Ch.6 SDN(1)
Overview

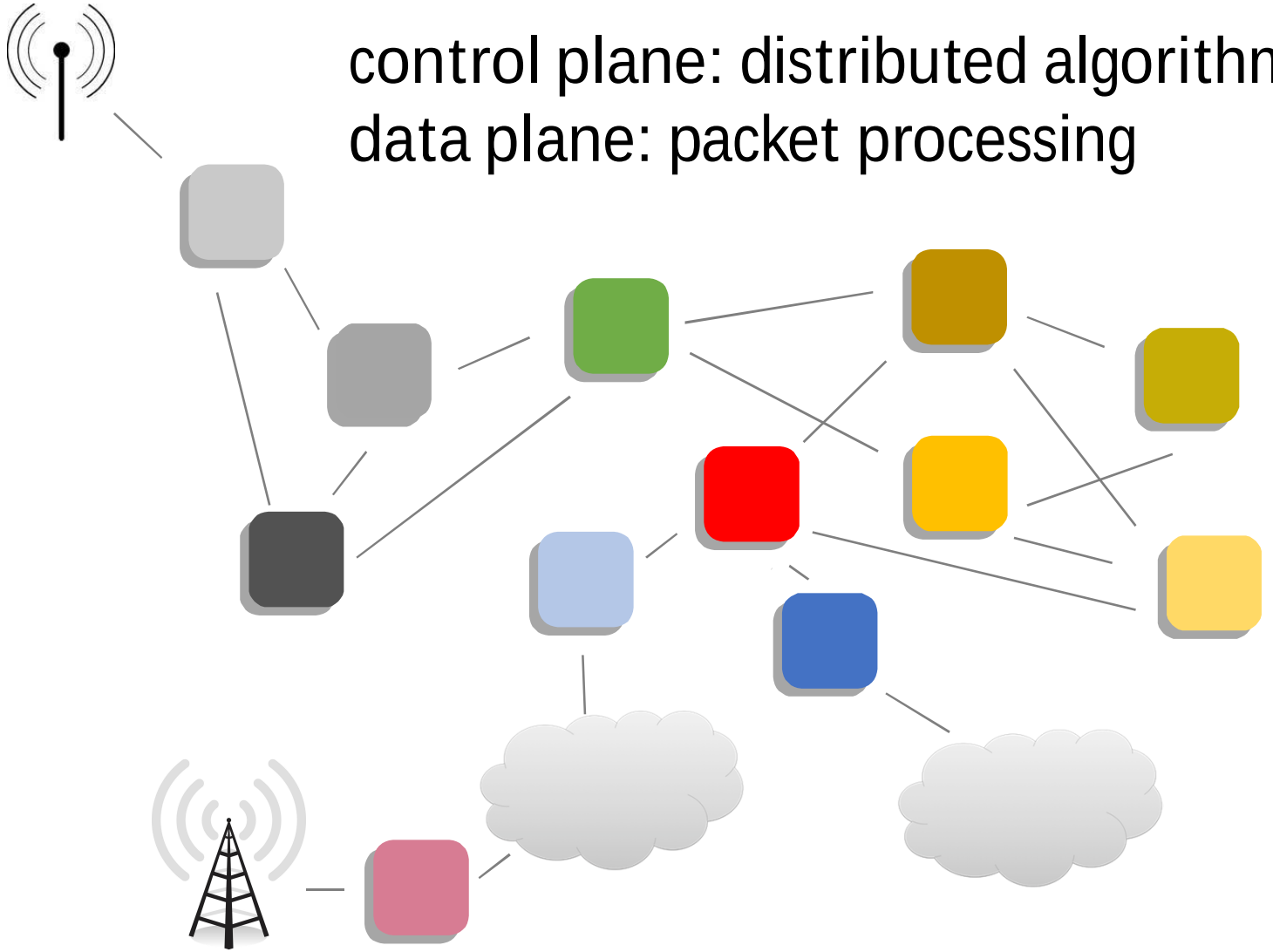
Outline

- What is SDN
- Why SDN
- Openflow
  - How does it work
  - Challenges
- What is NOT SDN
  - SDN vs. Openflow
  - SDN vs. NFV and NV

What is SDN

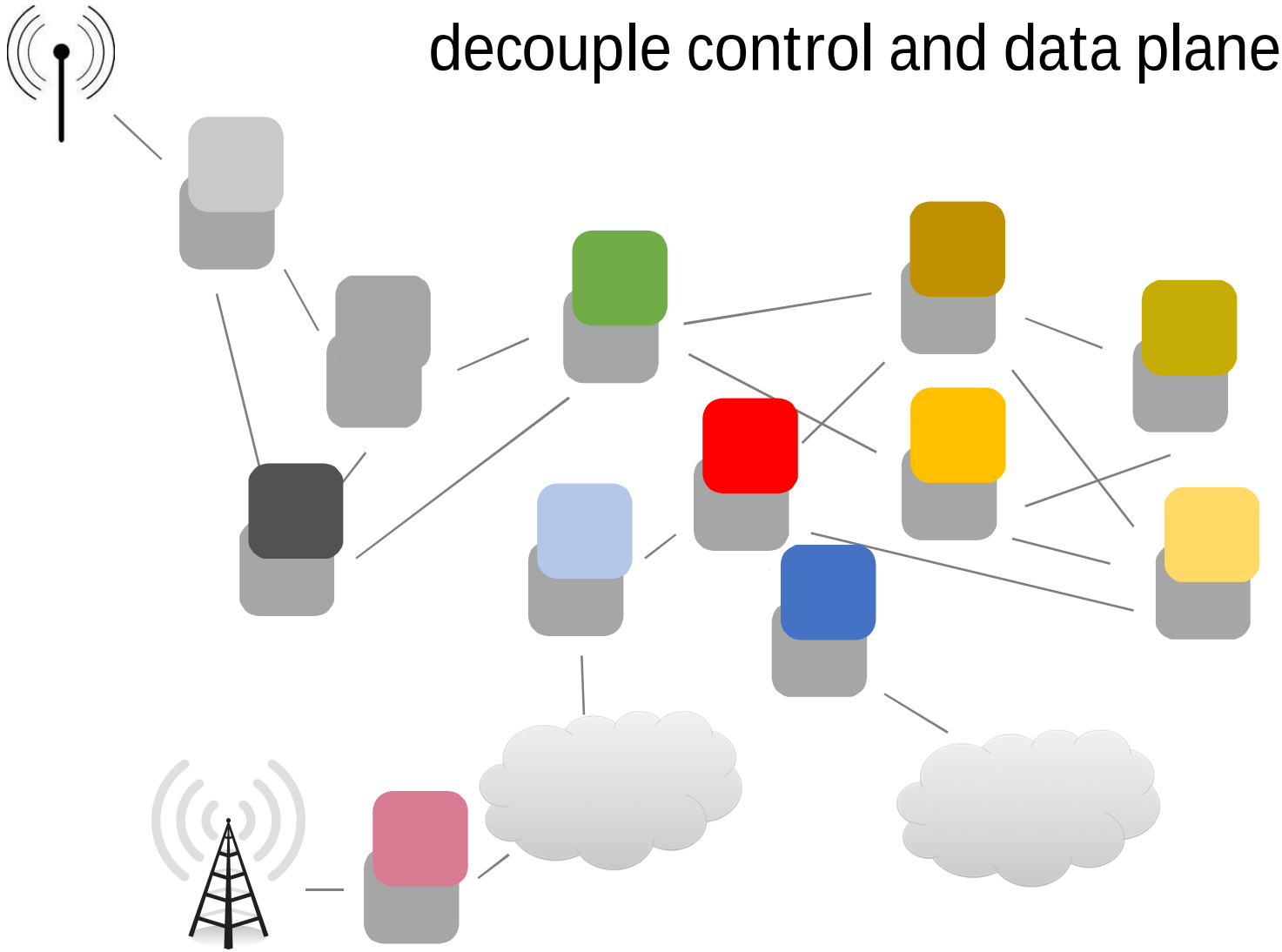
- Software Defined Networking / 软件定义网络
- 问题?
  - 什么叫做定义?
  - 运行在各种（硬件）设备中的不也是软件?
- 区分(传统网络 vs SDN)
  - Protocol vs. (Software) Application
  - Distributed vs. (Logically) Centralized
- 特性
  - Control plane 与 Data plane 分离
  - Programmable API

Software Defined Networks



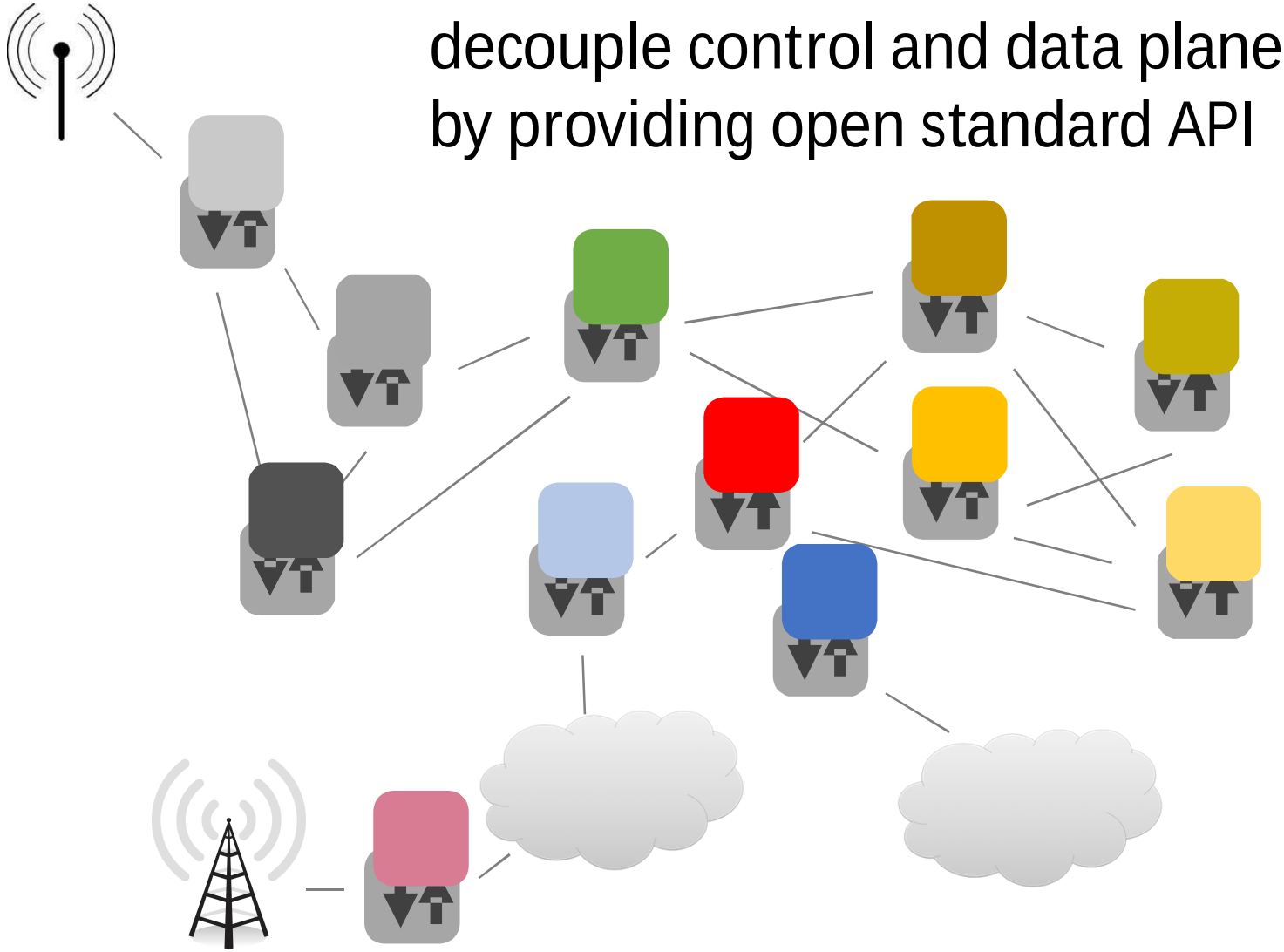
control plane: distributed algorithms
data plane: packet processing

Software Defined Networks



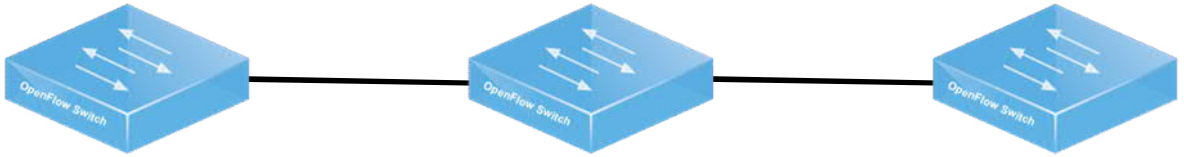
Software Defined Networks

decouple control and data planes
by providing open standard API



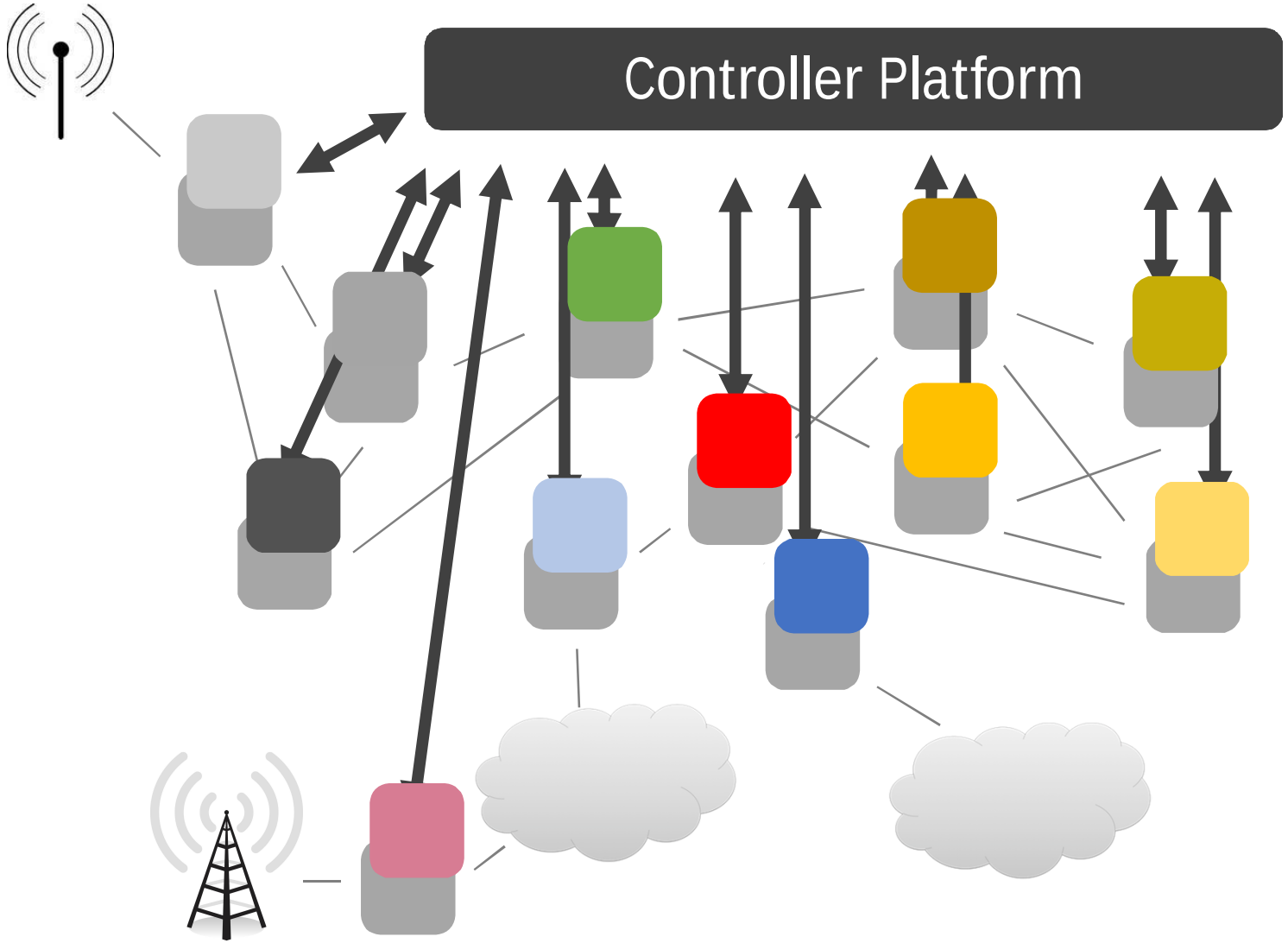
Simple, Open Data-Plane API

- Prioritized list of rules
  - Pattern: match packet header bits
  - Actions: drop, forward, modify, send to controller
  - Priority: disambiguate overlapping patterns
  - Counters: #bytes and #packets

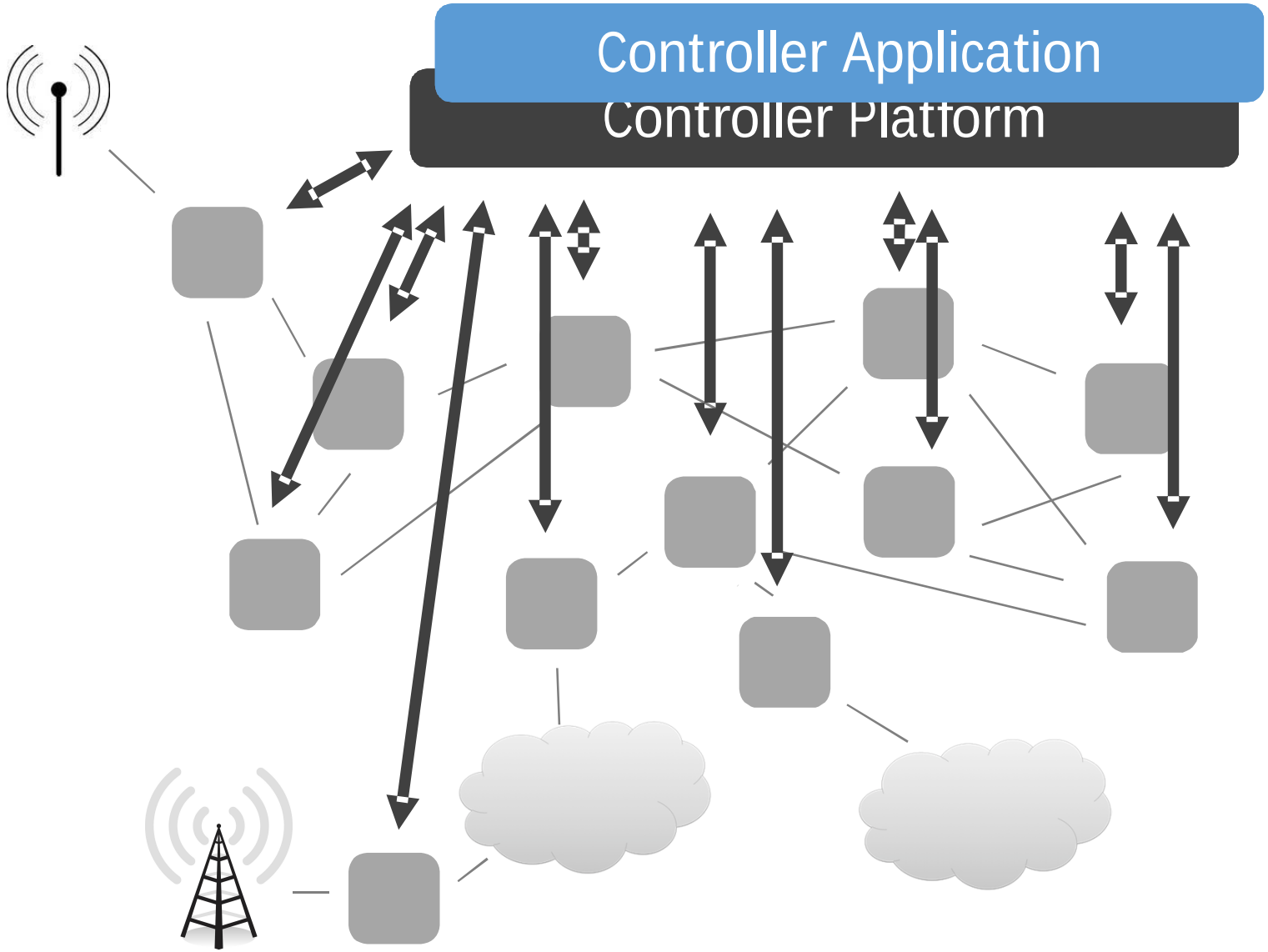


1. src=1.2.*.*, dest=3.4.5.* → drop
2. src = *.*.*.*, dest=3.4.*.* → forward(2)
3. src=10.1.2.3, dest=*.*.*.* → send to controller

(Logically) Centralized Controller

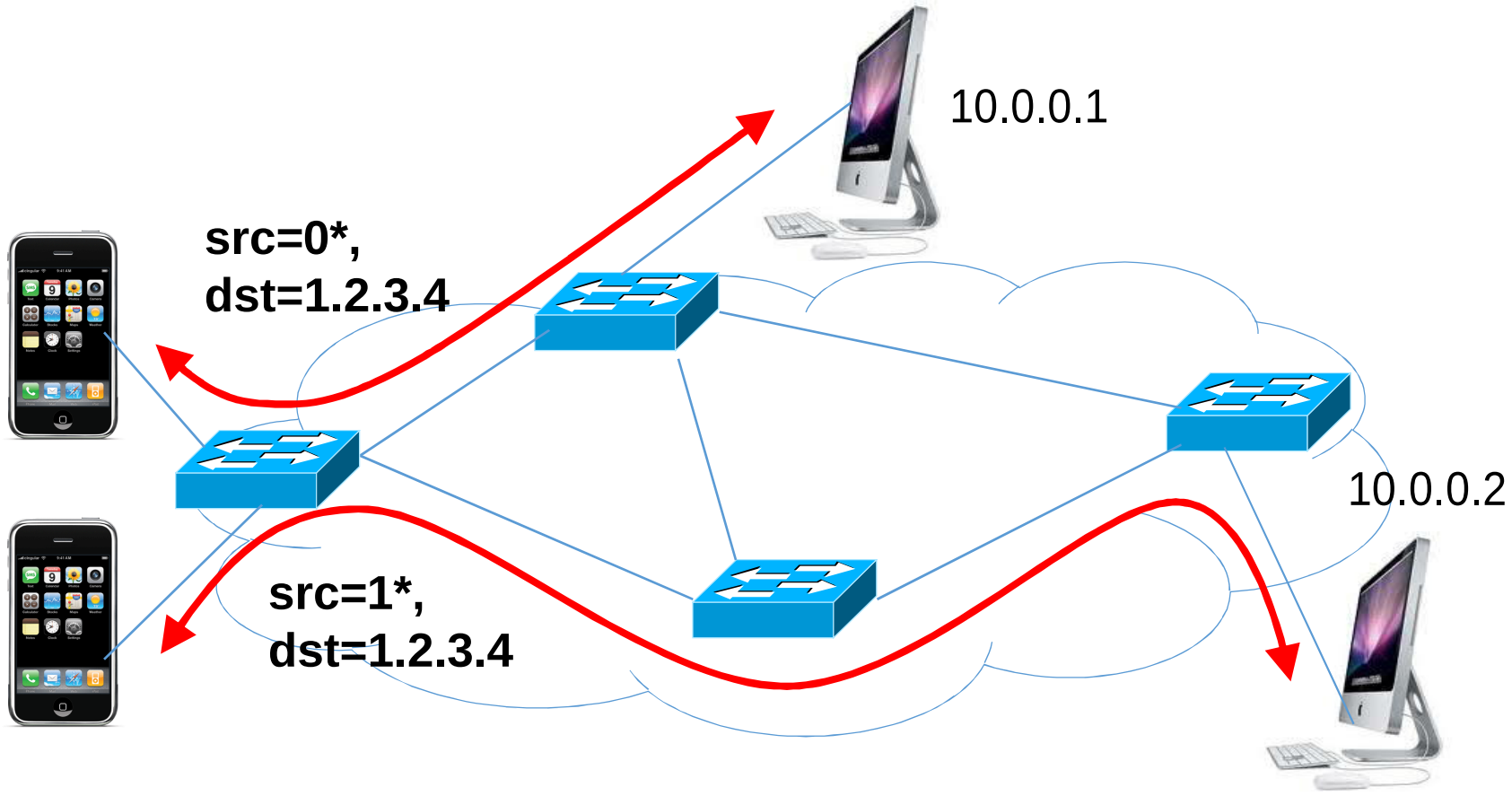


Protocols ➔ Applications



Server Load Balancing

- Pre-install load-balancing policy
- Split traffic based on source IP



Outline

- What is SDN
- Why SDN
- Openflow
  - How does it work
  - Challenges
- What is NOT SDN
  - SDN vs. Openflow
  - SDN vs. NFV and NV

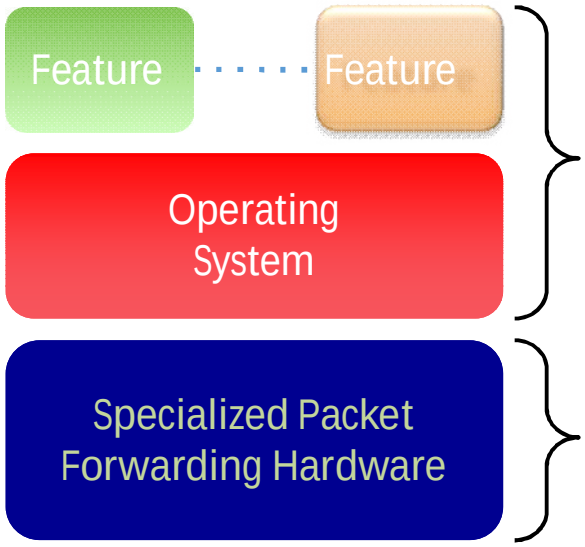
The Internet: A Remarkable Story

- Tremendous success
  - From research experiment to global infrastructure
- Brilliance of under-specifying
  - Network: best-effort packet delivery
  - Programmable hosts: arbitrary applications
- Enables innovation
  - Apps: Web, P2P, VoIP, social networks, …
  - Links: Ethernet, fiber optics, WiFi, cellular, …

Inside the ‘Net: A Different Story…

- Closed equipment
  - Software bundled with hardware
  - Vendor-specific interfaces
- Over specified
  - Slow protocol standardization
- Few people can innovate
  - Equipment vendors write the code
  - Long delays to introduce new features

Limitations of Current Networks



Million of lines of source code

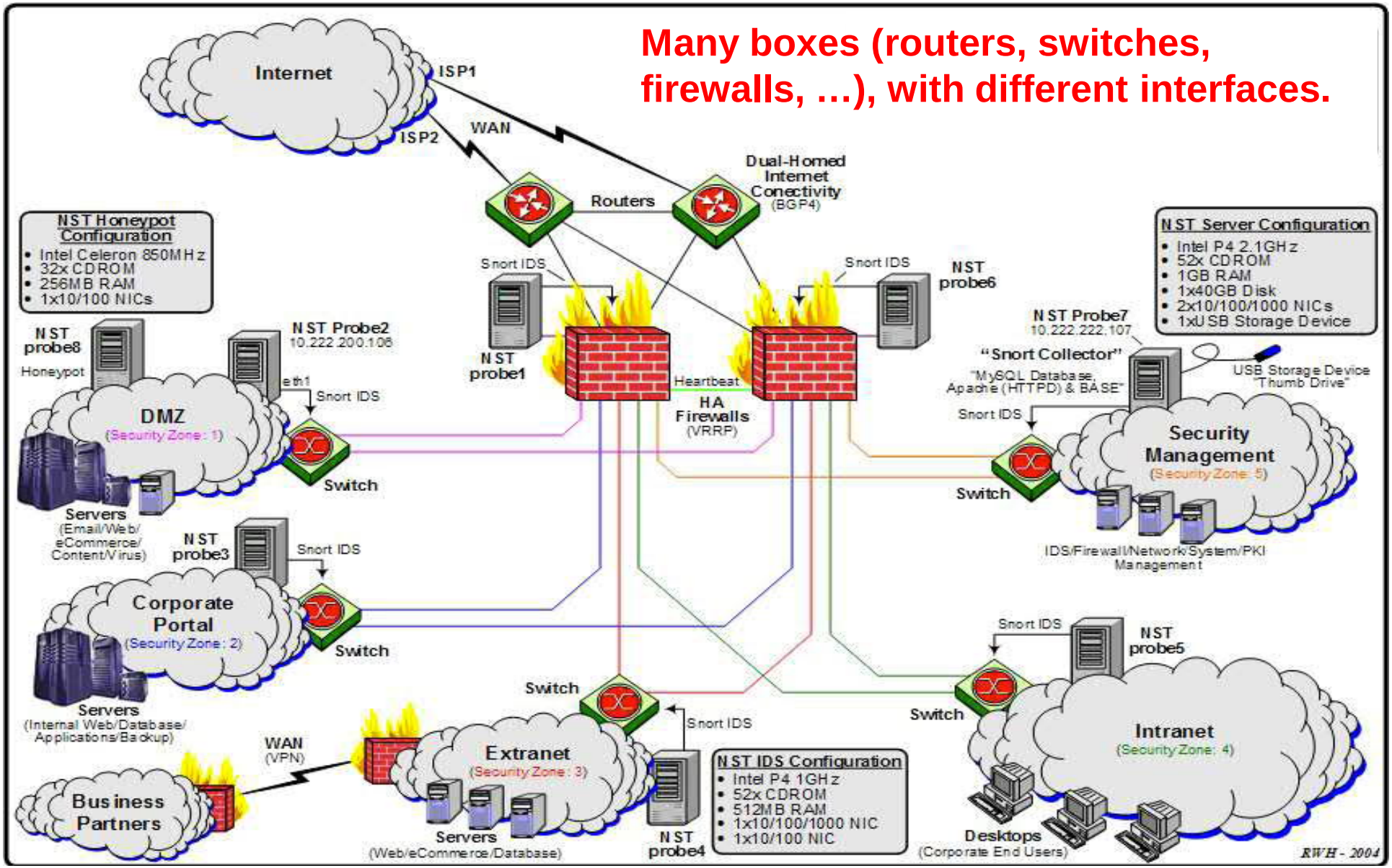
Billions of gates

Many complex functions baked into infrastructure

OSPF, BGP, multicast, differentiated services, Traffic Engineering, NAT, firewalls, …

Cannot dynamically change according to network conditions

Do We Need Innovation Inside?



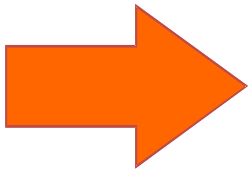
Do We Need Intellectual Progress?

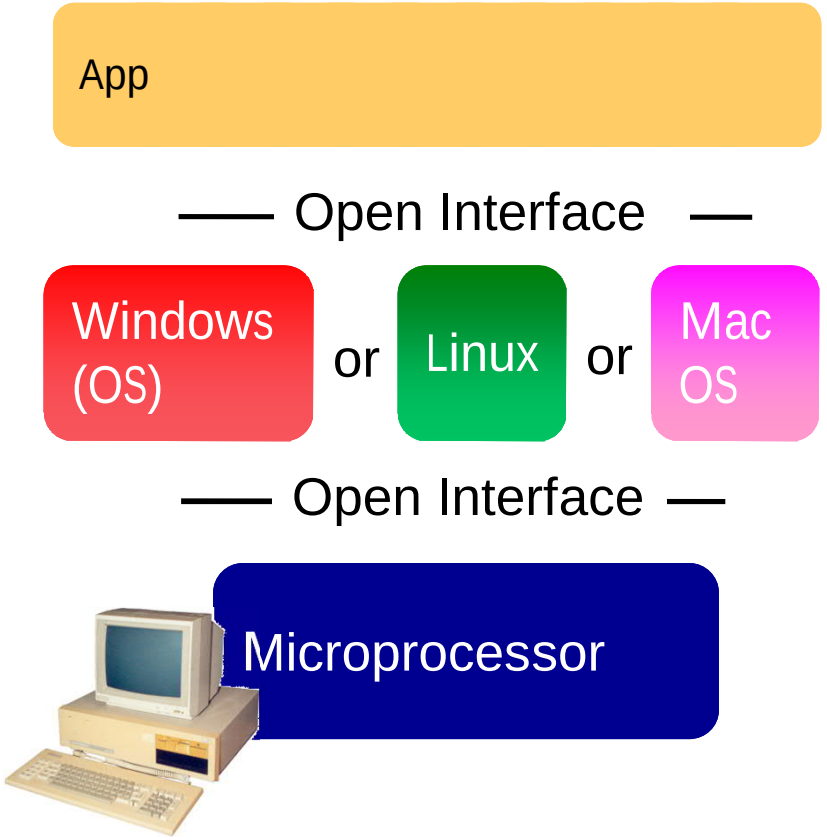
- Lots of domain details
  - Plethora of protocols
  - Heaps of header formats
  - Big bunch of boxes
  - Tons of tools
- Teaching networking
  - Practitioners: certification courses, on the job
  - Undergraduates: how the Internet works

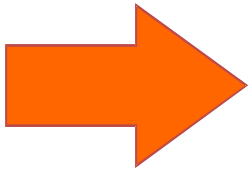
II） 启示

Mainframes

Vertically integrated
Closed, proprietary
Slow innovation
Small industry







Horizontal
Open interfaces
Rapid innovation
Huge industry

Routers/Switches

App

Open Interface

Control Plane or Control Plane or Control Plane

Open Interface

Merchant Switching Chips

Vertically integrated
Closed, proprietary
Slow innovation

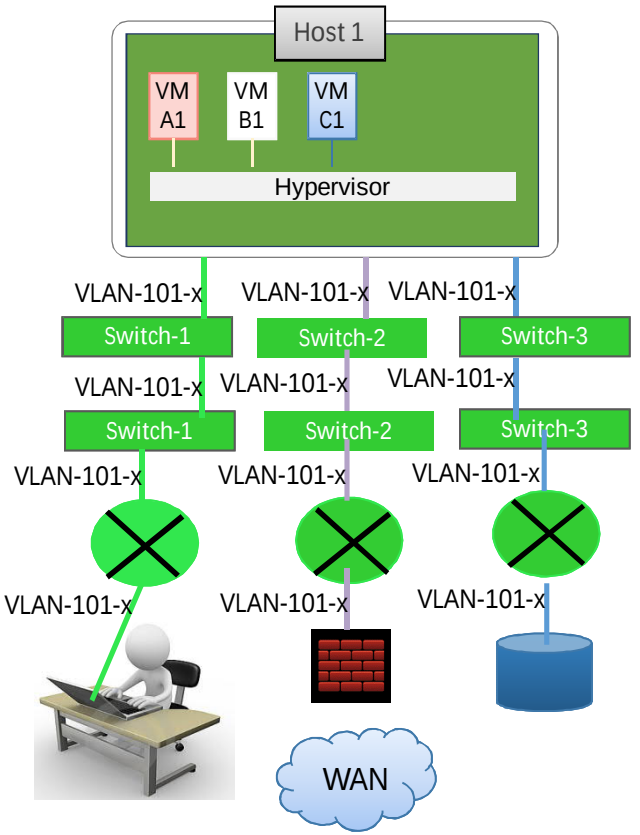
Horizontal
Open interfaces
Rapid innovation

Critical needs for cloud Data Center networks

1. Tenant virtualization
   - Traffic isolation, prioritization and rate limiting
   - Overlapping IP addressing, along with IPv6 support

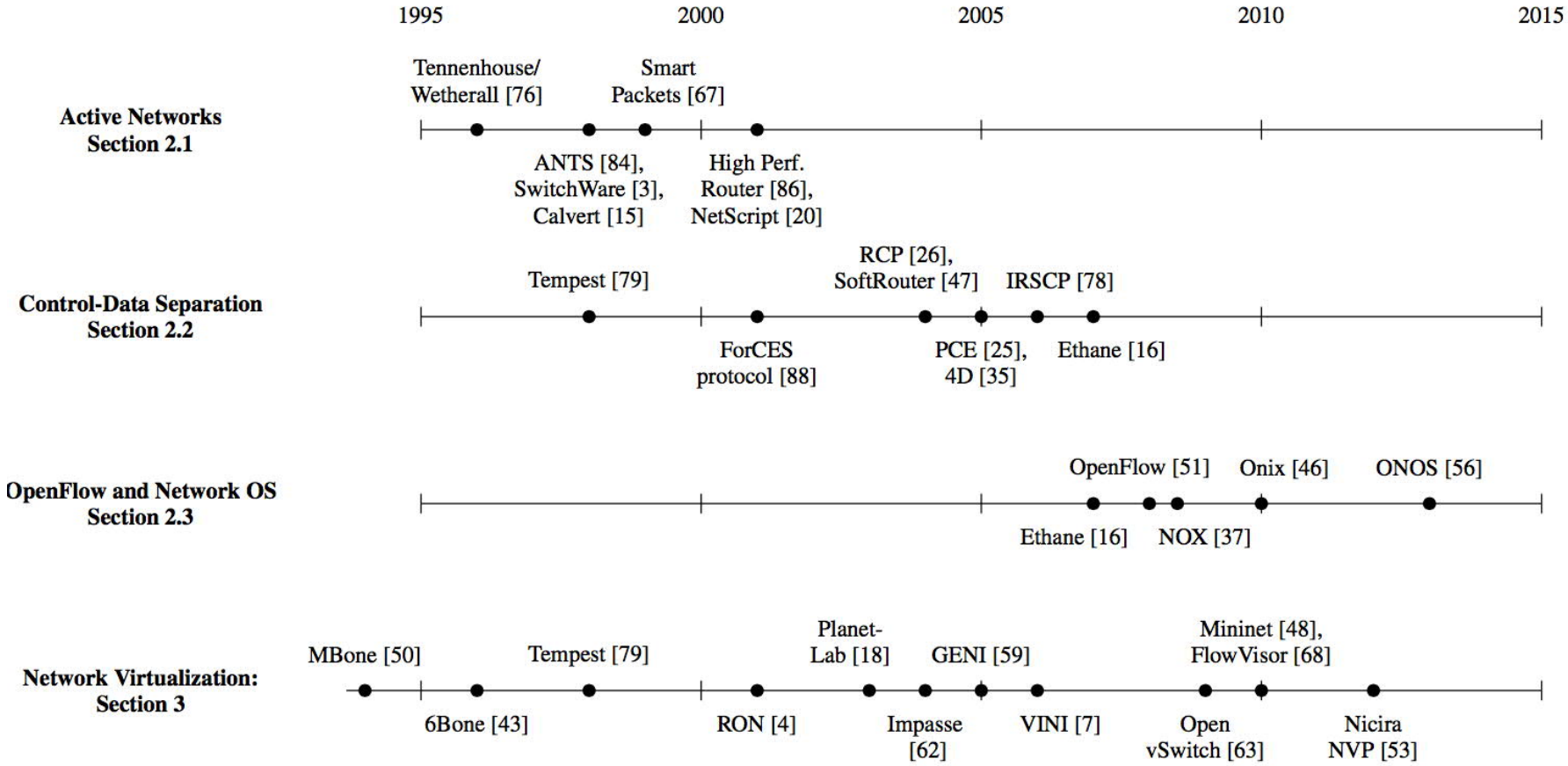
2. Speed up configuration to allow reduced time to revenue:
   - Automatically create required network configures for new tenants
   - Transparently bridging a L2 network will help reduce time

3. Hybrid clouds with bursting
   - Adding computational capacity (in the form of new VMs) as needed
   - Lossless live migration



The Road to SDN

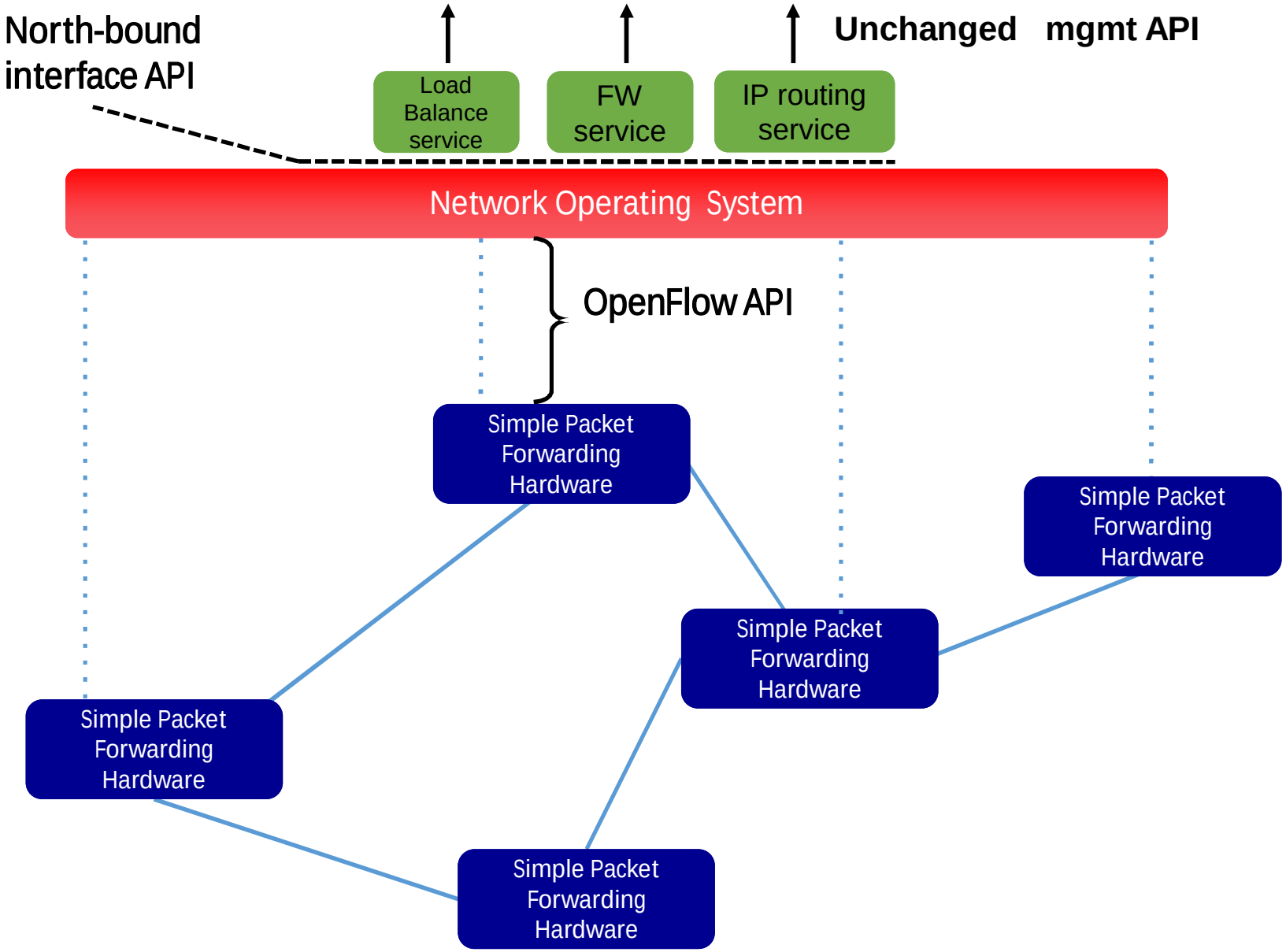
《The Road to SDN: An Intellectual History of Programmable Networks》



Outline

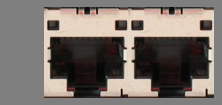
- What is SDN
- Why SDN
- Openflow
  - How does it work
  - Challenges
- What is NOT SDN
  - SDN vs. Openflow
  - SDN vs. NFV and NV

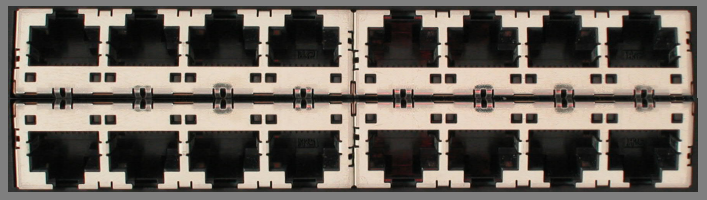
The "Software-defined Network"

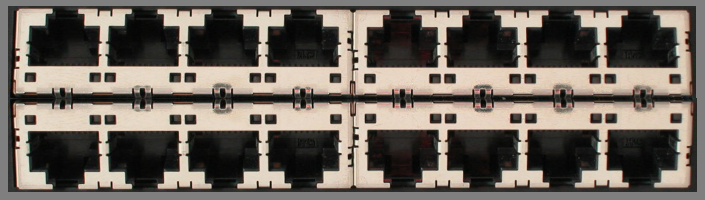


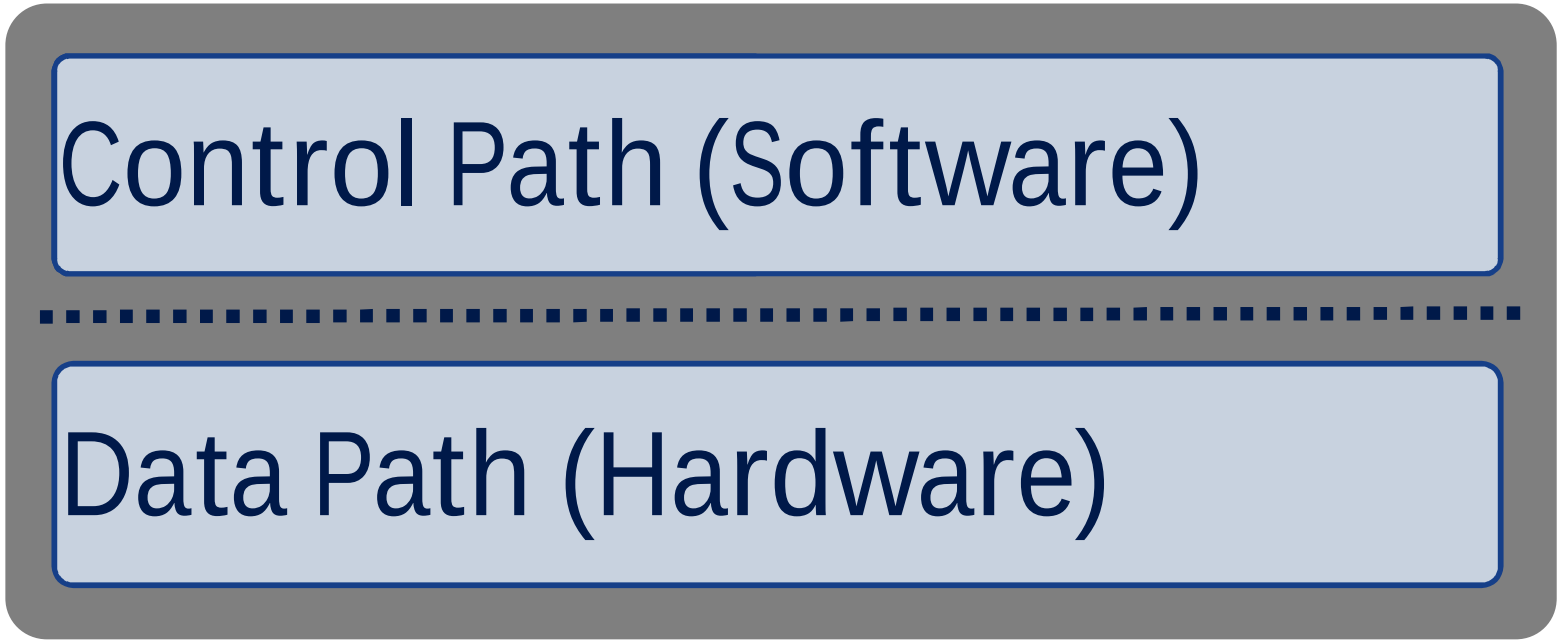
How does OpenFlow work?

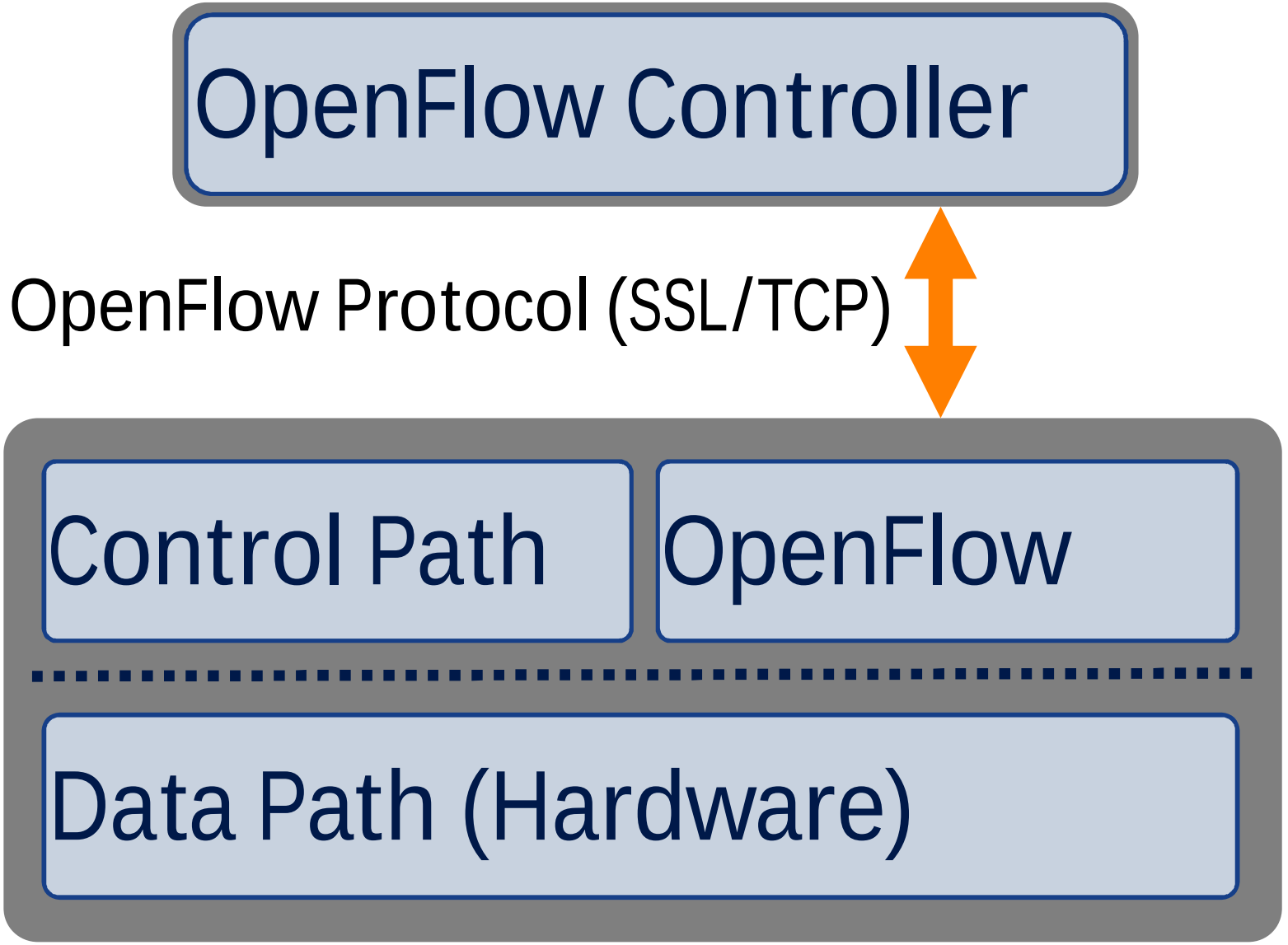
Ethernet Switch



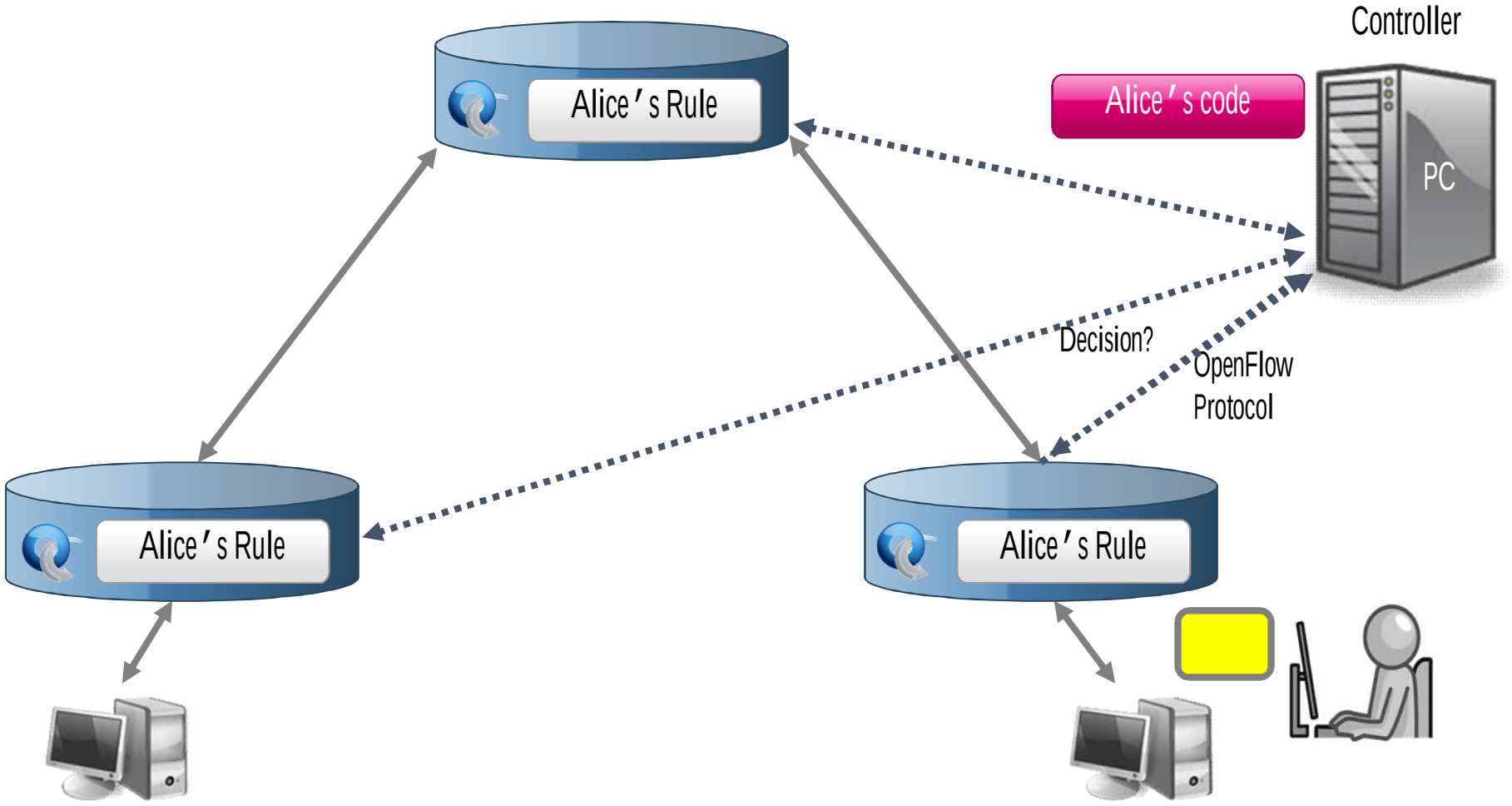





Control Path (Software)
Data Path (Hardware)

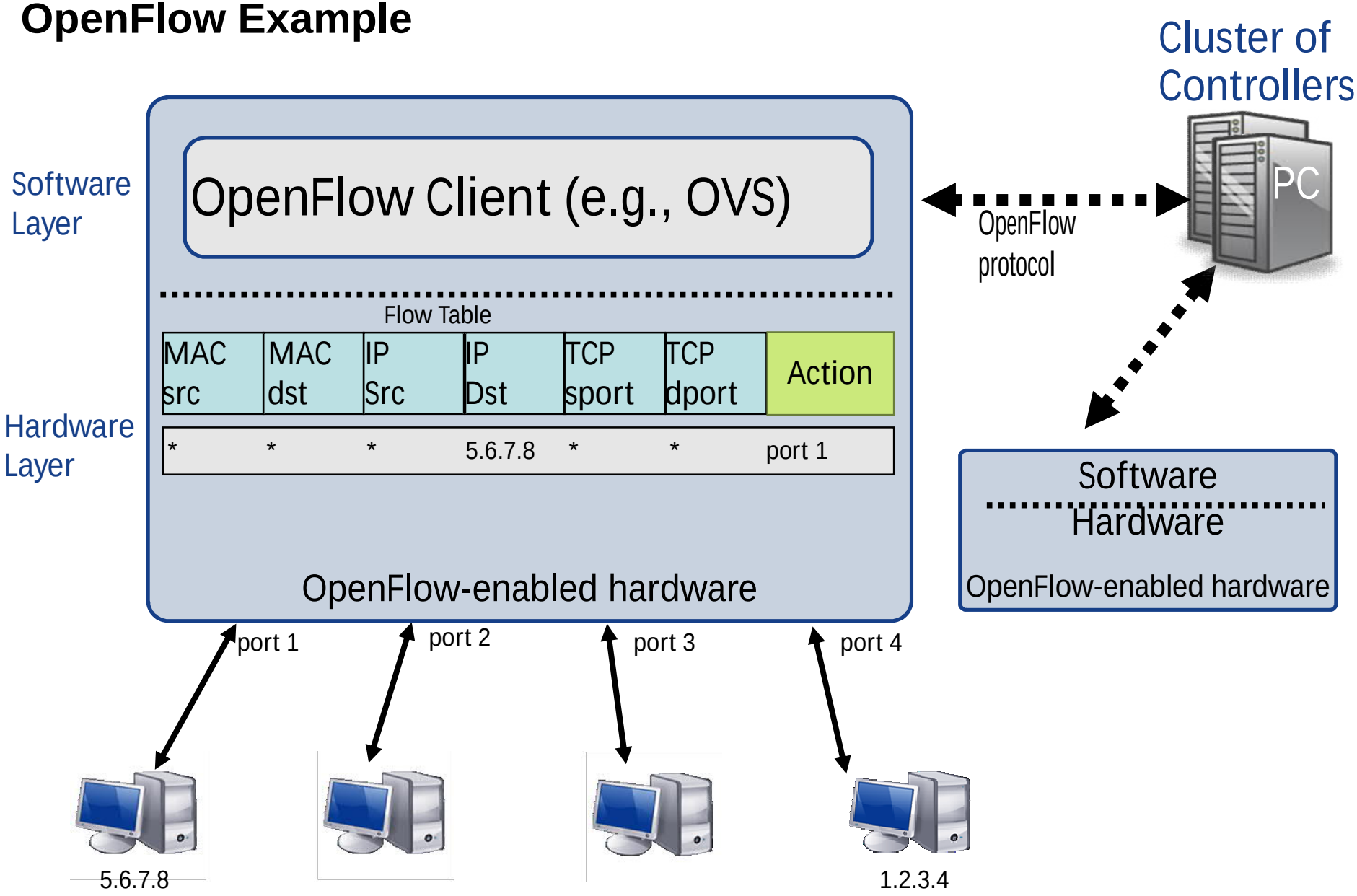

OpenFlow Controller
OpenFlow Protocol (SSL/TCP)
Control Path
OpenFlow
Data Path (Hardware)

OpenFlow usage



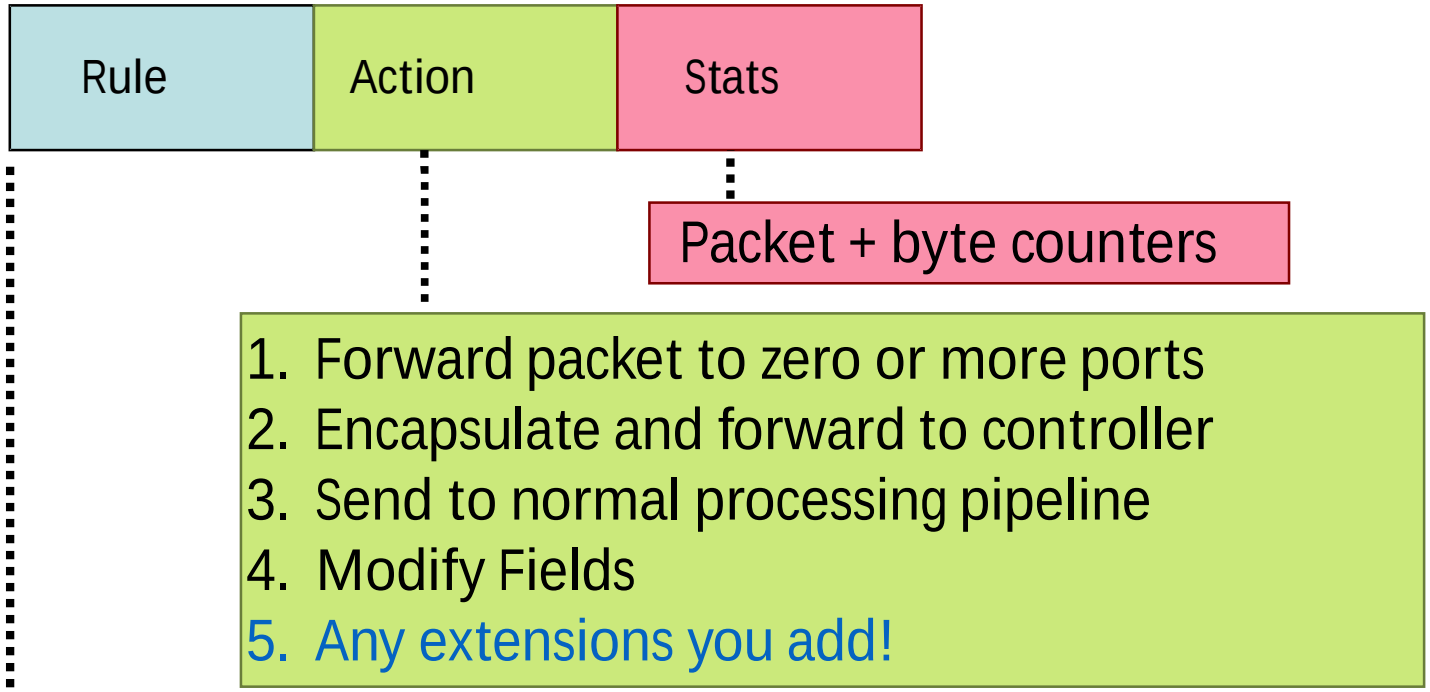
OpenFlow offloads control intelligence to a remote software

OpenFlow Example



OpenFlow Basics

Flow Table Entries



+ mask what fields to match
+ priority
+ timeout (idle and hard)

Examples

IP Routing service

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 multicast service

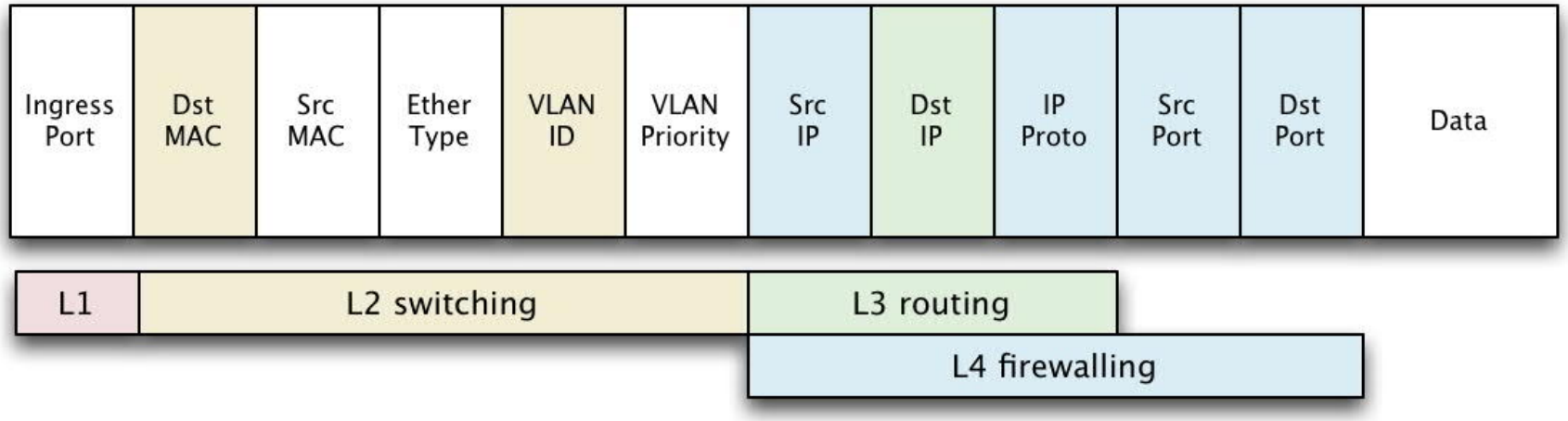
Switch Port	MAC src	MAC dst	Eth type	VLAN ID	IP Src	IP Dst	IP Prot	TCP sport	TCP dport	Action
*	*	00:1f..	*	vlan1	*	*	*	*	*	port6, port7, port9

Firewall service

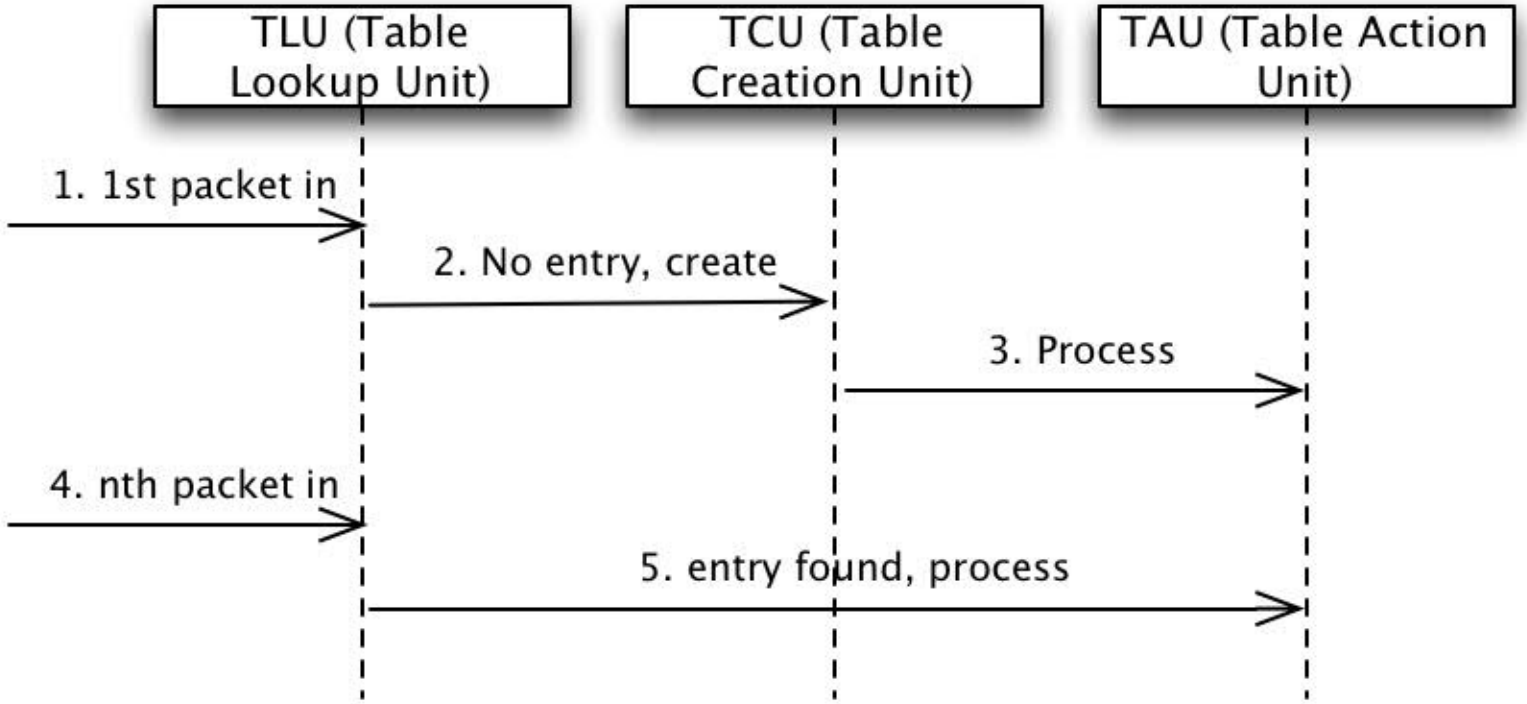
Switch Port	MAC src	MAC dst	Eth type	VLAN ID	IP Src	IP Dst	IP Prot	TCP sport	TCP dport	Action
*	*	*	*	*	*	*	*	*	22	drop

Form L1 to L4?

- PDU?
- Device?



Forwarding


TLU (Table Lookup Unit)
TCU (Table Creation Unit)
TAU (Table Action Unit)
1. 1st packet in
2. No entry, create
3. Process
4. nth packet in
5. entry found, process

OpenFlow benefits

- Hardware speed, scale, and fidelity for new services
  - Made possible through unified API supported by hardware platforms from multiple vendors
- Flexibility and control of software and simulation
- Vendors don't need to expose implementation
- Leverages hardware inside most switches today (ACL tables implemented using TCAMs((ternary content addressable memory))

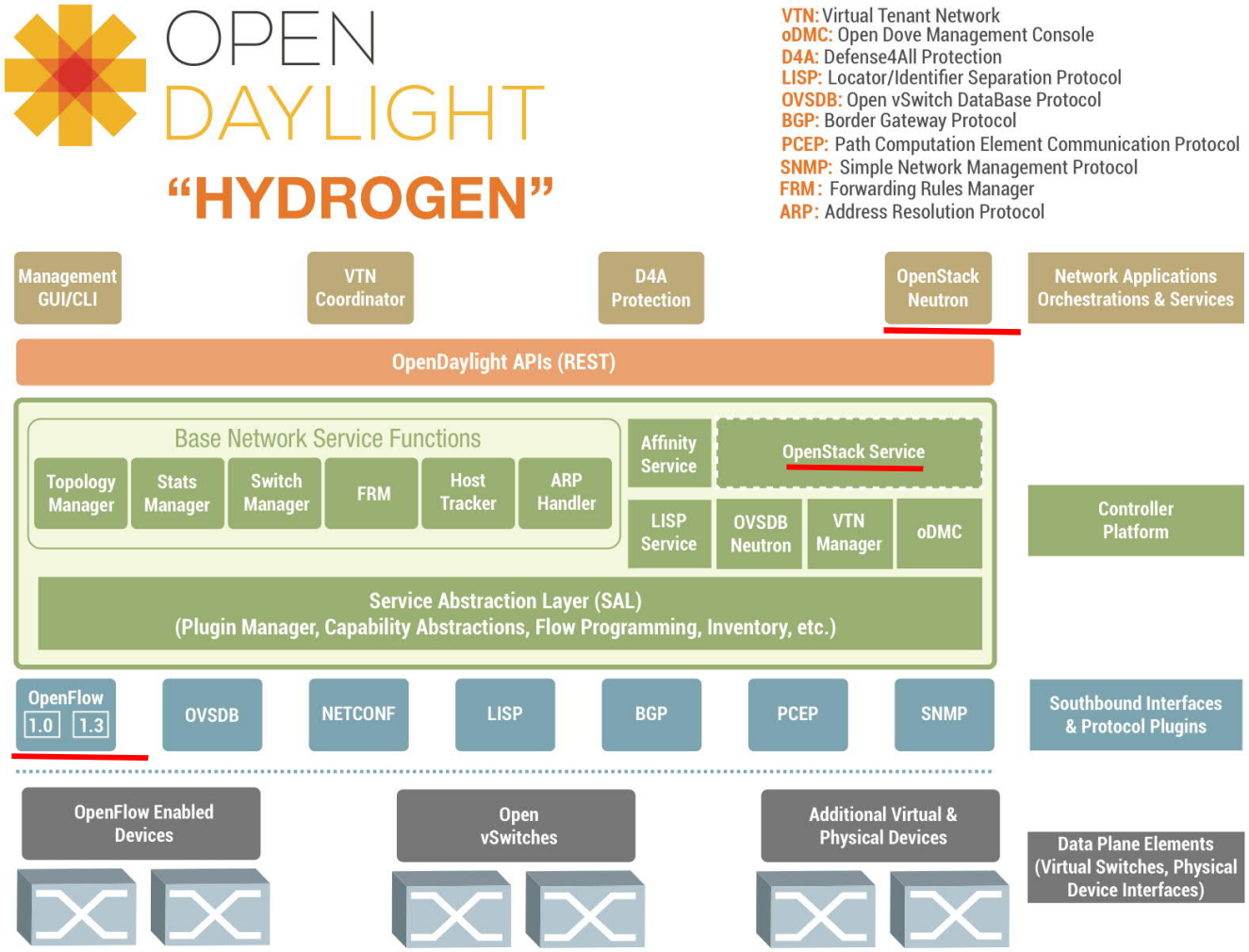
Challenges

- Control Plane
  - 集中式控制带来可扩展性问题
  - 大型网络流表配置速度问题
  - 安全性问题
- Data Plane
  - 芯片设计
    - TCAM容量限制
    - 多级流表支持
    - 协议无关的处理
    - 协议中的时序和同步

Outline

- What is SDN
- Why SDN
- Openflow
  - How does it work
  - Challenges
- What is NOT SDN
  - SDN vs. Openflow
  - SDN vs. NFV and NV

SDN vs. OpenFlow

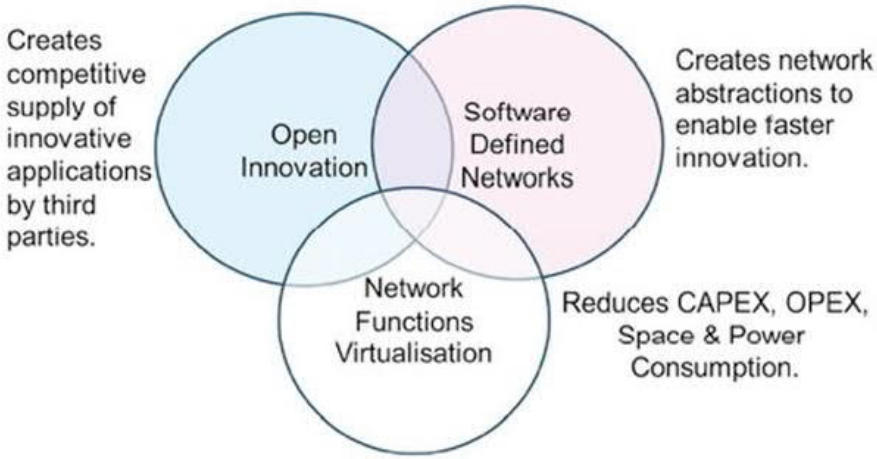


SDN vs. NFV and NV

- NV(Network virtualization)
  - refers to the virtualization of network resources or pathways to achieve application or tenant isolation.
  - Path isolation and network virtualization
    - overlay network technologies such as VXLAN and NVGRE（Data Plane支持的技术）
    - flow manipulation using SDN technologies like OpenFlow
- NFV(Network functions virtualization)
  - the concept of taking a function that traditionally runs on a dedicated network and running those functions as virtual machines on the virtual server infrastructure
  - may also rely on SDN flow programming techniques to force traffic through one or more virtualized network functions -- a process called service chaining.

SDN vs. NFV and NV

- NFV, SDN, and network virtualization are related when considering ways to design and implement a modern, scalable, secure, and highly available data center environment for multiple applications or tenants.



Ref: http://www.networkcomputing.com/networking/sdn-network-virtualization-and-nfv-in-a-nutshell/a/d-id/1315755
http://www.techrepublic.com/article/nv-nfv-and-sdn-whats-with-the-networking-acronym-explosion/