Look out

Network virtualization

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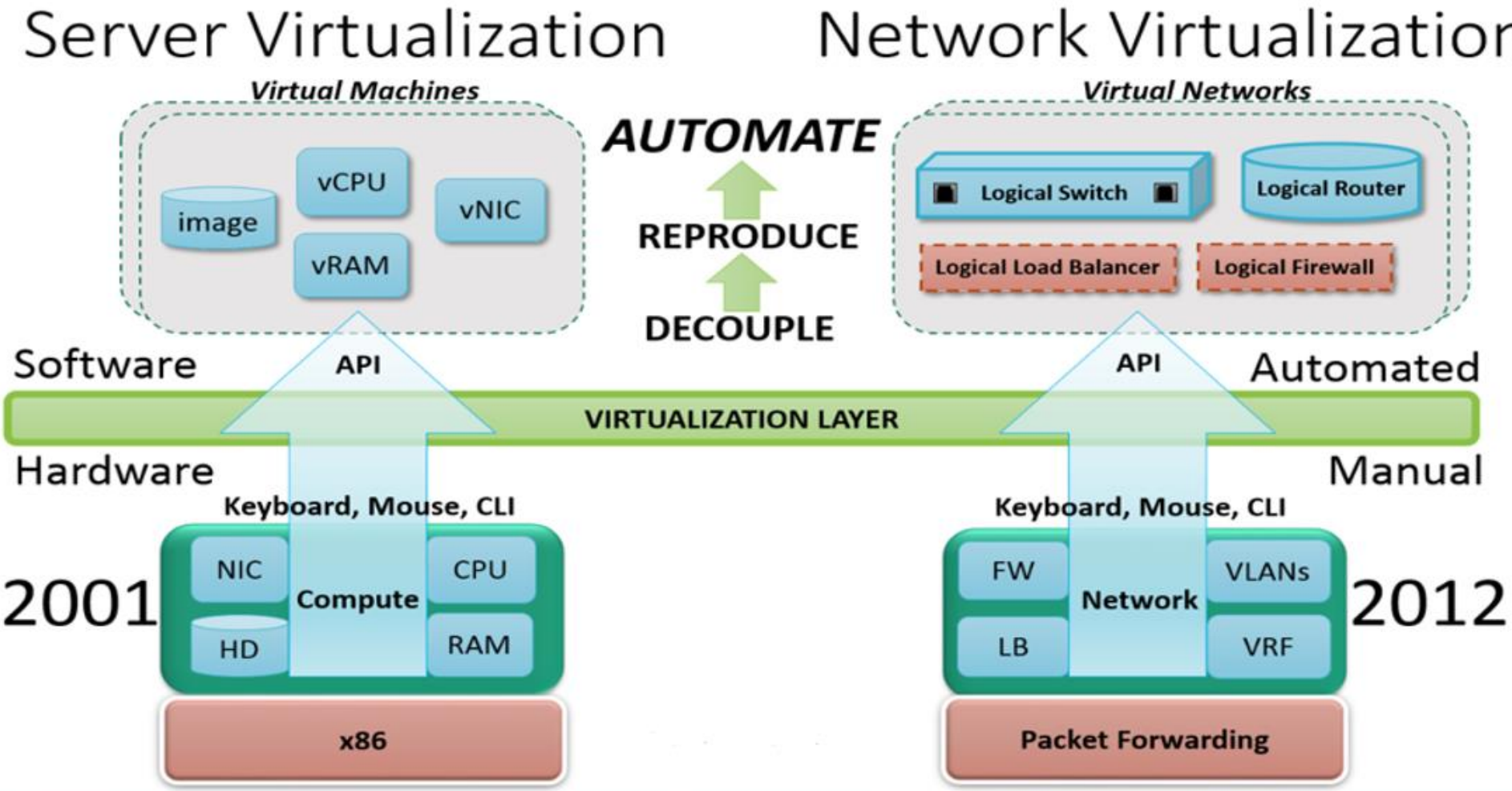
Network Virtualization

- **Network virtualization** is the process of combining hardware and software network resources and network functionality into a single, software-based administrative entity, a **virtual network**.


Server Virtualization
Network Virtualization
Virtual Machines
Virtual Networks
AUTOMATE
REPRODUCE
DECOUPLE
image
vCPU
vRAM
vNIC
Logical Switch
Logical Router
Logical Load Balancer
Logical Firewall
Software
API
API
Automated
VIRTUALIZATION LAYER
Hardware
Manual
Keyboard, Mouse, CLI
Keyboard, Mouse, CLI
2001
NIC
HD
Compute
CPU
RAM
FW
LB
Network
VLANs
VRF
2012
x86
Packet Forwarding

SDN CONCEPT

SDN

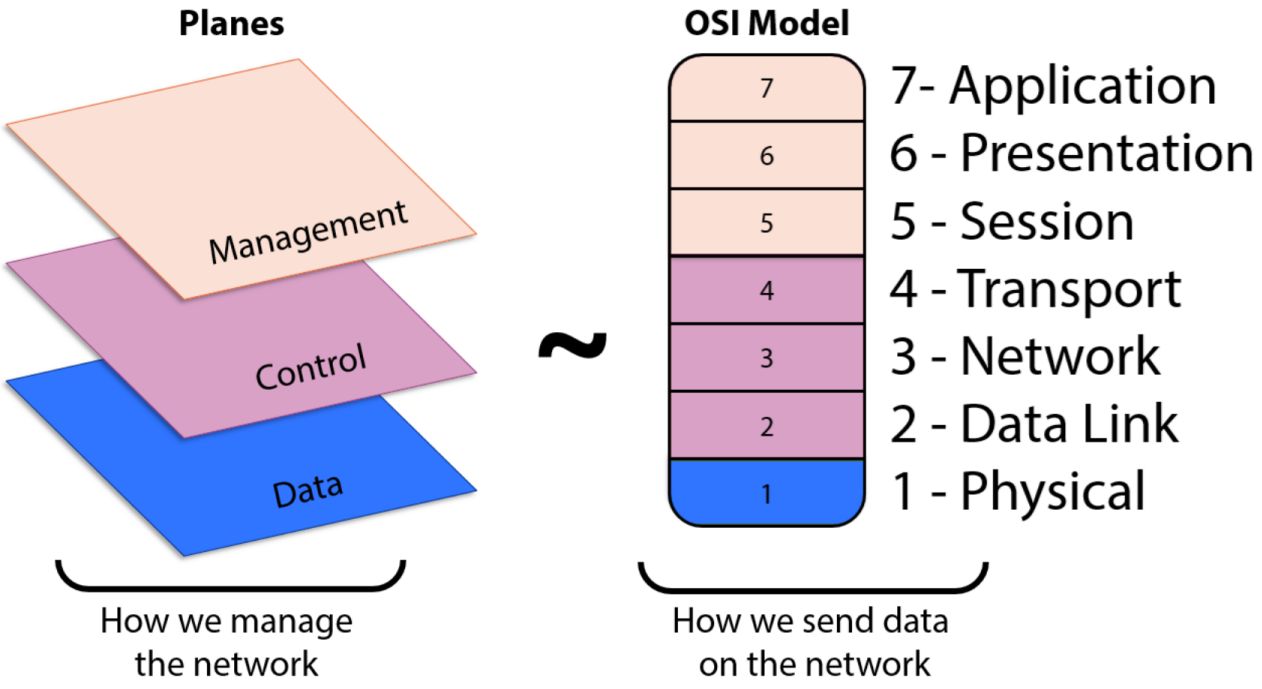
Software Defined Networking (SDN) centralizes and automates management of network devices.

Defining SDN

- **Software Defined Networking (SDN):**
  - Centralizes command and control in the network
  - Delegates the network flow control decision making to a device with network omniscience
  - Separates the Control plane from the Data plane

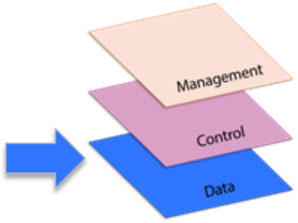
Architecture

- **SDN is not a product or protocol… it's an architecture!**



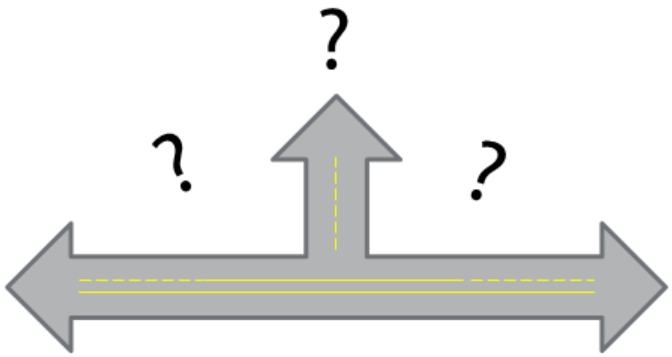
Data Plane

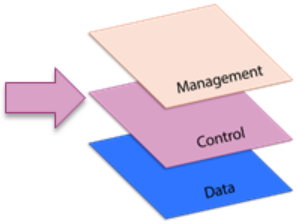
- Moves data packets from place to place
- Like a data highway, the Data Plane represents only the infrastructure
- Decisions are not made in the Data Plane, but there are different roads to take



Control Plane

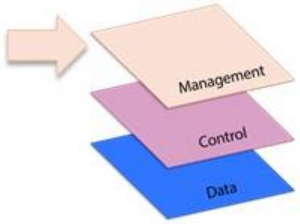
- **Logistics and tactical decisions**
  - Where does the packet go?
- **Like Flow control on a highway, or route guidance (GPS)**
  - Examples: STP, OSPF, EIGRP





Management Plane

- High level configuration commands
- The human or application interface
  - Examples: Consoles, SSH, Web GUIs



SDN enabler: OpenFlow

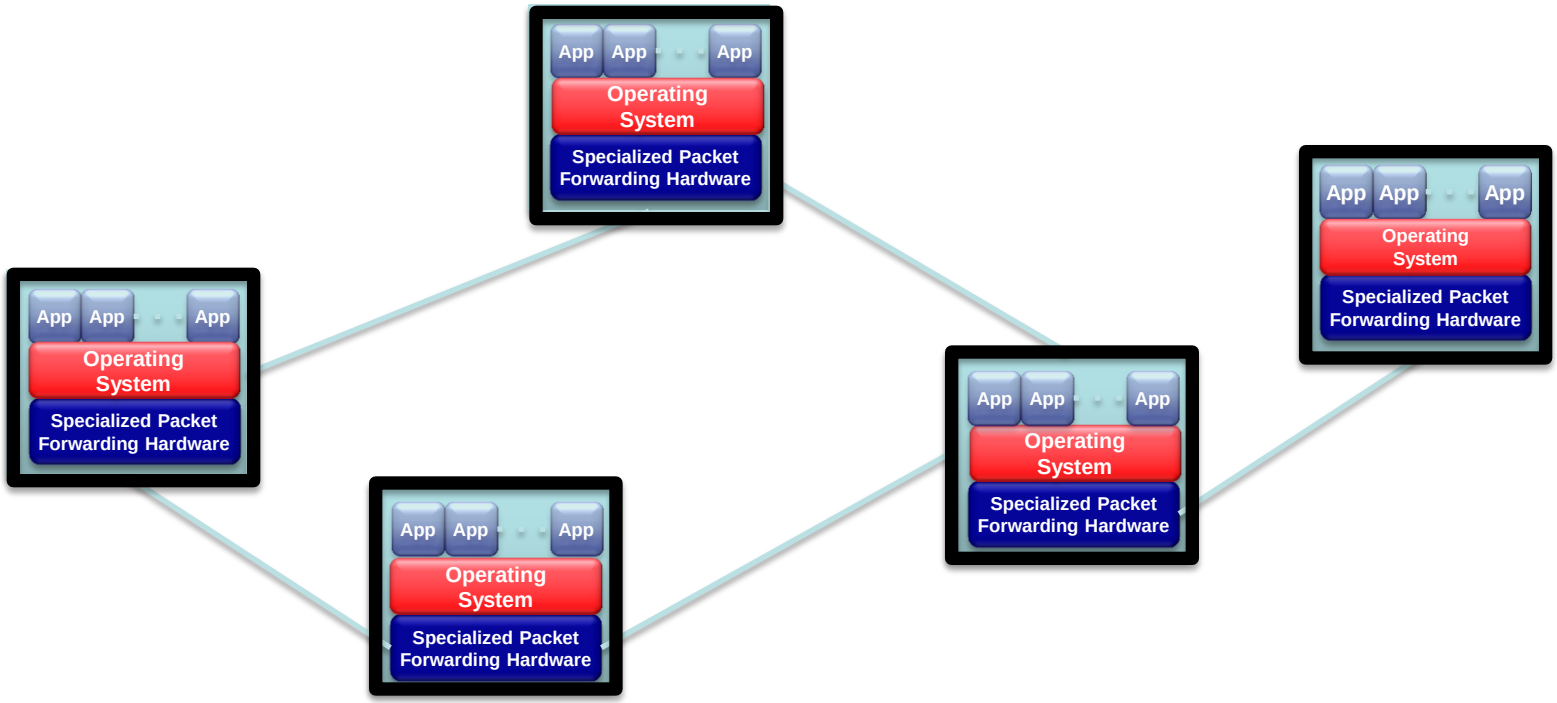
- OpenFlow
  - Control-data separation+
  - Abstraction of networking devices
  - Generalization of operations
  - New concept: network OS

  - One realization of SDN (concepts)
  - BUT there are others
    - E.g. BGP based
    - Vendor specific.: Cisco ONE platform, Juniper JunOS SDK

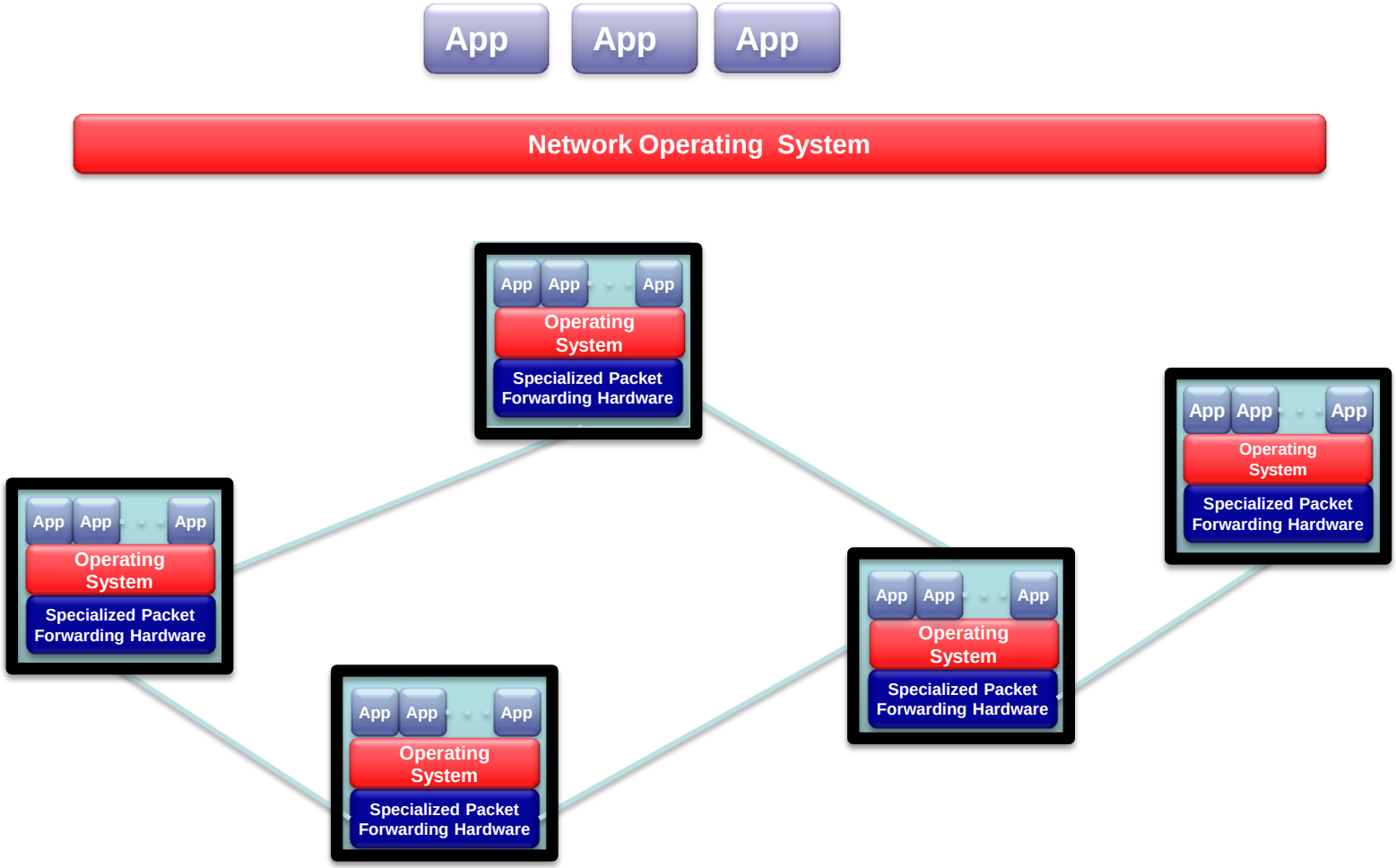
How did we get to SDN?

- OpenFlow
  - Success – many backed up
  - Academic use
    - Best universities (USA, EU)
  - Industrial users
    - Vendors
      - NEC, HP, Cisco, Pronto, Brocade, Broadcom, Ericsson, IBM, …
    - Cloud providers
      - Amazon, Google, Microsoft, …
    - Service providers
      - Facebook, …
    - carriers
      - DT, Telecom Italia, Telefonica, NTT, …
  - Today – standardization bodies
    - Open Networking Foundation
    - OpenDaylight initiative

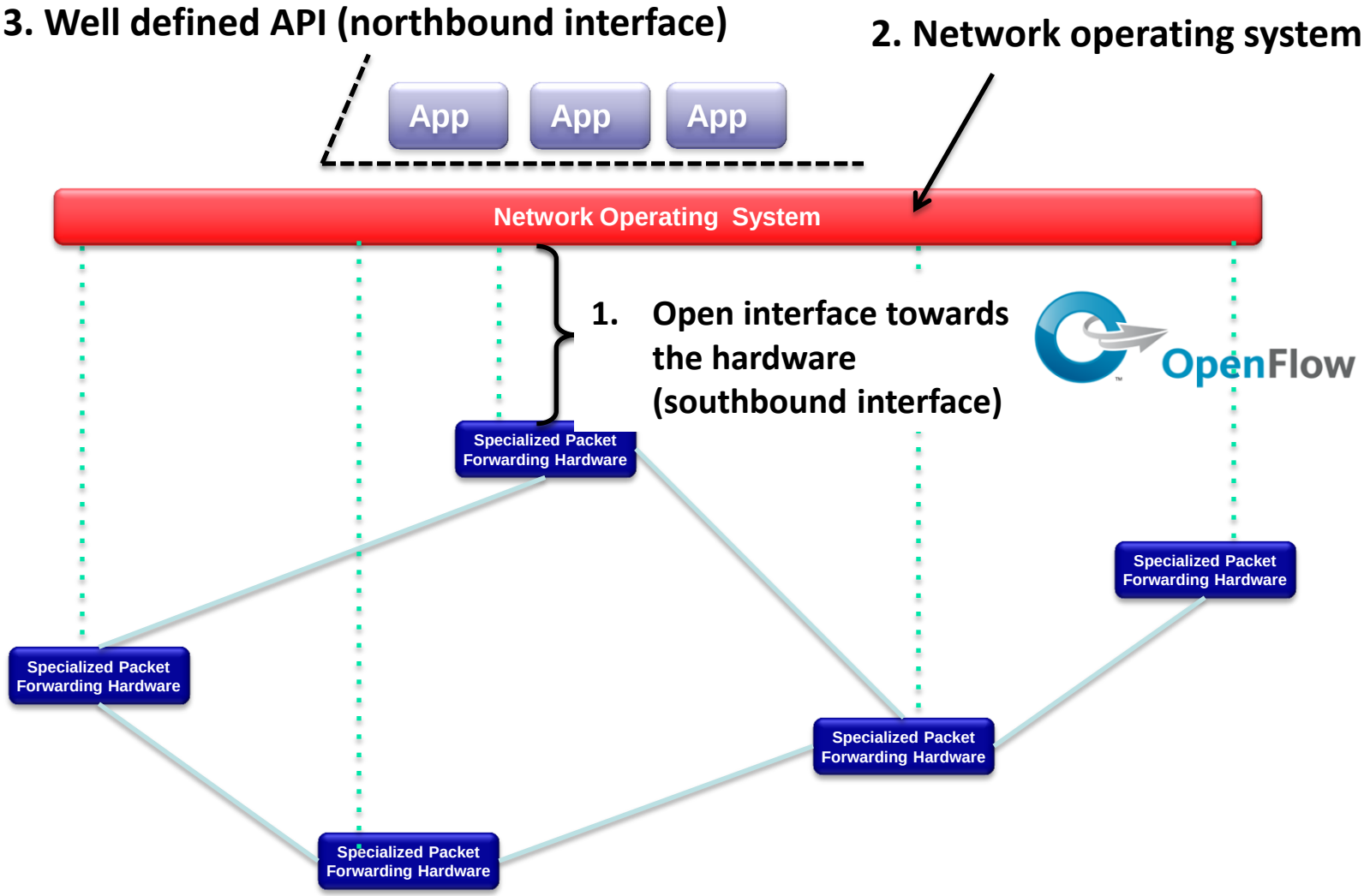
Internet traditionally



SDN: “open it up”



SDN: “open it up”



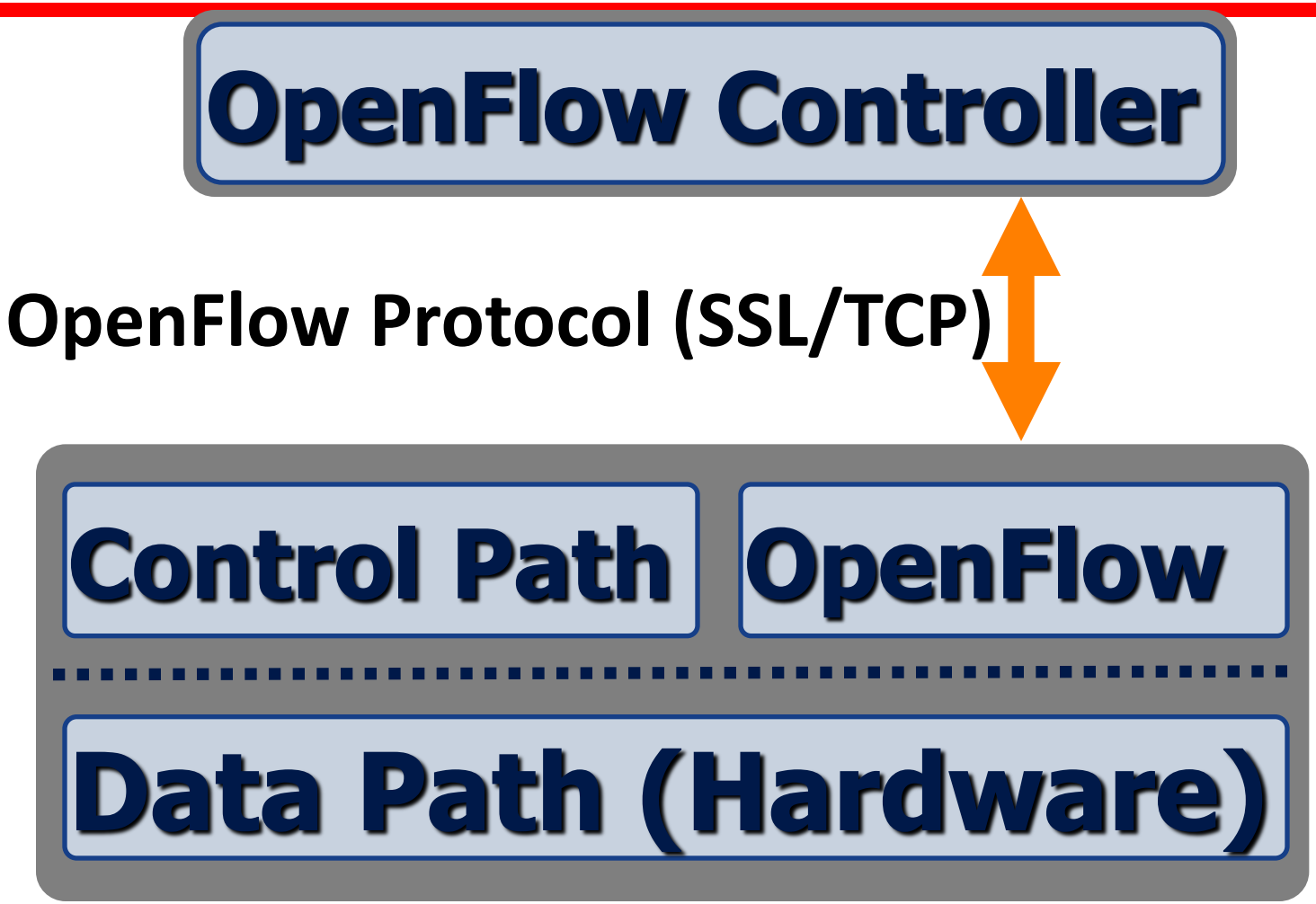
What is OpenFlow?

- OpenFlow is an API, interface

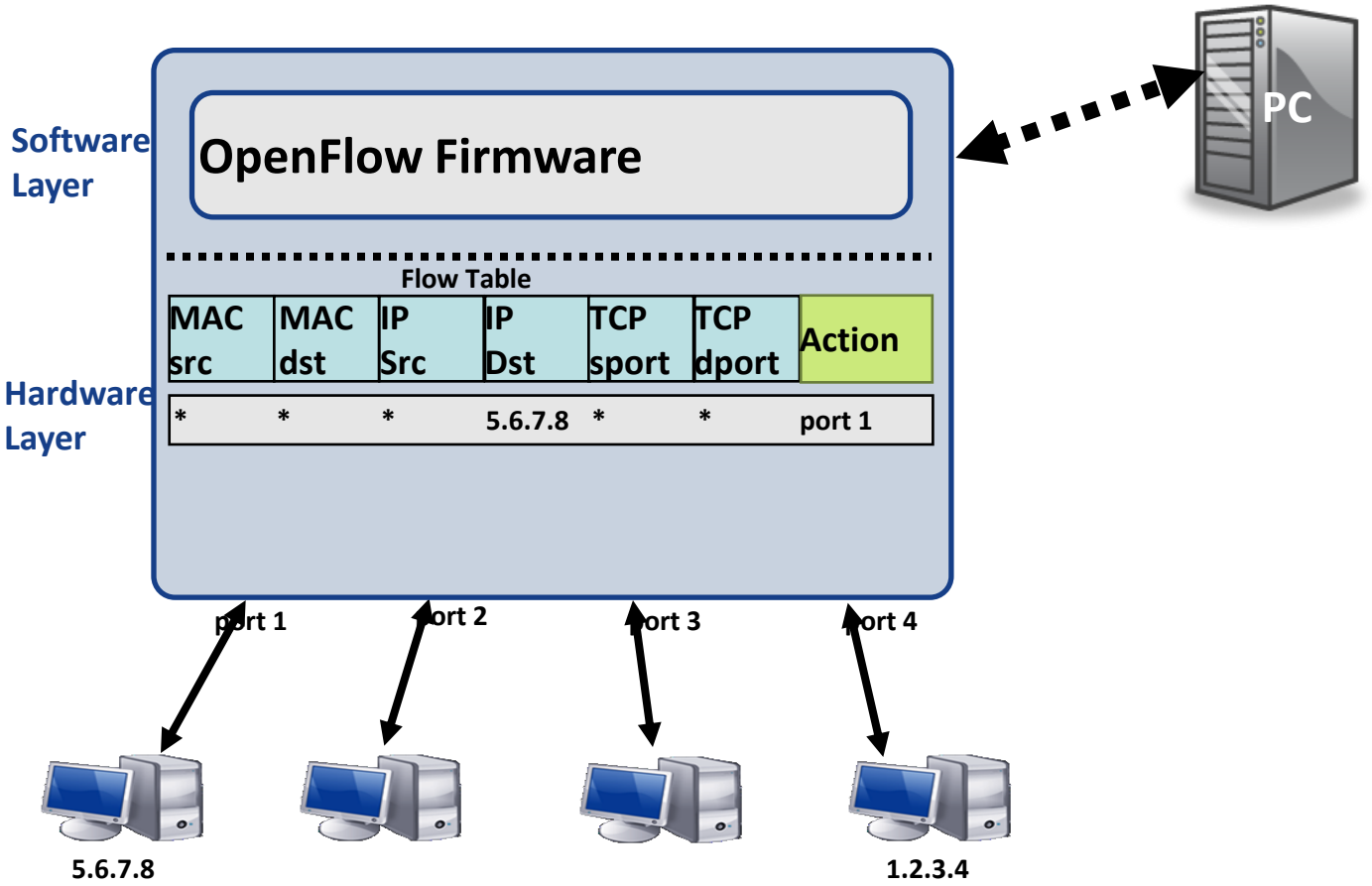
- Packet processing can be programmed through it (forwarding)
- Can run on cheap hardware
- The configured network becomes programmable
  - Not just configurable
- Easier innovation
- (simpler operation, easier to introduce new services)

- Main reasons
  - No special testbeds
  - Experimental solutions on real networks,real traffic, line speed

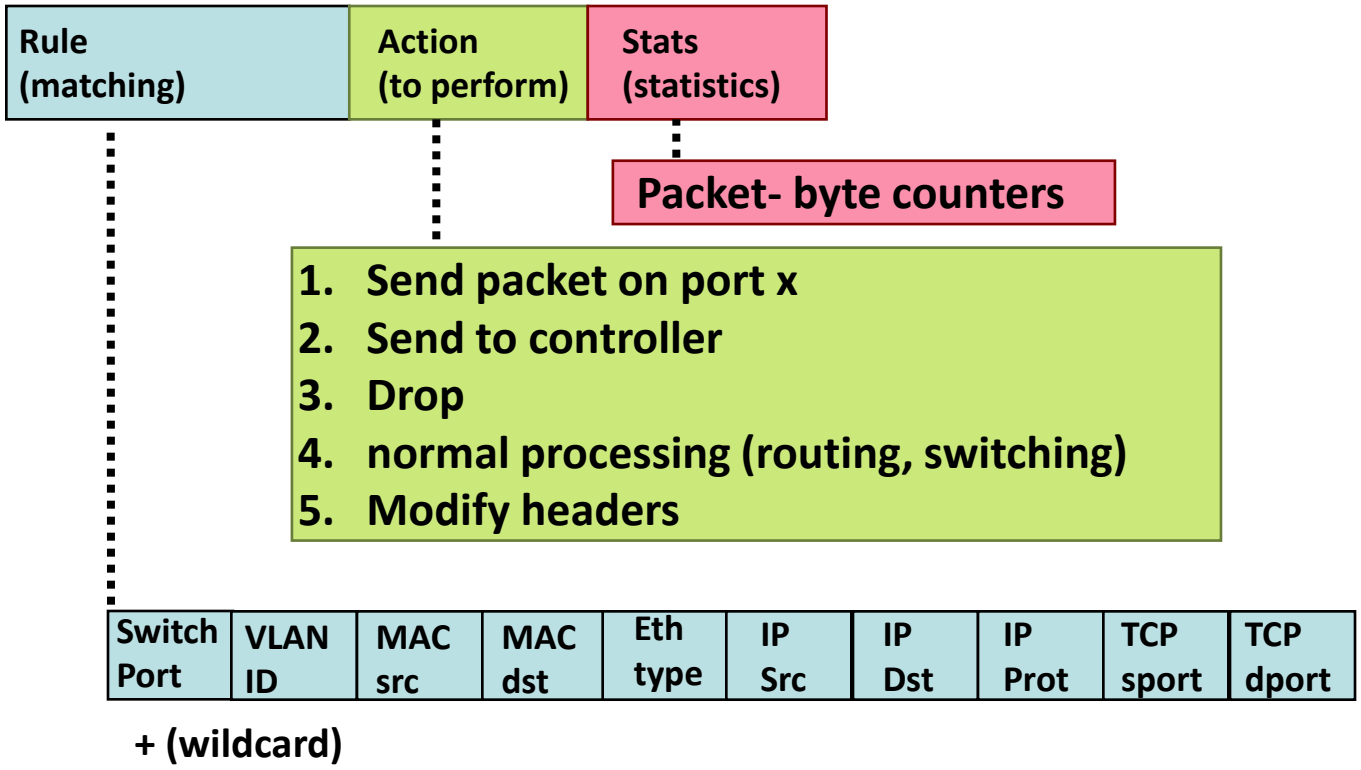

Control Path (Software)
Data Path (Hardware)


OpenFlow Controller
OpenFlow Protocol (SSL/TCP)
Control Path
OpenFlow
Data Path (Hardware)

OpenFlow flow table



Flow table entries



Flow example

Switching (L2 switching)

Switch Port	MAC src	MAC dst	Eth type	VLAN ID	IP Src	IP Dst	IP Prot	TCP sport	TCP dport	Action
*	*	00:1f:..	*	*	*	*	*	*	*	port6

Routing (L3 routing)

Switch Port	MAC src	MAC dst	Eth type	VLAN ID	IP Src	IP Dst	IP Prot	TCP sport	TCP dport	Action
*	*	*	*	*	*	5.6.7.8	*	*	*	port6

VLAN Switching

Switch Port	MAC src	MAC dst	Eth type	VLAN ID	IP Src	IP Dst	IP Prot	TCP sport	TCP dport	Action
*	*	00:1f..	*	vlan1	*	*	*	*	*	port6, port7, port9

OF switch: Software → Hardware

- Stanford Reference implementation v1.0
- Ericsson, CPqD implementation v1.1, v1.2, v1.3, v1.4
  - Linux-based **soft switch (User Space)**
- Open vSwitch
  - Linux-based **soft switch (Kernel Space)**
  - Not only an OF switch, is used in virtual machines (VirtualBox, XEN, OpenStack)
  - Real hardware firmware (SW part) often builds on Open vSwitch
- OpenWRT based routers
- NetFPGA cards

OF switches: Software → Hardware

Prototype → Product

Core Router

Cisco Catalyst 6k (prototype)

Juniper MX-series (prototype)

HP ProCurve 5400 and others

Enterprise Campus Data Center

Cisco Catalyst 3750 (prototype)

Arista 7100 series (Q4 2010)

Pronto

NEC IP8800

Circuit Switch

Ciena CoreDirector

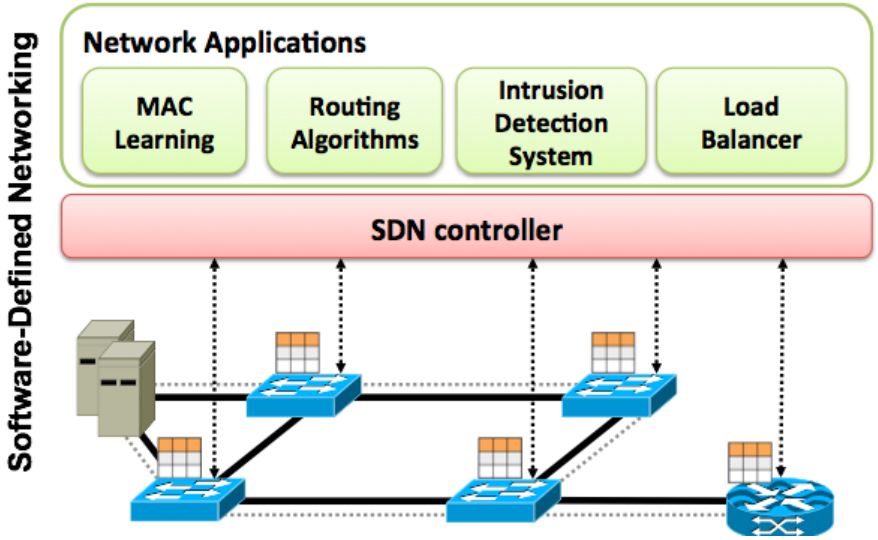
Wireless

WiMAX (NEC)

more to follow...

OF controllers

- Many platforms
- Programming
  - Different environments
  - Different languages
- Different goals
- Different processing power



NFV

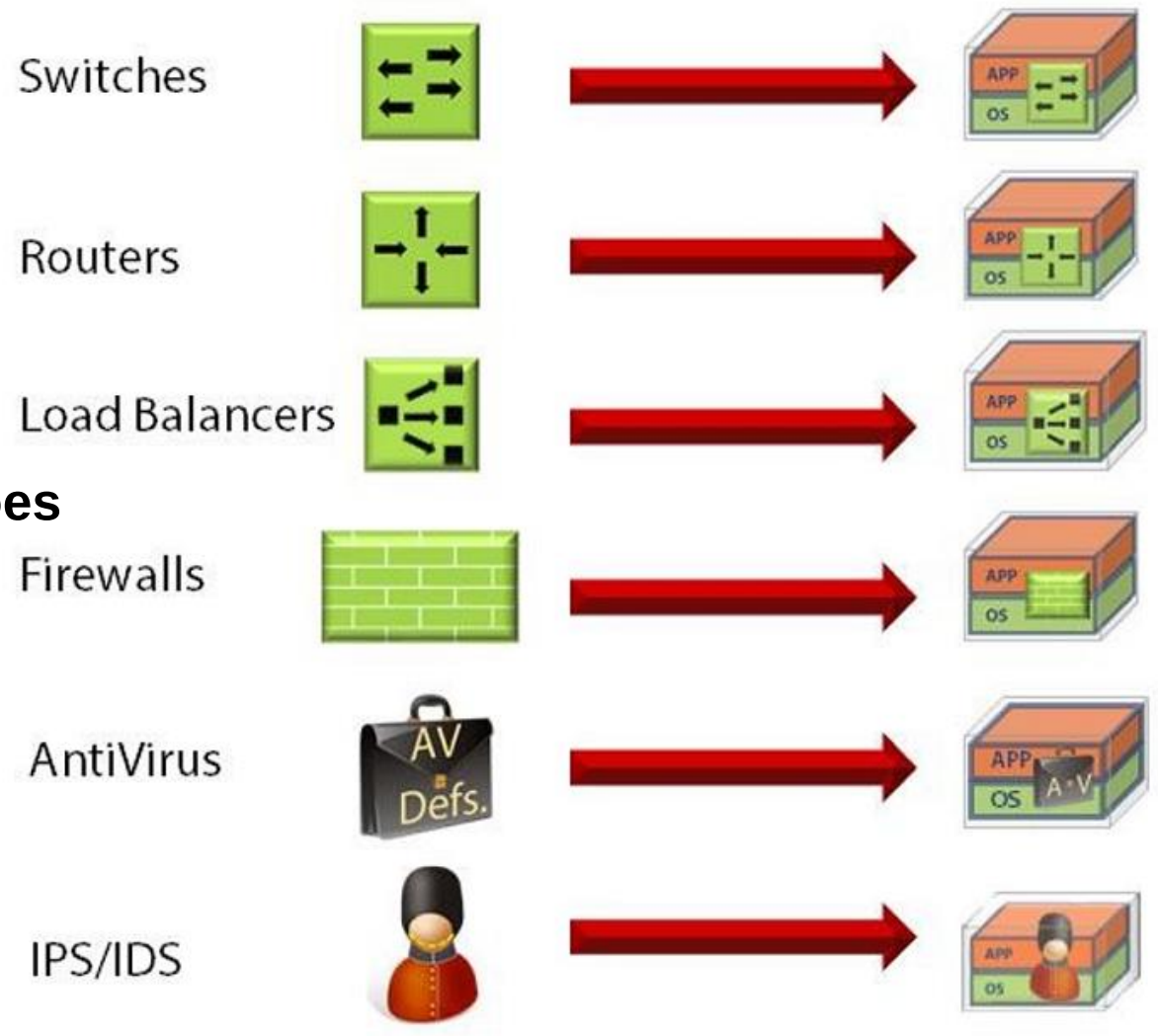
- Network Functions Virtualization

NFV

Network Functions Virtualization (NFV) is the next step in virtualization, taking physical networking equipment and running it in a VM.

NFV

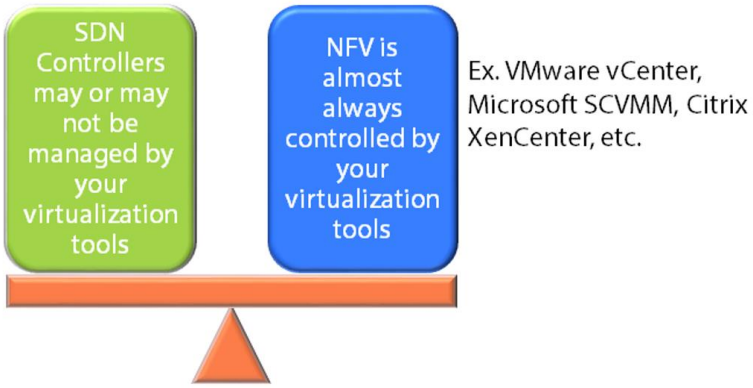
Describing What NFV Does



Introduction to NFV(Contd.)

How is NFV Different from SDN

- **While SDN is typically thought of as managing and automating tasks for physical devices, NFV is all about provisioning new networking devices.**
  - **SDN may then be used to manage the new virtual as well as the existing physical devices.**



Az SDN and NFV

- SDN: traditionally manages physical equipment
- NFV deploys virtual network equipment

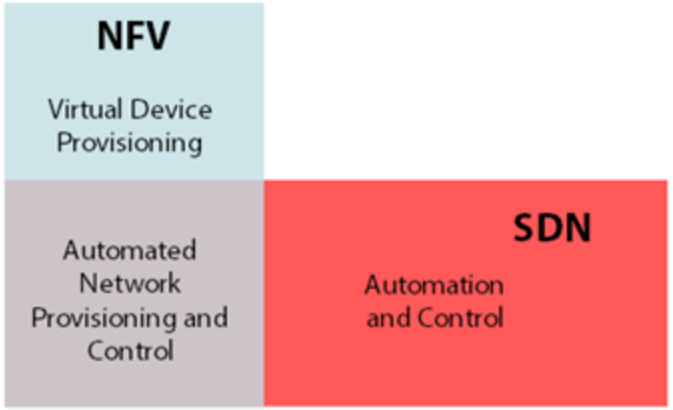
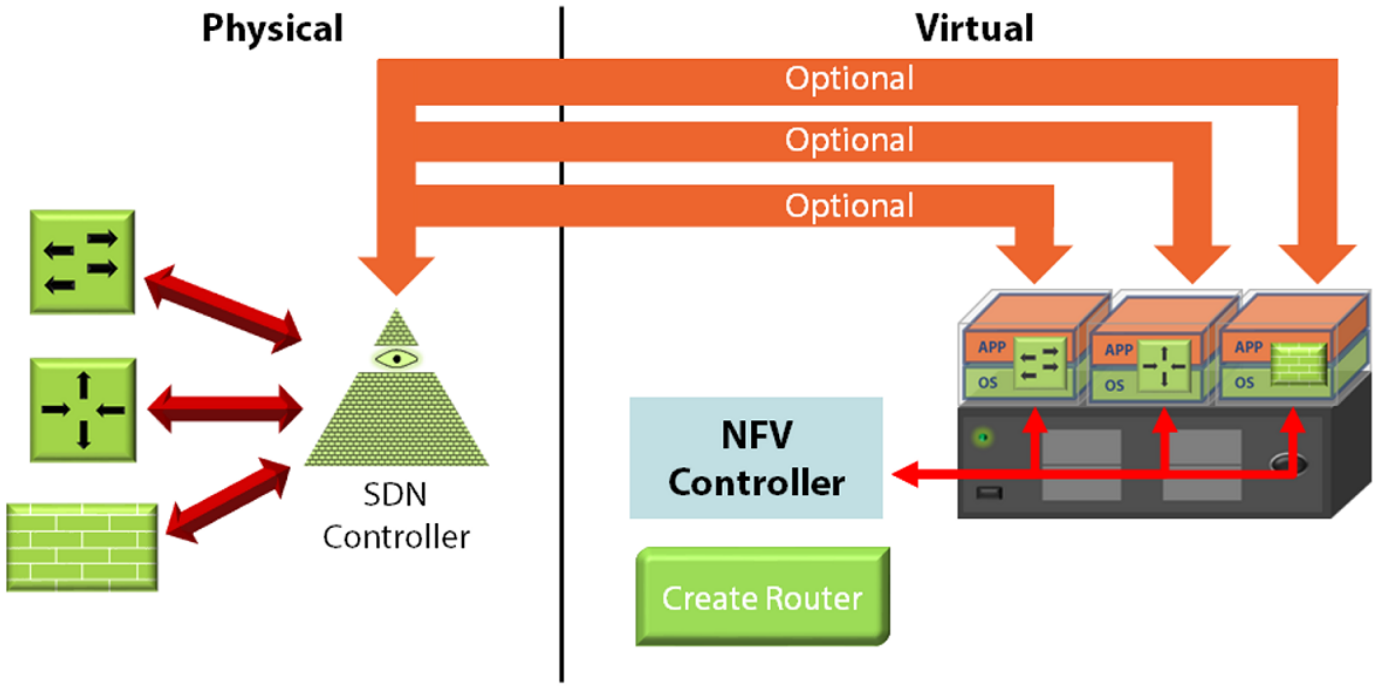
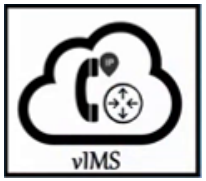


Illustration of SDN vs NFV

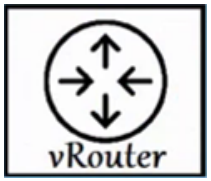


VNF examples



IMS VNF

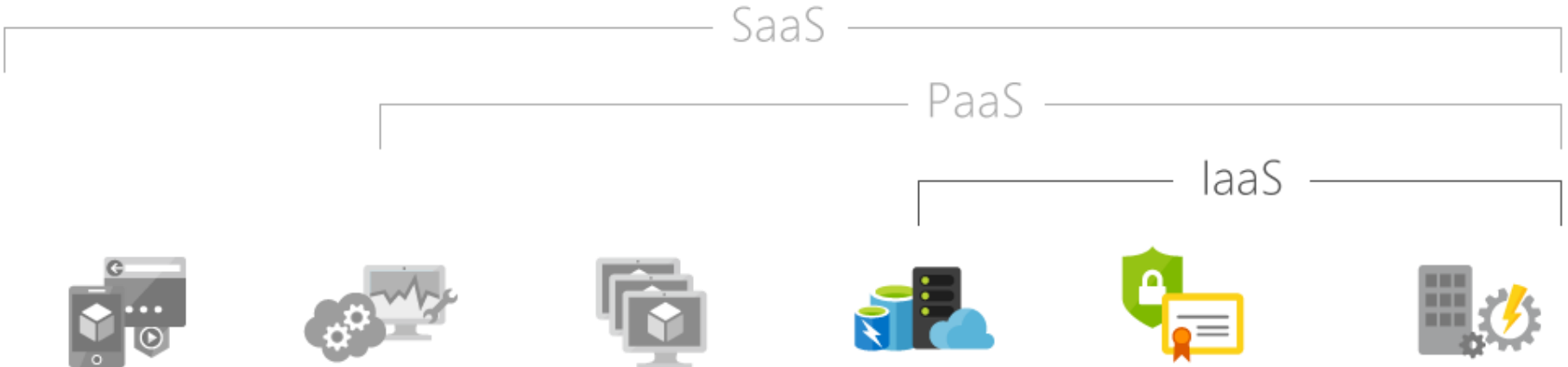
Firewall VNF



Router VNF

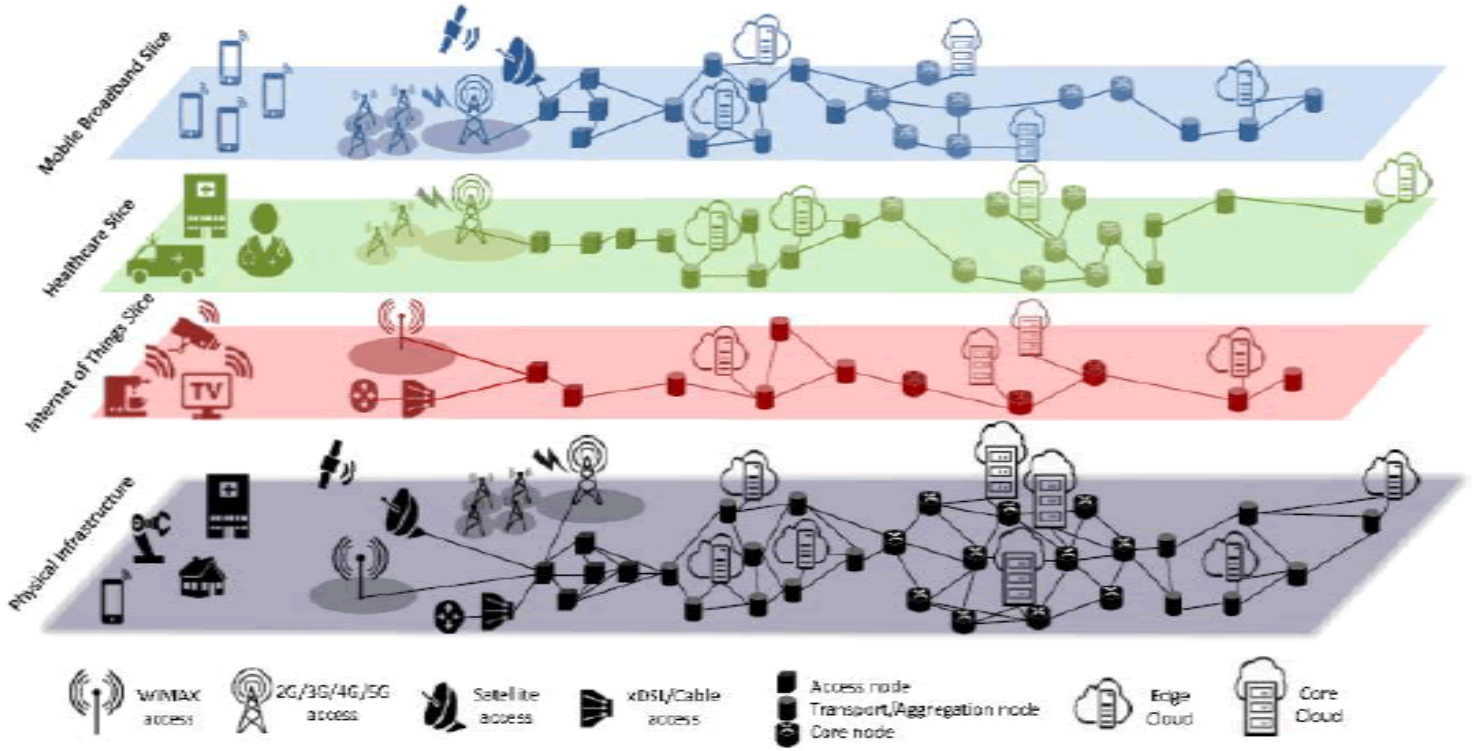
Next Step: NFaaS

- Network Function as a Service: service provisioning model
  - Dynamic, scalable secure and isolated network access for multiple tenants
- Analogy from Cloud computing
  - Software-, Platform-, Infrastructure as a Service



Network Slicing

- Virtual functions according to the services
  - „slices” of the same physical network
  - Standardization ongoing in 3GPP, IETF etc.



Thank You for your attention!

Questions?

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