

# Introduction to Software Defined Networking (SDN)

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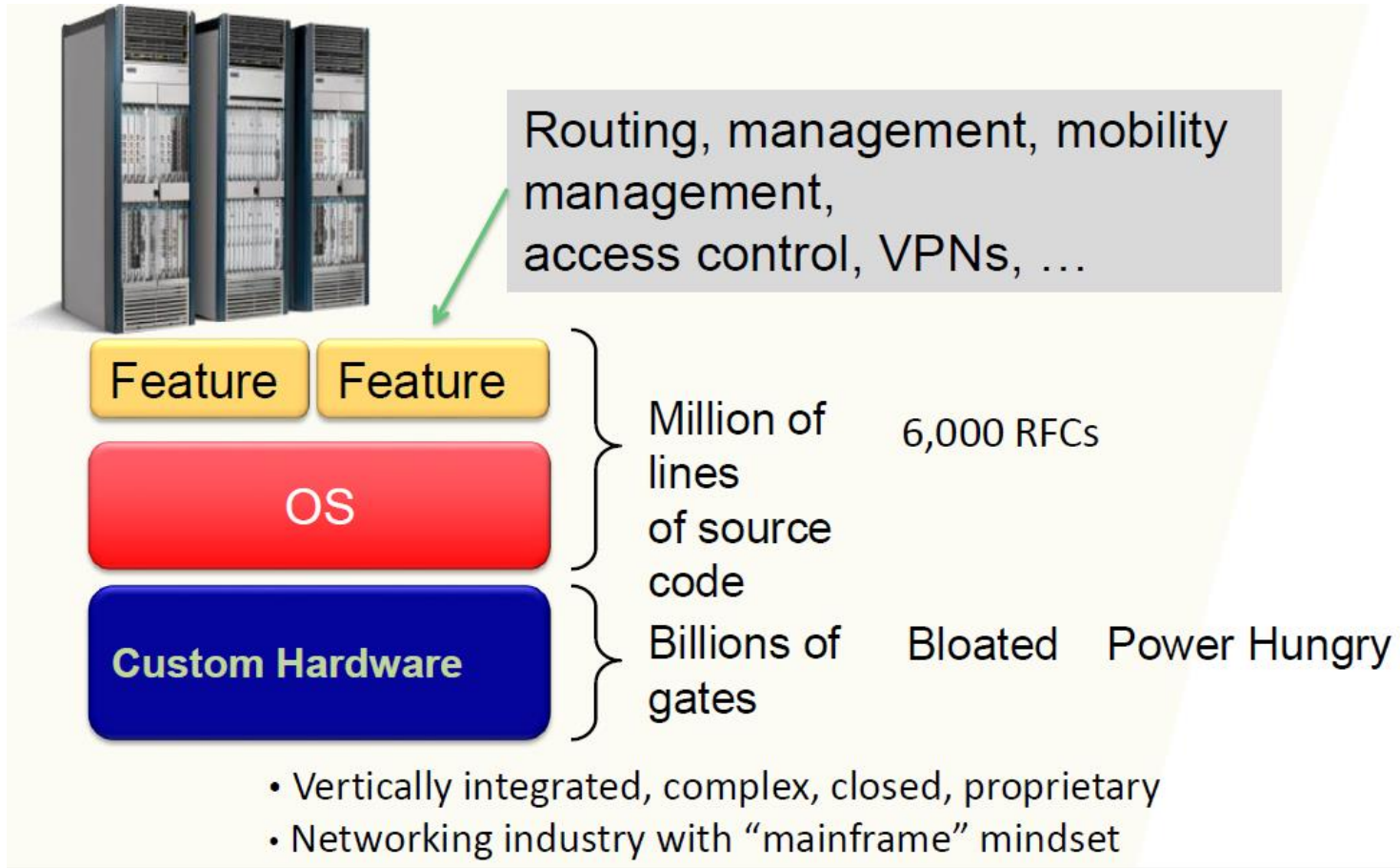
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# Today's Routers





Vertically integrated  
Closed, proprietary  
Slow innovation



— Open Interface —



— Open Interface —



Horizontal  
Open interfaces  
Rapid innovation

# What is SDN?

- Software-defined networking (SDN) is an approach to computer networking that allows network administrators to programmatically initialize, control, change, and manage network behavior dynamically via open interfaces and abstraction of lower-level functionality.
  - Directly programmable
  - Agile
  - Centrally managed
  - Programmatically configured
  - Open standards-based and vendor-neutral

# Why SDN?

- SDN is meant to address the fact that the static architecture of traditional networks doesn't support the dynamic, scalable computing and storage needs of more modern computing environments such as data centers.

# Why SDN?

1. Virtualization: Use network resource without worrying about where it is physically located, how much it is, how it is organized, etc.
2. Orchestration: Should be able to control and manage thousands of devices with one command.
3. Programmable: Should be able to change behavior on the fly.
4. Dynamic Scaling: Should be able to change size, quantity
5. Automation: To lower OpEx minimize manual involvement
  - Troubleshooting
  - Reduce downtime
  - Policy enforcement
  - Provisioning/Re-provisioning/Segmentation of resources
  - Add new workloads, sites, devices, and resources

# Why SDN?

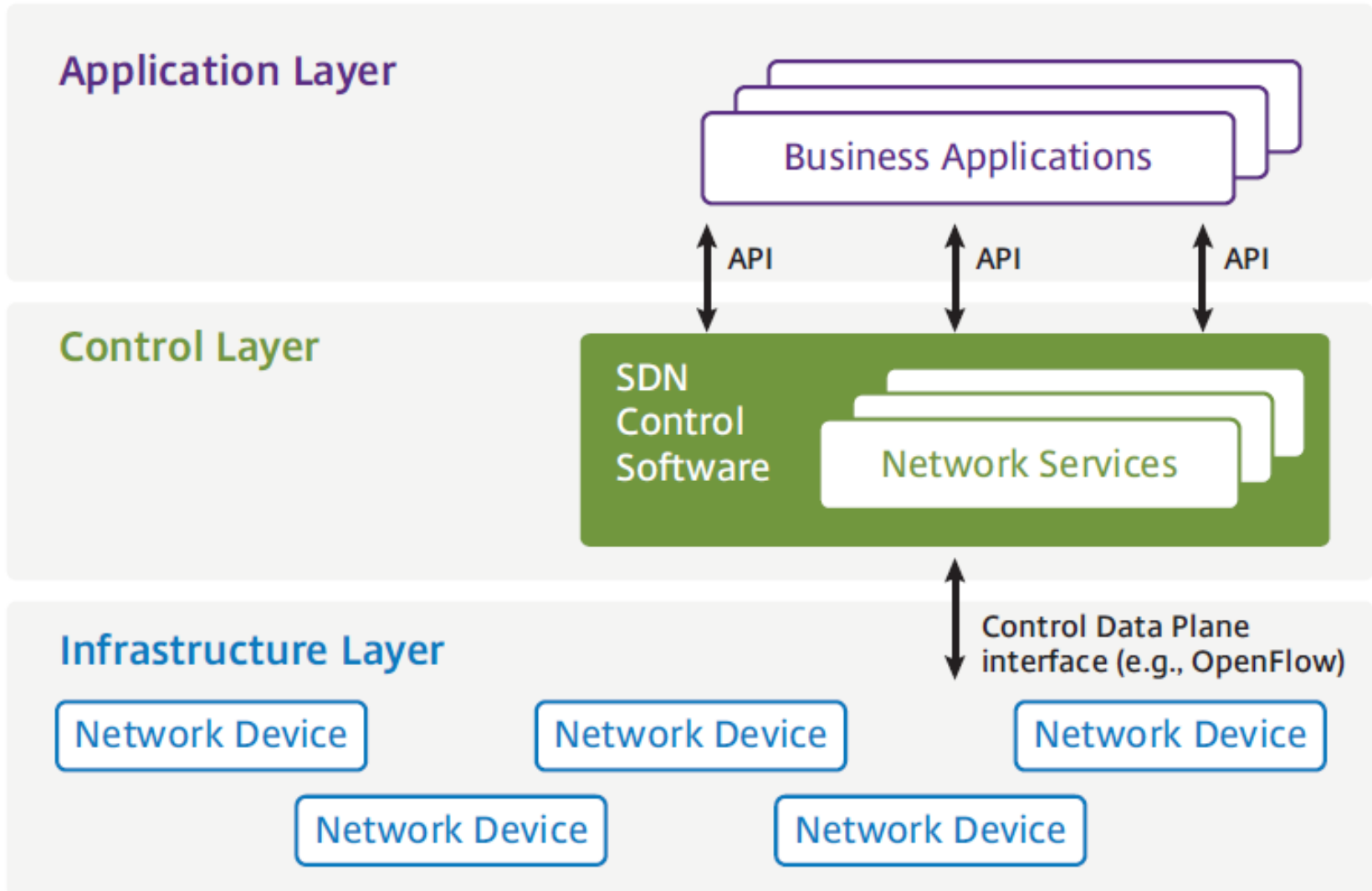
6. Visibility: Monitor resources, connectivity
7. Performance: Optimize network device utilization
  - Traffic engineering/Bandwidth management
  - Capacity optimization
  - Load balancing
  - High utilization
  - Fast failure handling
8. Multi-tenancy: Tenants need complete control over their addresses, topology, and routing, security
9. Service Integration: Load balancers, firewalls, Intrusion Detection Systems (IDS), provisioned on demand and placed appropriately on the traffic path
10. Openness

# How does SDN work?

- This is done by decoupling or disassociating the system that makes decisions about where traffic is sent (the SDN controller, or control plane) from the underlying systems that forward traffic to the selected destination (the data plane).
- SDN was commonly associated with the OpenFlow protocol (for remote communication with network plane elements for the purpose of determining the path of network packets across network switches).



# The SDN System Architecture

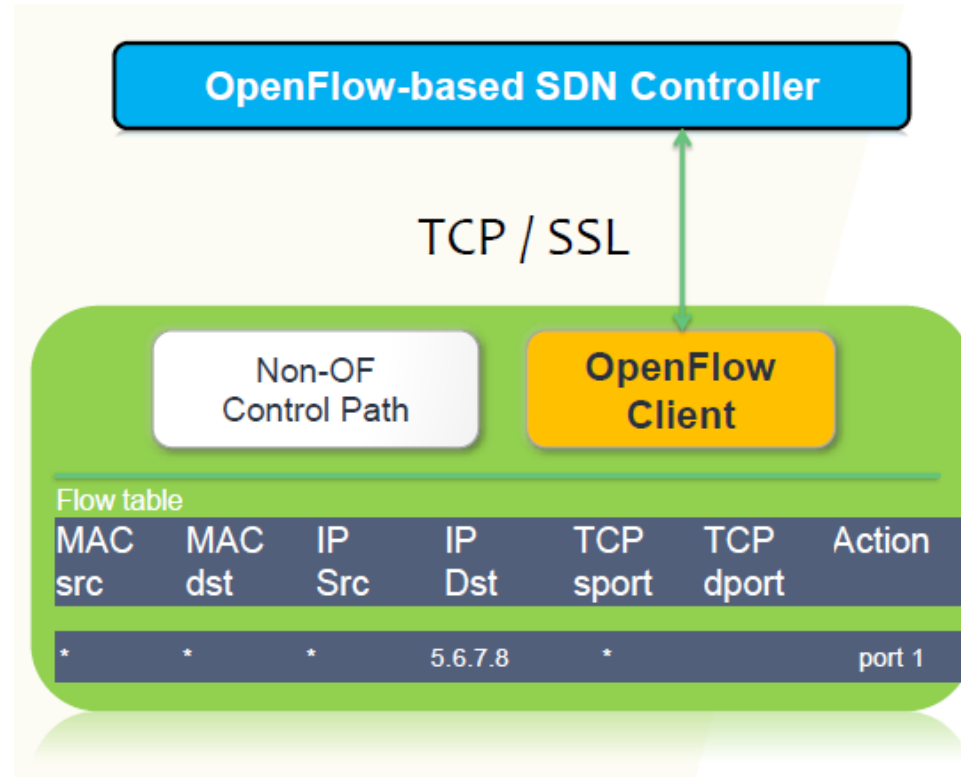


# Planes of Networking

- Data Plane: All activities involving as well as resulting from data packets sent by the end user, e.g.,
  - Forwarding
  - Fragmentation and reassembly
  - Replication for multicasting
- Control Plane: All activities that are necessary to perform data plane activities but do not involve end-user data packets
  - Making routing tables
  - Setting packet handling policies (e.g., security)
  - Base station beacons announcing availability of services

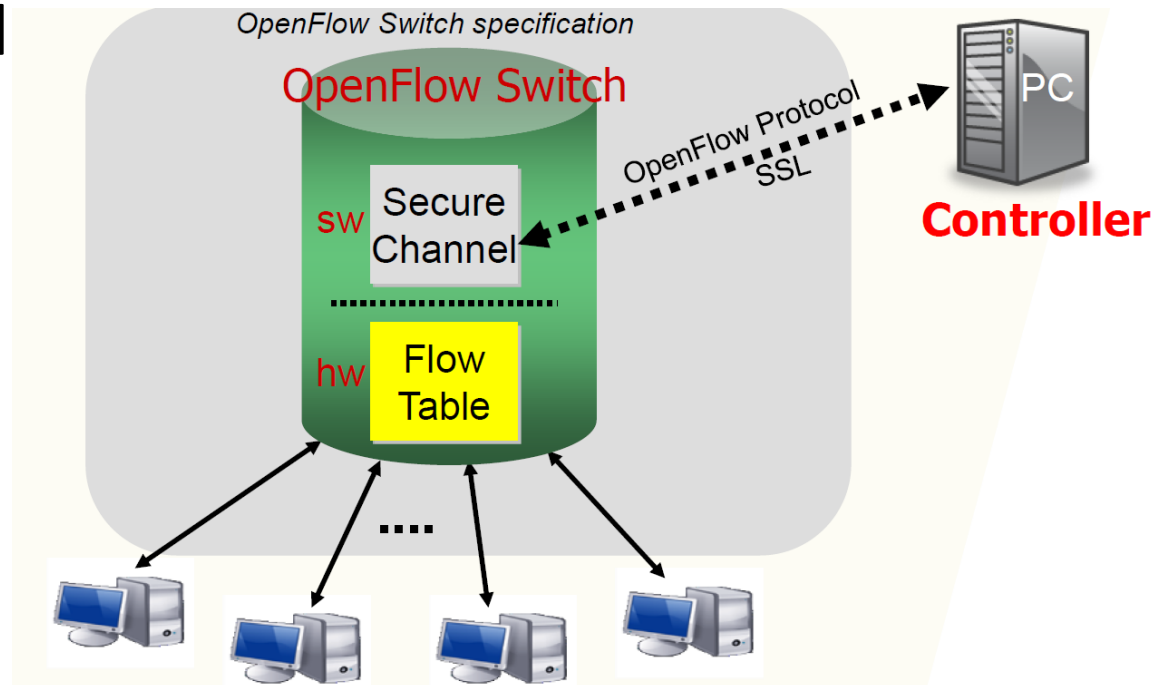
# Introduction to OpenFlow

- x86 style instruction set
- Based on Ethernet Switch with:
  - OF software client
  - Hardware flow table
- Control channel between switch and controller

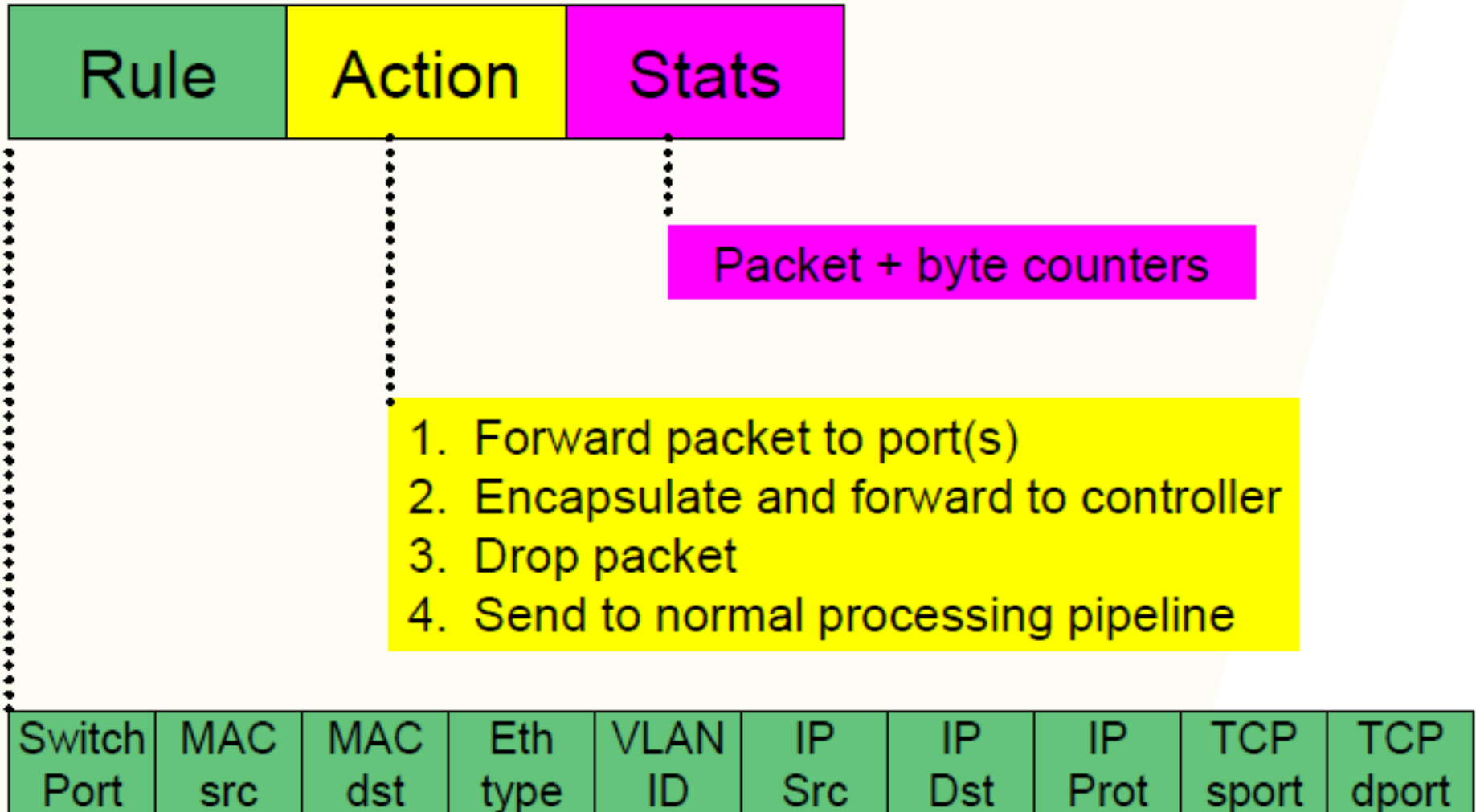


# OpenFlow

- Separation of control and data planes
- Centralization of control
- Flow based control



# Flow Table

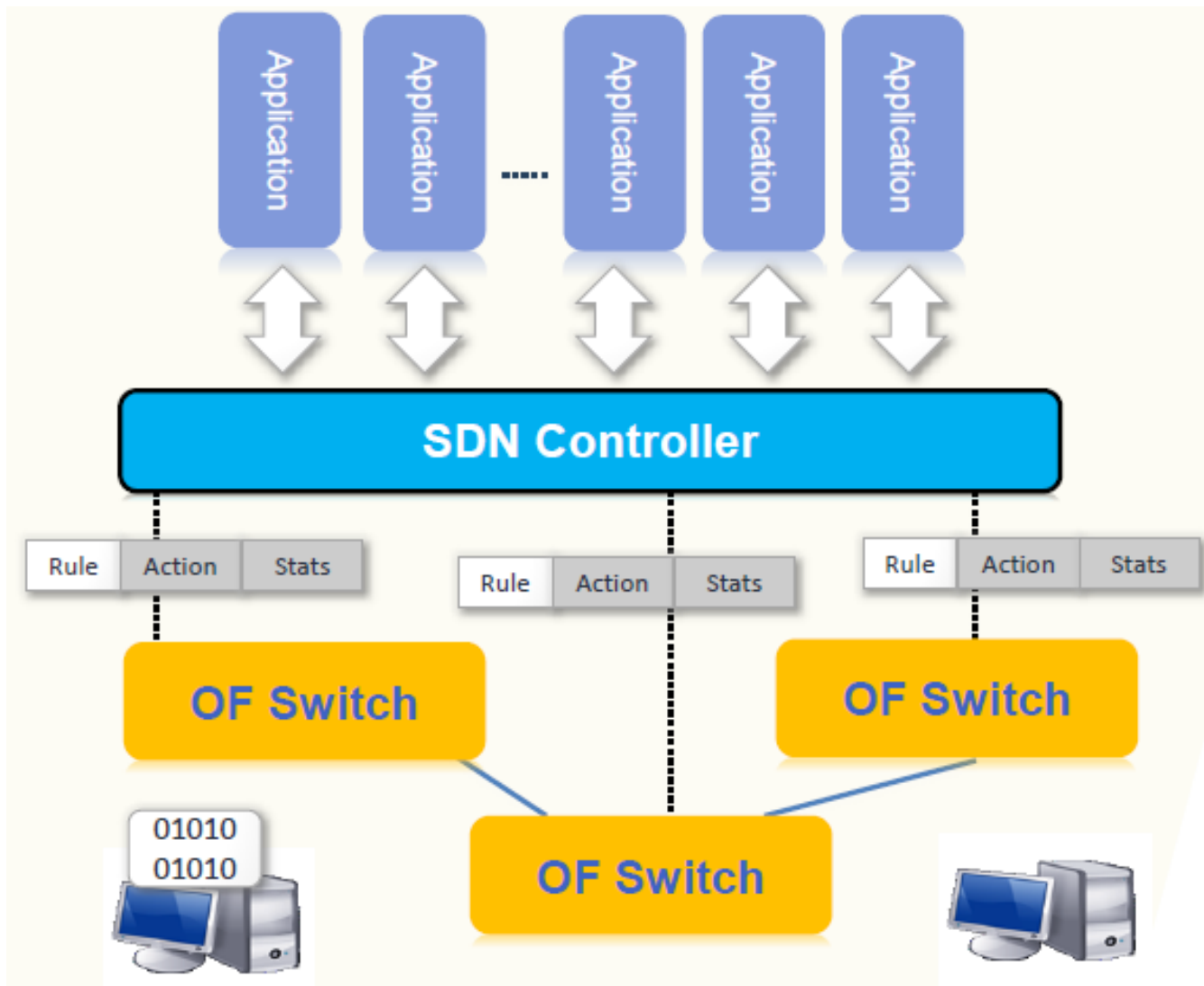


+ mask

# Flow Table Example

Port	Src MAC	Dst MAC	VLAN ID	Priority	EtherType	Src IP	Dst IP	IP Proto	IP ToS	Src L4 Port ICMP Type	Dst L4 Port ICMP Code	Action	Counter
*	*	0A:C8:*	*	*	*	*	*	*	*	*	*	Port 1	102
*	*	*	*	*	*	*	192.168.*.*	*	*	*	*	Port 2	202
*	*	*	*	*	*	*	*	*	*	21	21	Drop	420
*	*	*	*	*	*	*	*	0x806	*	*	*	Local	444
*	*	*	*	*	*	*	*	0x1*	*	*	*	Controller	1

# OpenFlow in Action



# OpenFlow Standards

- OF v1.0, Dec 2009
  - Initial OpenFlow specification
  - match on 12-tuple
- OF v1a.1: Extensions for WAN, late 2010
  - multiple tables: dodge state space explosion
  - fast failover, interface bonding
- OF v1.2 :
  - IPv6 support, generalized match, vendor extensions
- OFv1.3:(most popular now)
- OF v1.4



# Nowadays

- Since 2012, however, many companies have moved away from OpenFlow, and have embraced different techniques. These include Cisco Systems' Open Network Environment and Nicira's network virtualization platform.

# Applications for SDN Networks

- QoS management
- Security management
- Network (wired + wireless) management
- BYOD management
- Over the top (OTT) management
- Smart Traffic engineering
- Intelligent Billing
- Intelligent 5G backbone networks

# Over The ToP(OTT) Management

- Most applications over Carriers' networks without paying anything today
- Collaboration between Carriers and Application Providers is the trend. For example,
  - Netflix is paying AT&T to make movies stream faster
- Identifying application traffic is the first step to provide better OTT management

# Challenges and Opportunities for 5G Networks and SDN

- For 5G networks, it is better to provide application-aware management, such as
  - Over the Top (OTT) Management
  - QoS/Security Management
  - Smarter Traffic Engineering
  - Intelligent Billing
  - Network Function Virtualization (NFV)

# References

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[https://en.wikipedia.org/wiki/Software-defined\\_networking](https://en.wikipedia.org/wiki/Software-defined_networking)