IXP in the Cloud era: the SDN opportunity

Antonio Cianfrani

DIET Department – Networking Group

SAPIENZA
UNIVERSITÀ DI ROMA

Outline

- Software Defined Networks (SDN): an overview

- IXP: the right place for SDN deployment?

- IXP and the Cloud scenario

SDN

- SDN: new paradigm to overcome the ossification of legacy IP networks:
  - Network devices are proprietary → Configuration procedures are different
  - A device for each network function (router, firewall, load balancer)
  - New network function → standardization, device update

- SDN idea comes from the Clean Slate Project:

  "...explore what kind of Internet we would design if we were to start with a clean slate and 20-30 years of hindsight."

Legacy network devices

- Vertical integrated stacks
  - Dedicated networking hardware
  - Network Operating System (closed)
  - Functionalities to be added → new operating system or new device!

- A legacy device performs:
  - Data plane actions (forwarding of packets)
  - Control plane action (protocols → network intelligence)

| L3 Rout. | VLAN | Secur. | ... |

Network OS

Hardware

Control Plane
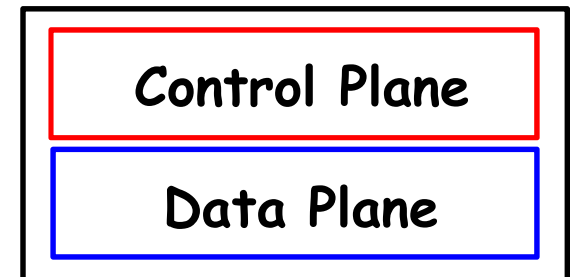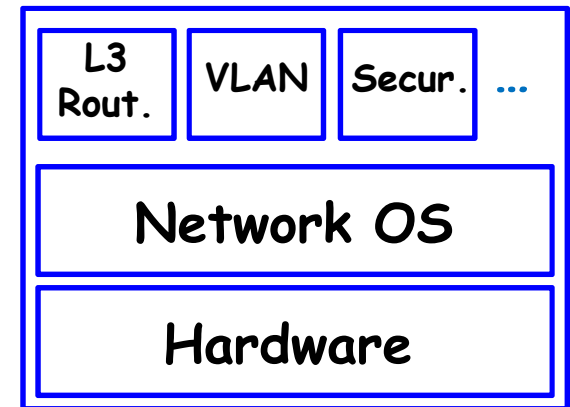
Data Plane

Software Defined Networking: the idea

- The control and the data plane are decoupled
- The control plane is logically centralized
- The data plane is programmable and abstracted from the control plane

SDN switch

Data Plane

Control Plane   **SDN Controller**

Data Plane

Data Plane

Data Plane

Data Plane
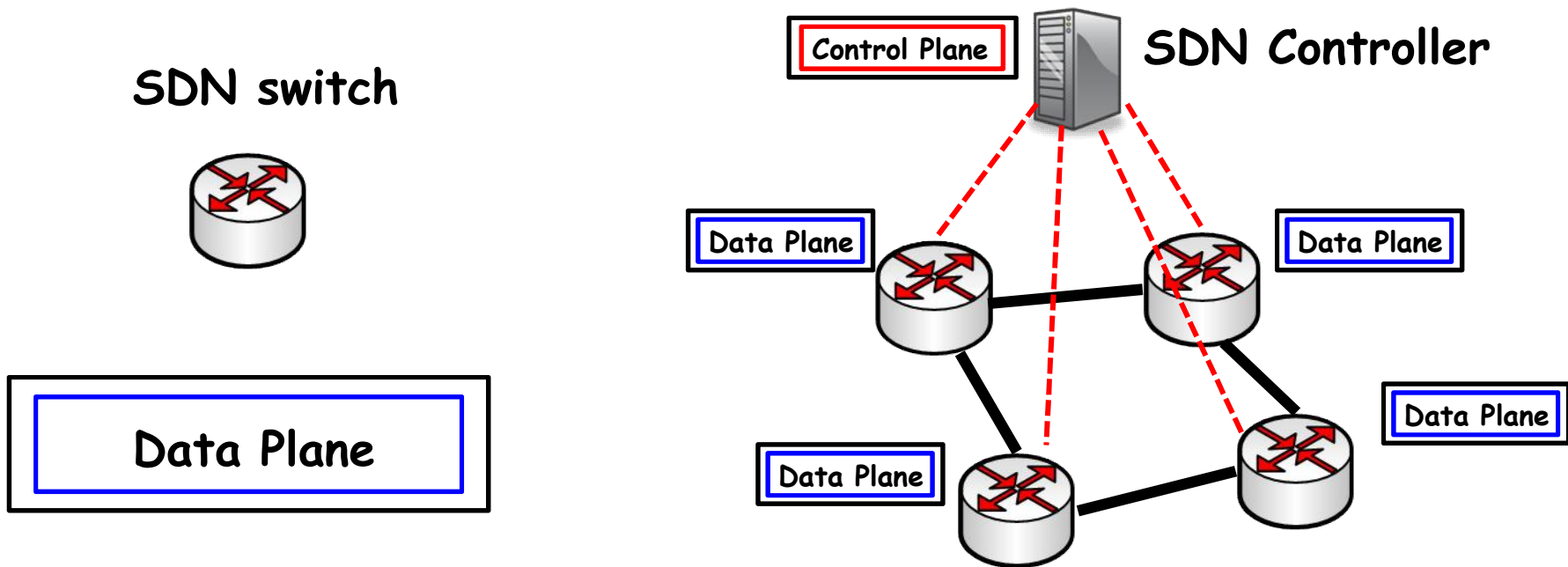
SDN: the Controller

- The control plane software runs on general purpose hardware → the SDN Controller
- The SDN Controller controls and programs the SDN switches, executing Network Applications decisions
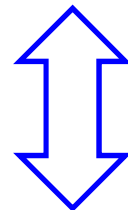
| Network App | Network App | Network App |

Northbound Interface

The SDN controller has a global view of the network

Network Operating System

Southbound Interface

Network Applications

- Network Applications:
    - switching, routing
    - NAT, L3/L4 firewalling
    - network slicing, traffic engineering
    - ....

- Applications are decoupled from specific networking hardware → the network is open!

- Functions can be added/removed/changed by configuring software on top of the controller; no need to touch SDN switches.

SDN switch

- The network infrastructure is programmable and abstracted from the applications

- An SDN switch has a Flow Table to perform forwarding:
  - Forwarding based on many header fields → Flow based forwarding
  - Advanced forwarding: encapsulation / header fields modification

- Southbound protocol
  - OpenFlow
  - NetConf
  - BGP-LS
  - ……

SDN in action

- Open Source activity
  - Data Plane: Open vSwitch
  - Controller: NOX, Floodlight, ONOS; etc…

- Networking companies:
  - OpenFlow Switches (Cisco, Juniper, NEC, HP, Pronto,…)
  - Programmable hardware: FD.IO (Cisco, Ericsson, Intel,..)

- A real SDN implementation "B4: Experience with a Globally-Deployed Software Defined WAN"

SDN from an IXP perspective

- An IXP is the <u>right place </u>where to deploy SDN:

  - An IXP has an intrinsic SDN architecture: the switches as Data Plane and the Route Server as Controller

  - New SDN based functionalities will be able to provide benefits for all its peering ISPs

  - The cloud scenario

The Cloud scenario

- Content Providers, CDN, Cloud Providers

- New service requirements:
  - fast and efficient services for their users;
  - highly dynamic.

- Cloud Providers ask for new inter-domain TE routing policies:
  - QoS constrained end-to-end service
  - Fine grained service specific peering (application-specific peering)

Inter-domain TE policies

- Routing policies are managed by BGP. Constraints:
  - Routing only based on destination IP prefix
  - Paths are not directly selected (indirect policies such as local-pref and AS prepending)
  - QoS constrained end-to-end services difficult (impossible?) to be provided

An SDN based IXP

- New features provided by SDN :

  - Forwarding based on many packet header fields → Flexible Forwarding and fine grained policies (<u>application-specific forwarding</u>)

  - New Control Plane functionalities on top of the SDN Controller → new communication mechanism for path selection (<u>QoS constrained end-to-end path</u>)

  - Backward compatibility (BGP support) → Incremental deployment

More applications

- Redirection to middleboxes

- Security

- Load-balancing

- Traffic offloading

Thanks!