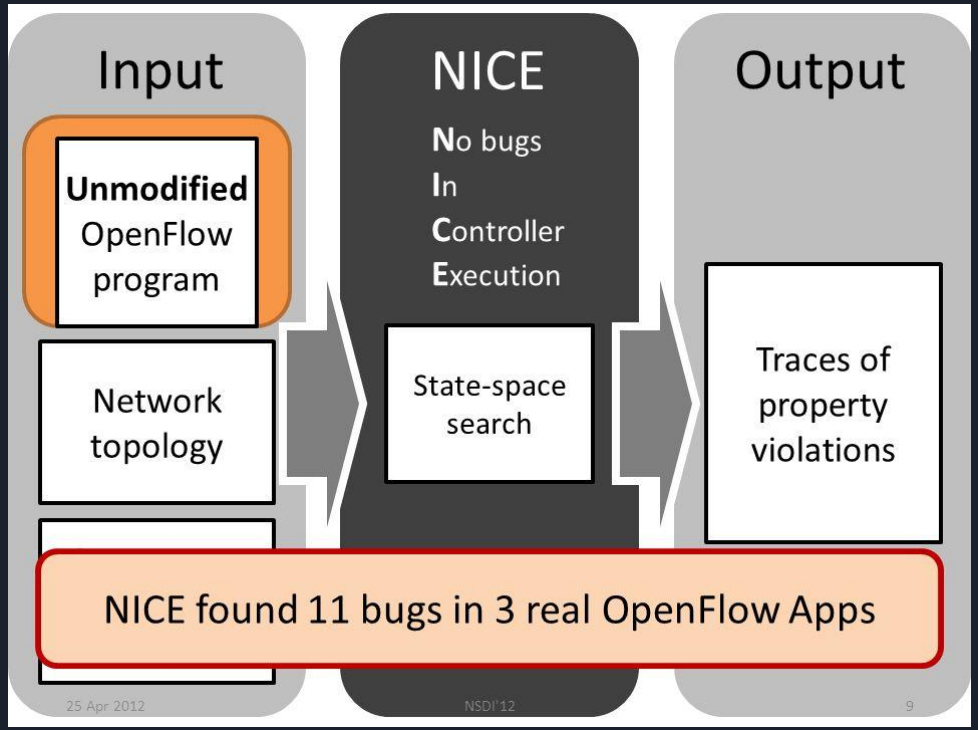
enable massive network automation through programmatic extension

distribution across multiple physical servers similar to VMware



NICE

Code Verification and Debugging



SDN BENEFICIAL

- Enterprise Networks

- Data Centers

- Infrastructure-based Wireless Access Networks

- Optical Networks

- Home and Small Business

Statistic on Datacenter

network subset which satisfies current traffic conditions and

turns off switches that are not needed.

- **3 billion kWh in 2006.**

- **energy savings between 25-62%**
- **0.75 - 1.86 billion kWh**