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Introduction to SDN and NFV

Tomás Lynch

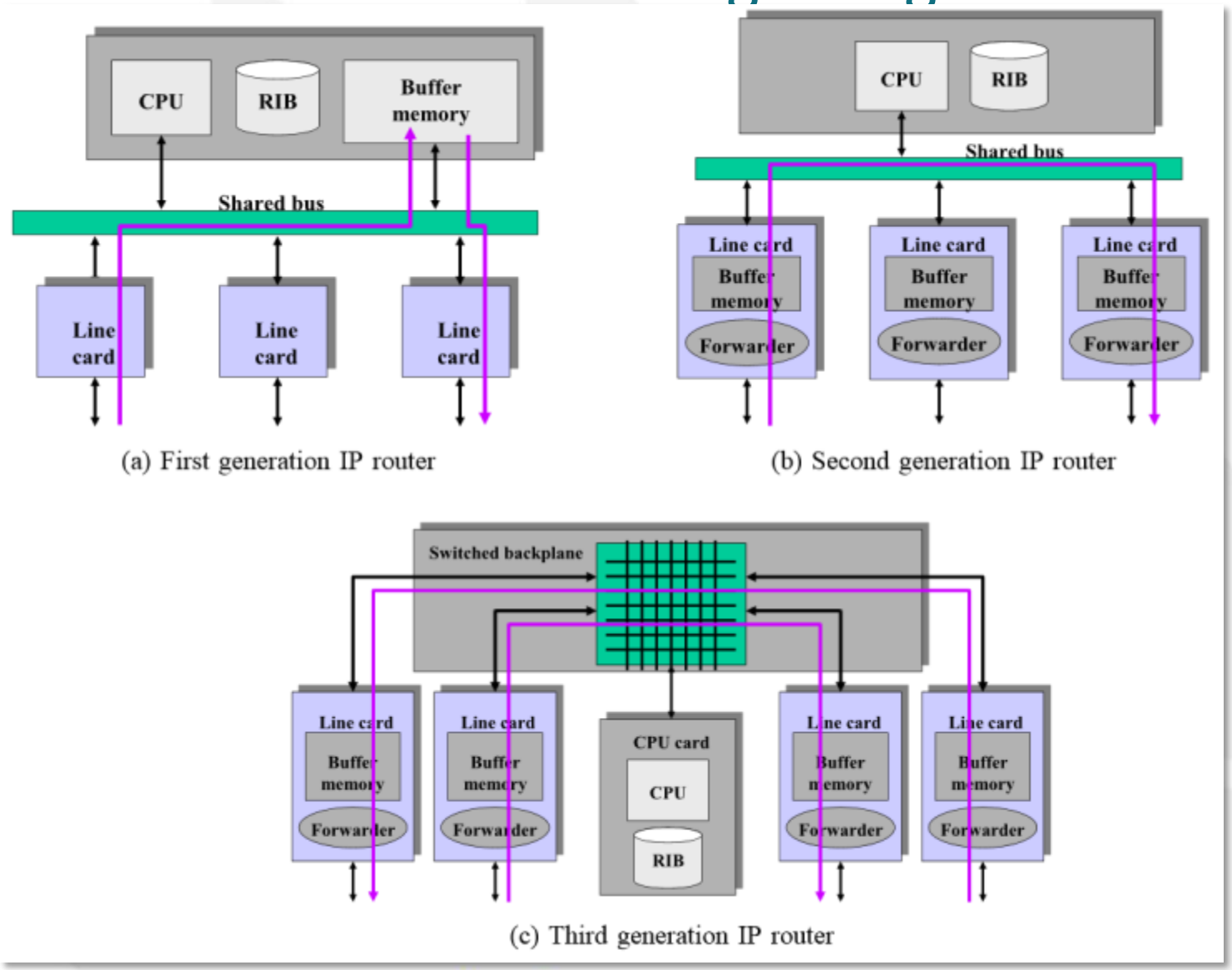
Solution Architect III

Ericsson

Software-Defined Networking

THE PATH TO SDN

IP Router Evolution – In the beginning

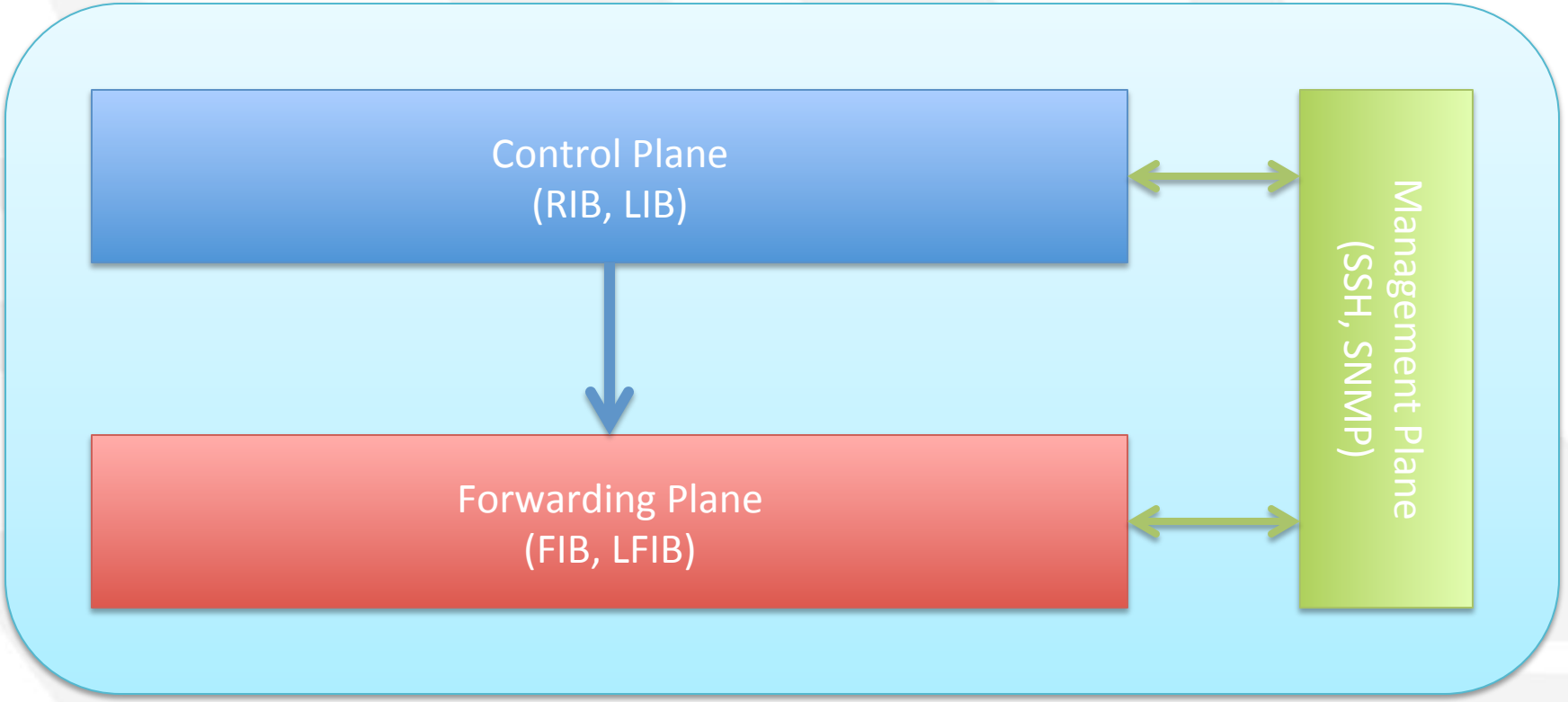


Császár, András et al., "Converging the Evolution of Router Architectures and IP Networks,"

IP Router Planes Evolution

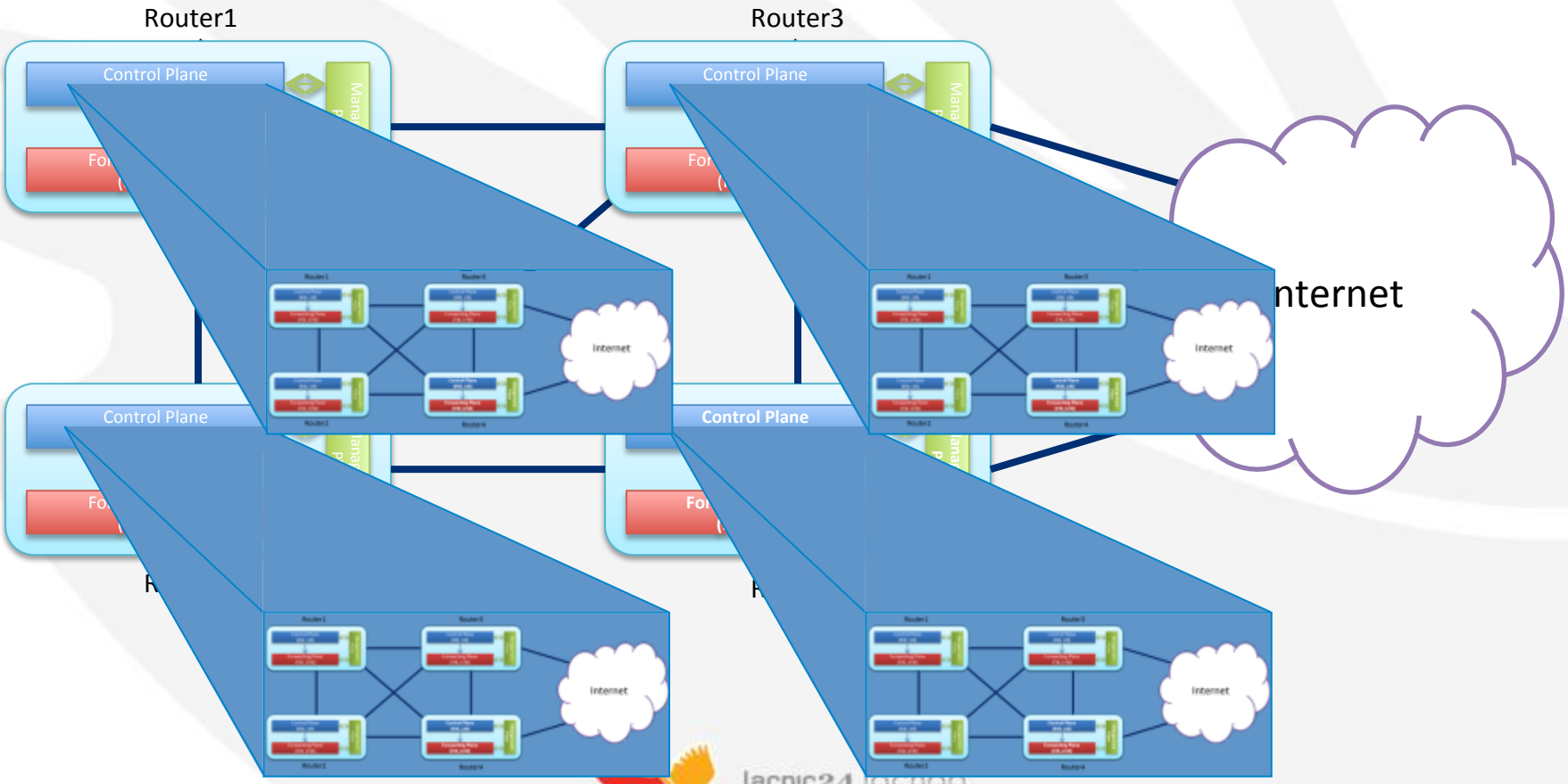
- Routers have three well-identified planes
  - Forwarding
  - Control
  - Management
- Architectural development had taken place almost exclusively for the data plane,
- Control plane had remained virtually the same.

IP Router Evolution – Plane Separation



Router

IP/MPLS Backbone – Example



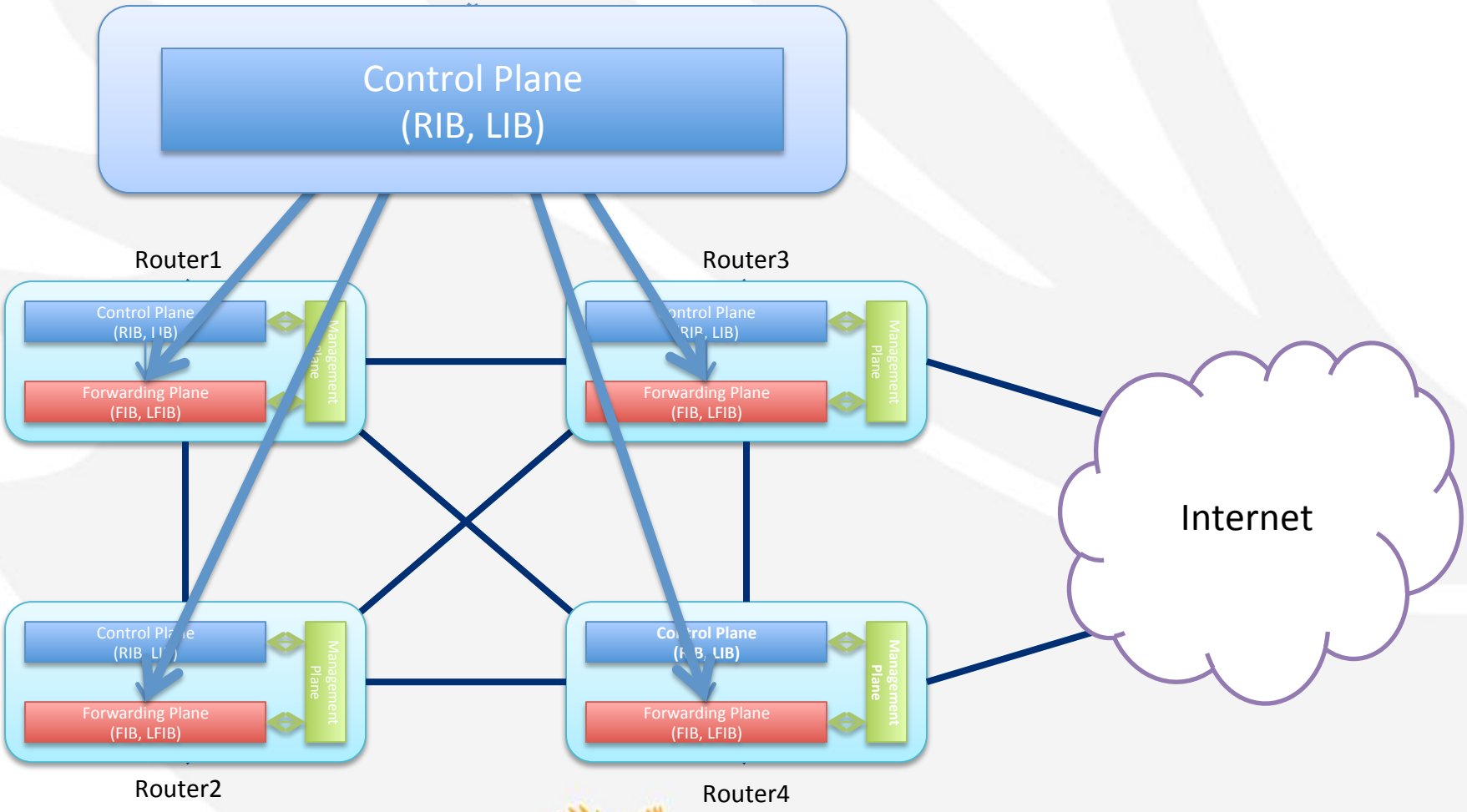
So far, so good. But…

- Moore’s law =~ processing doubles every 24 months
- Nielsen's Law =~ bandwidth doubles every 12 months
- Teenager Law =~ the App I was using last week is soooooo boring, I need a new phone every month

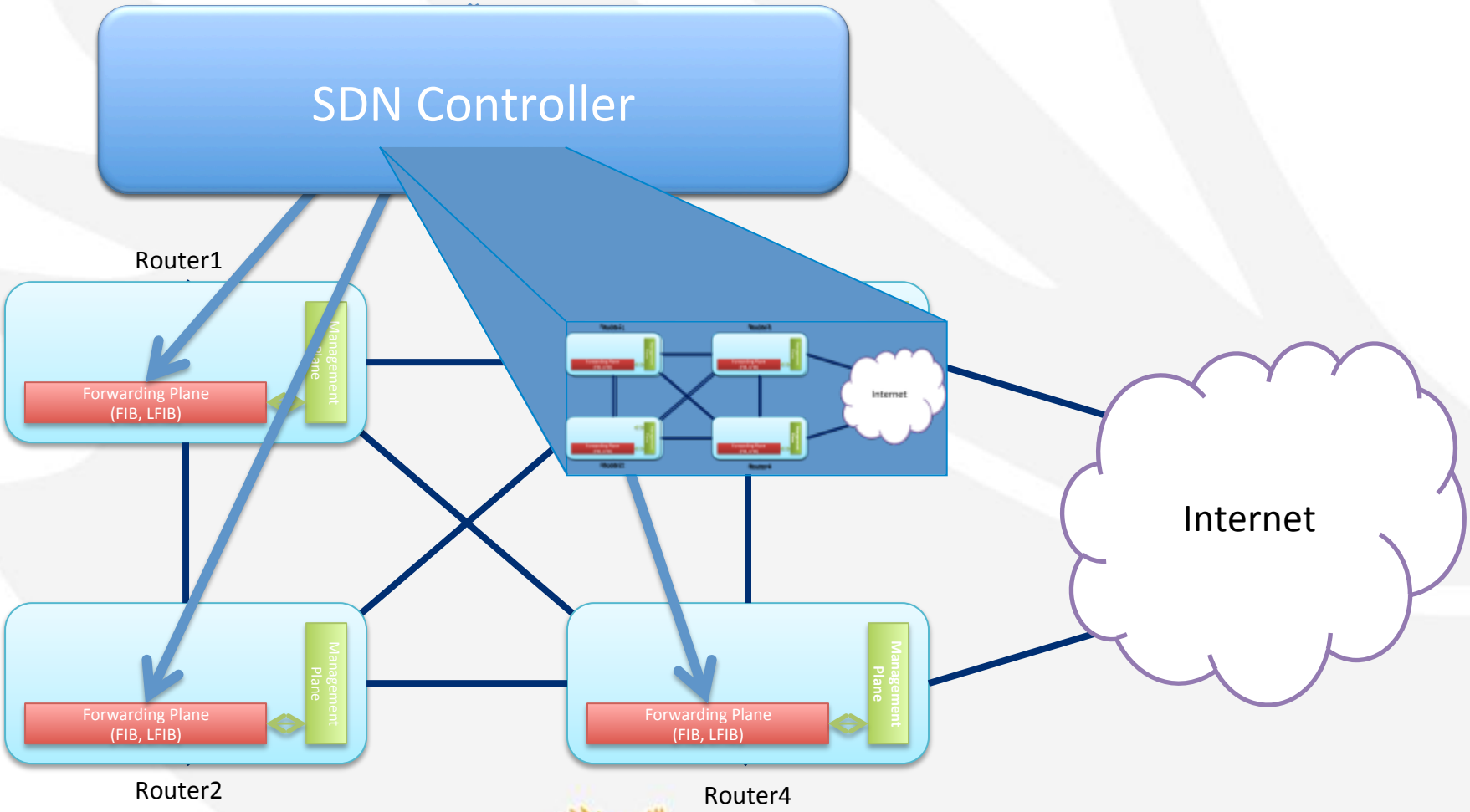
New Network Requirements

- Efficiency
  - Simplify network & operations
- Speed
  - Fast deployment of new services
- Innovation
  - Implement new business models

Efficiency – Physically Decoupling Control Plane



Efficiency – Physically Decoupling Control Plane



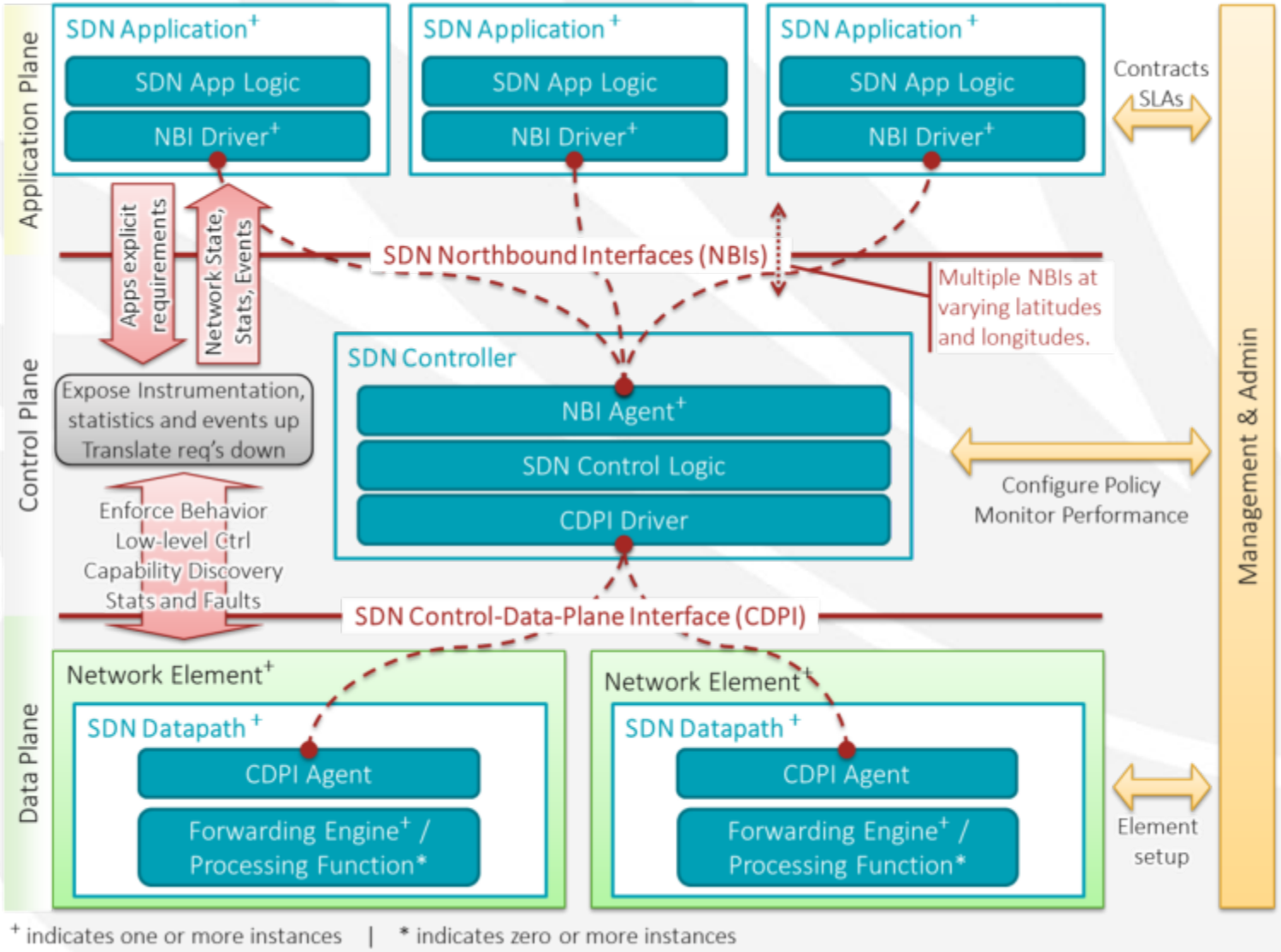
Software-Defined Networking Definition?

Software-Defined Networking Definition…

Software-Defined Networking

SDN ARCHITECTURE

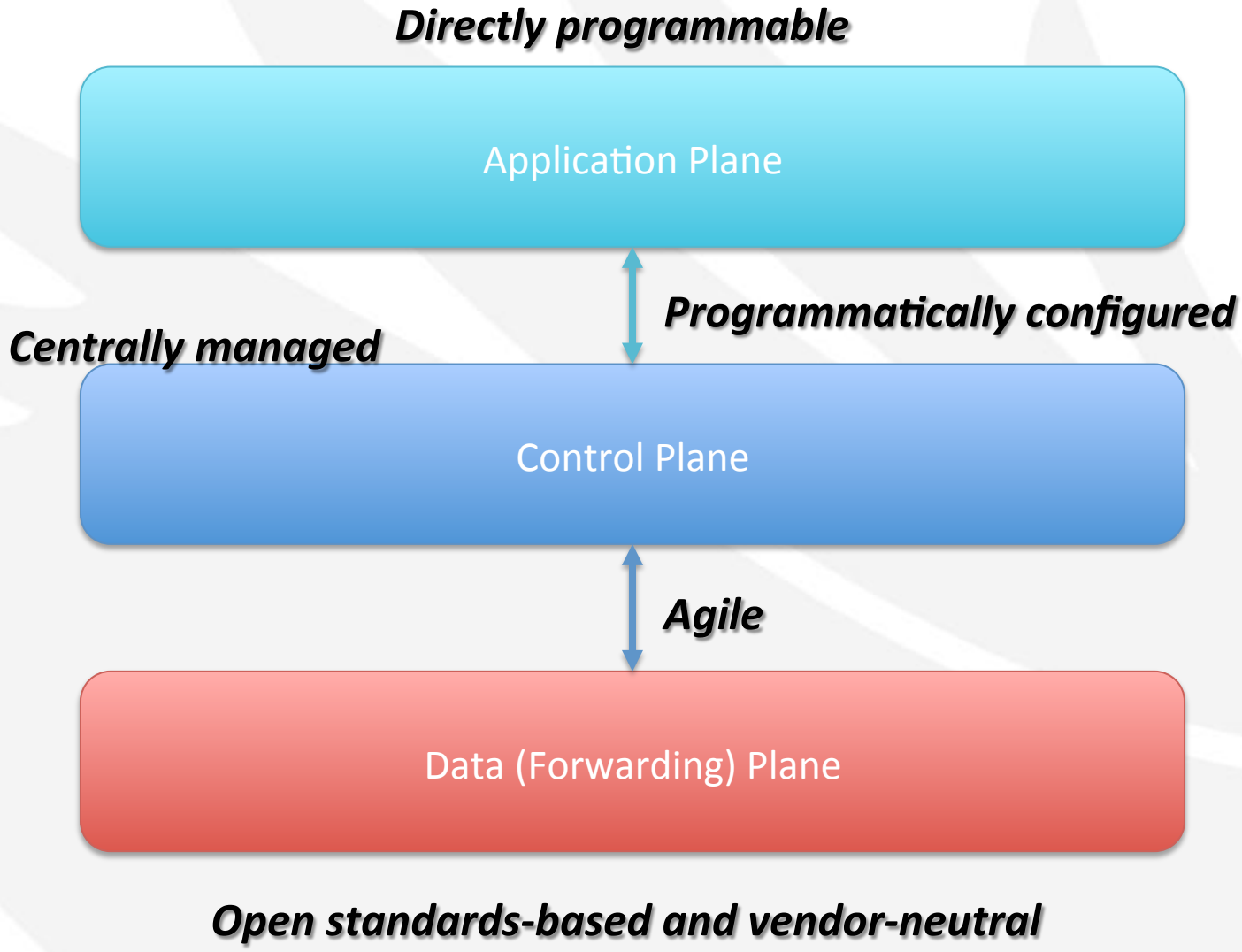
SDN Architecture



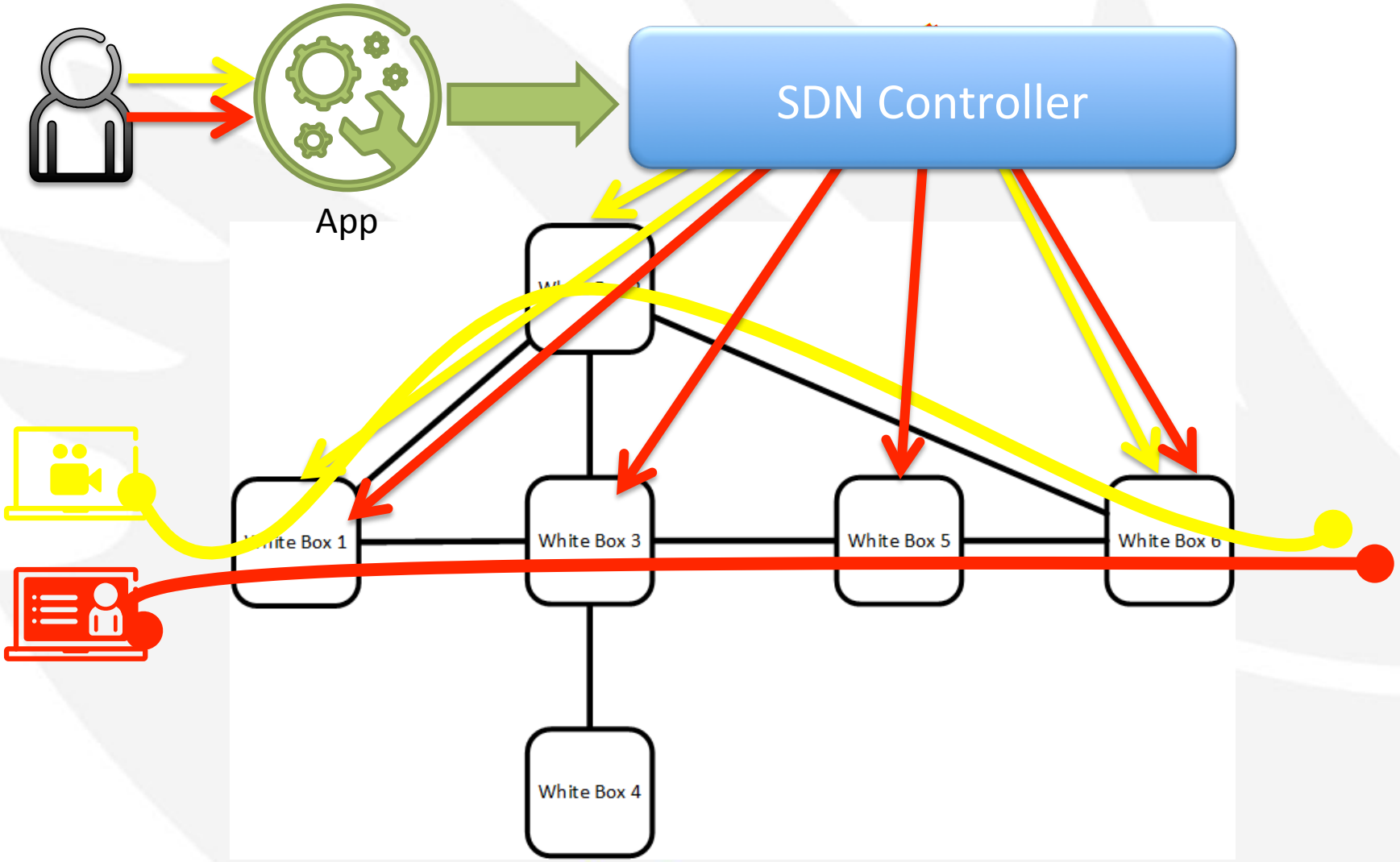
+ indicates one or more instances | * indicates zero or more instances

"SDN-architecture-overview-transparent" by Open Networking Foundation (ONF) - SDN Architecture Overview (PDF), Version 1.0, December 12, 2013.. Licensed under CC BY-SA 3.0 via Wikimedia Commons

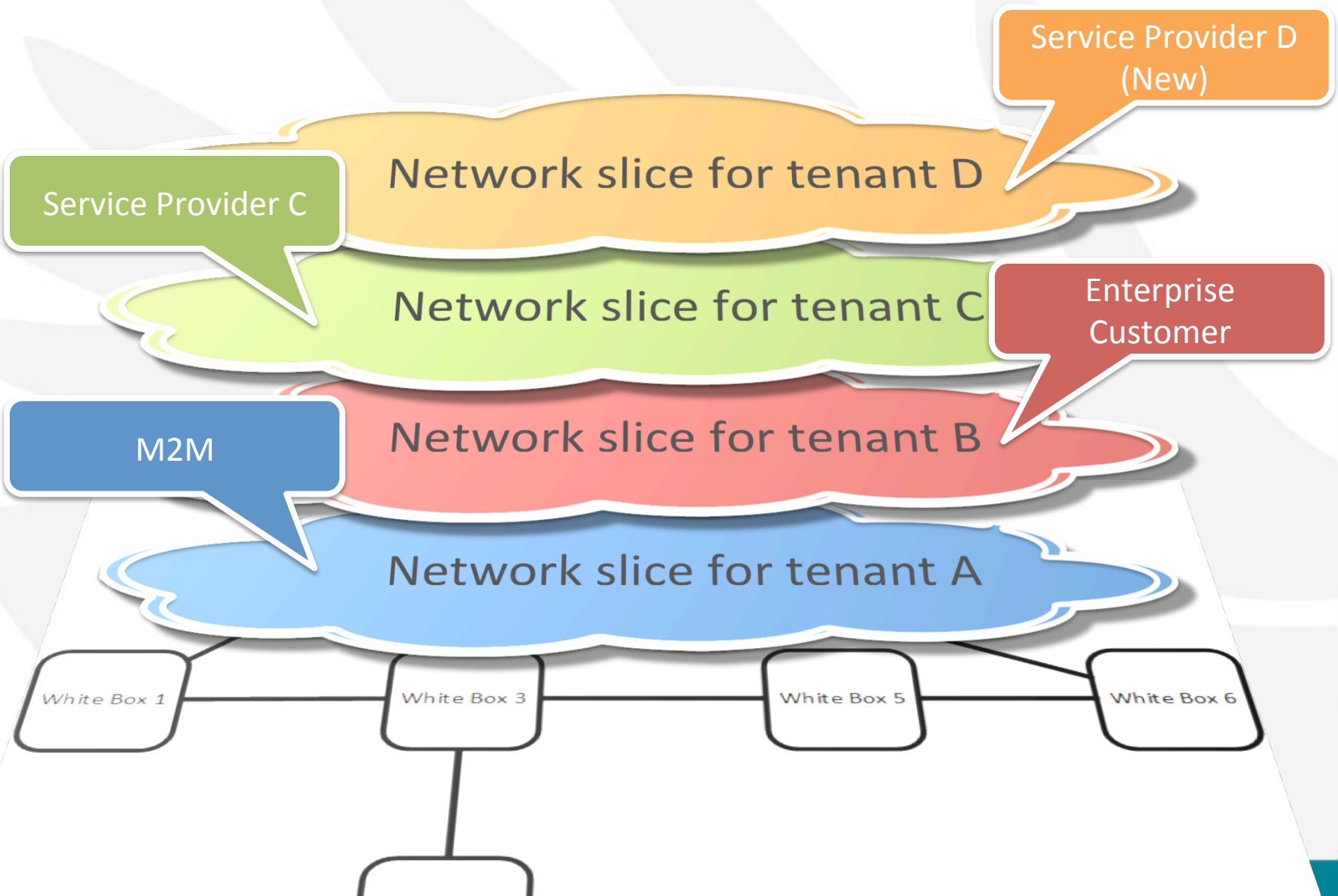
Simplified SDN Architecture



SDN – Speed & Innovation: Configuring Services

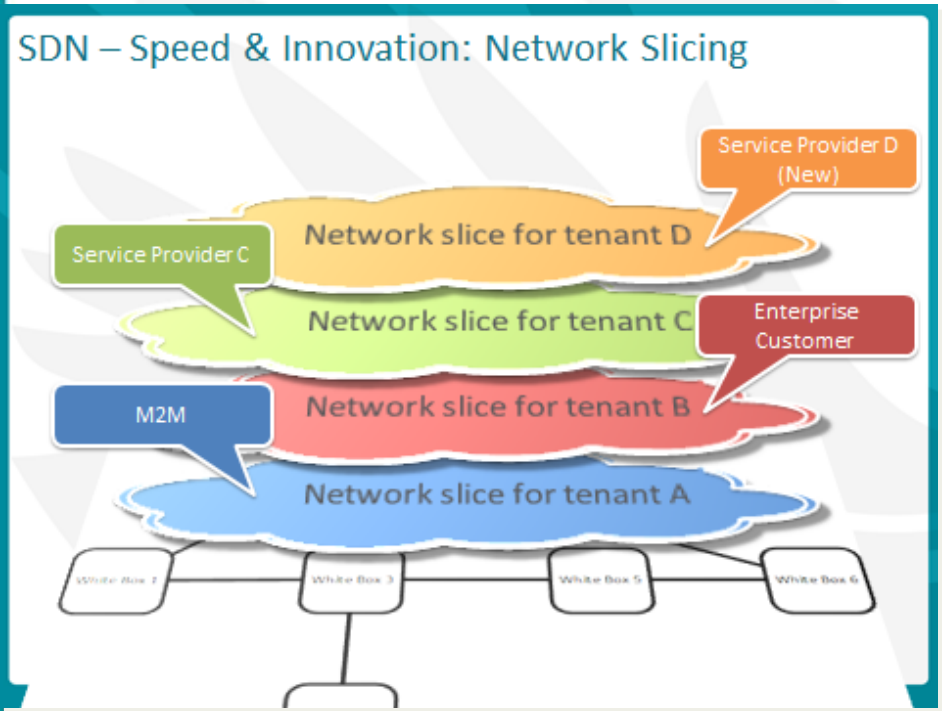


SDN – Speed & Innovation: Network Slicing



SDN – Speed & Innovation: Network Slicing

- Wait!! That's MPLS!!!!



- No,
  - It is centrally managed
  - It is agile
  - It is programmatically configured
- It is SDN

Software-Defined Networking

OPENDAYLIGHT AND OPENFLOW

SDN Controller Software

- Open and community driven initiatives:
  - OpenDaylight
  - OpenContrail
  - ONOS
  - Project Floodlight
  - Beacon
  - NOX/POX
- Vendor specific initiatives:
  - Juniper Contrail
  - Alcatel-Lucent Nuage

	OpenDayLight	OpenContrail	ONOS
Lines of code	2.48 Millions	1.37 Millions	0.25 Millions
Contributors	364	55	78

Source: www.openhub.net

OpenDaylight

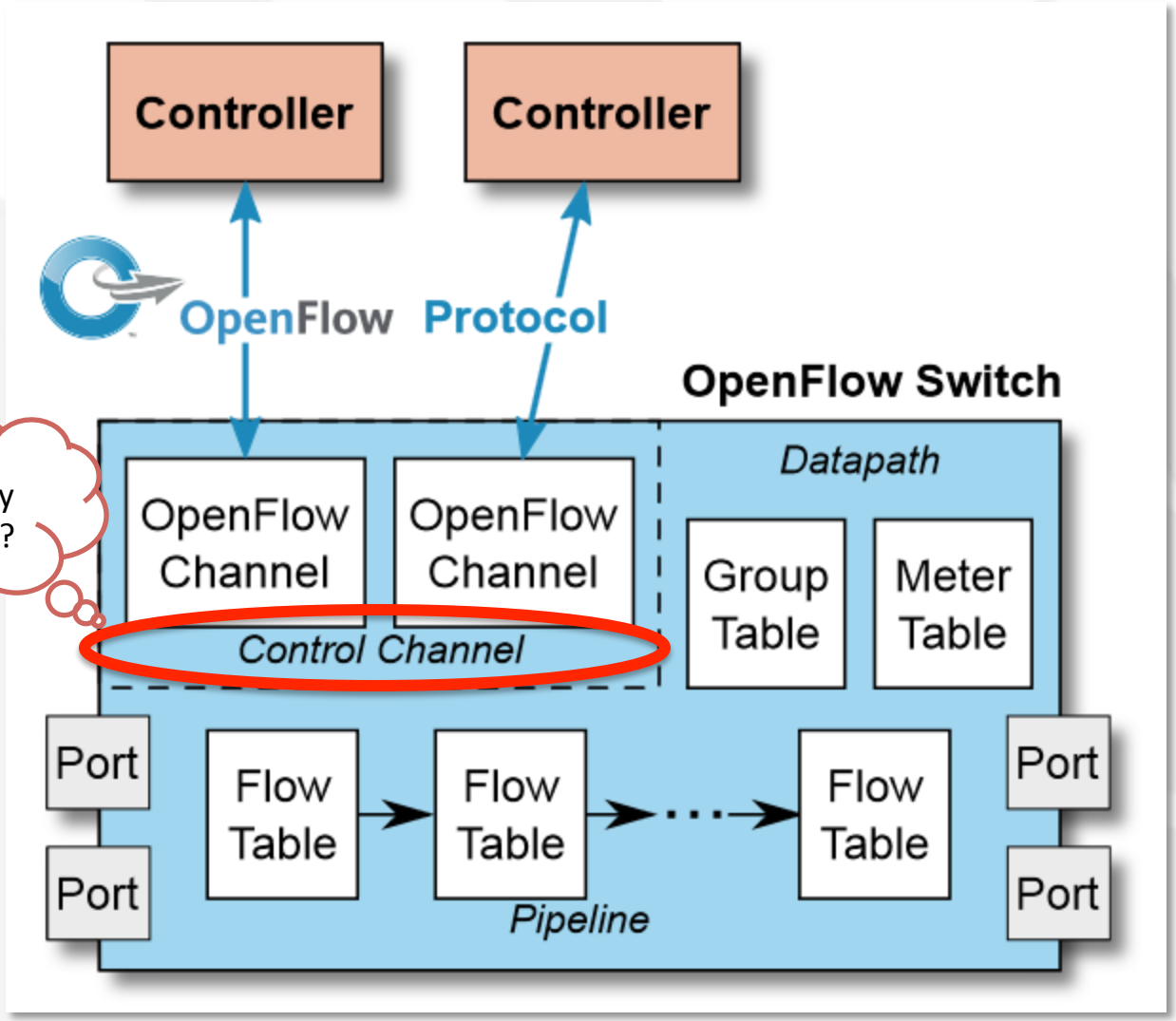
- An Open Source project to build a versatile SDN Controller
- Participants from many companies
  - Platinum members are Brocade, Cisco, Citrix, Dell, Ericsson, HP, Intel, and Red Hat.
- Includes support for multiple southbound protocols
  - OpenFlow, OVSDB, NetConf, BGP-LS, PCE…
- Northbound is principally RestConf with YANG
- Central core is a YANG drive Model Based Service Abstraction

OpenFlow

- First standard communications interface defined between the control and forwarding layers of an SDN architecture.
- Allows direct access to and manipulation of the forwarding plane of network devices
- Allows switches from different suppliers to be managed remotely.

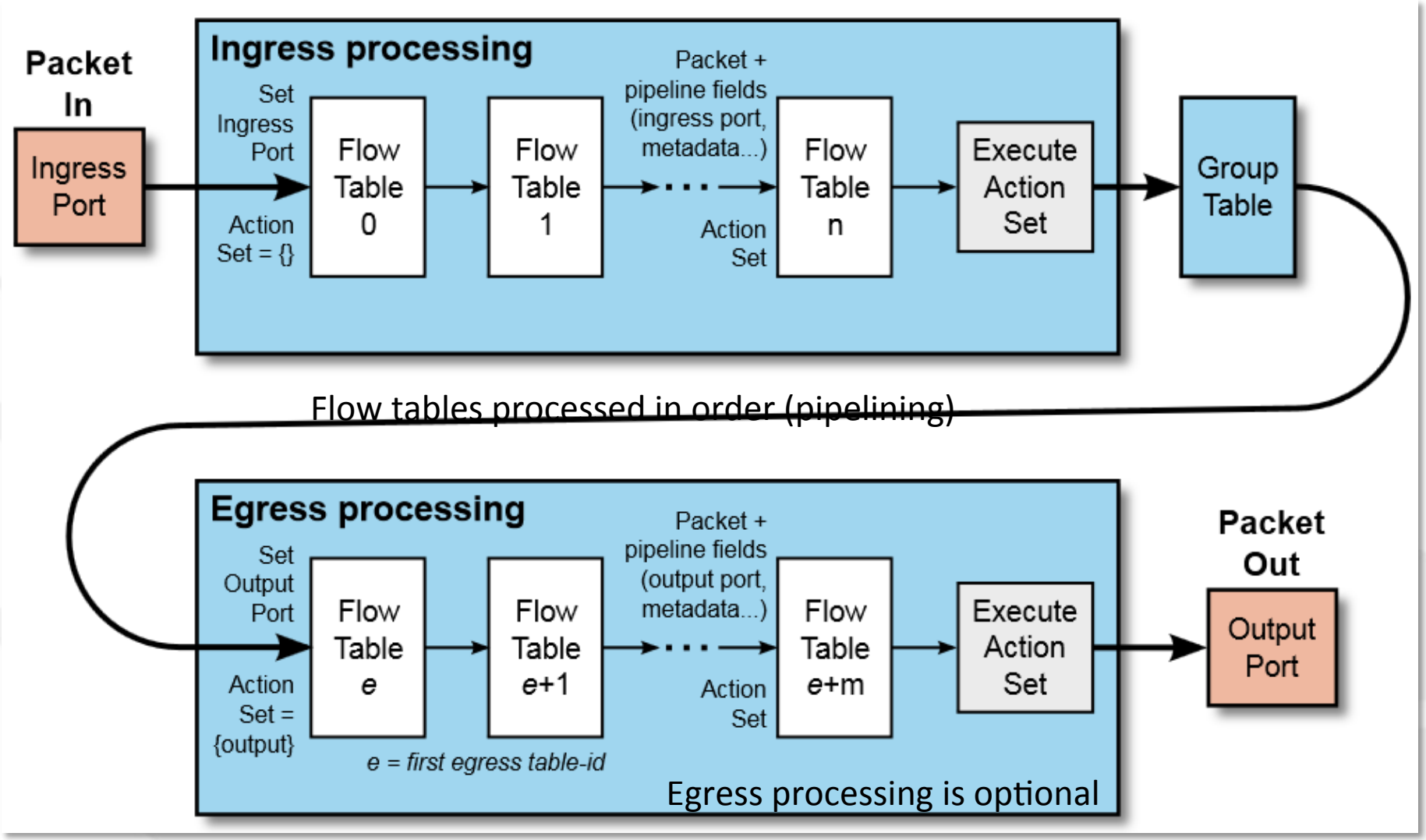
Source: https://www.opennetworking.org/sdn-resources/openflow/

OpenFlow Switch



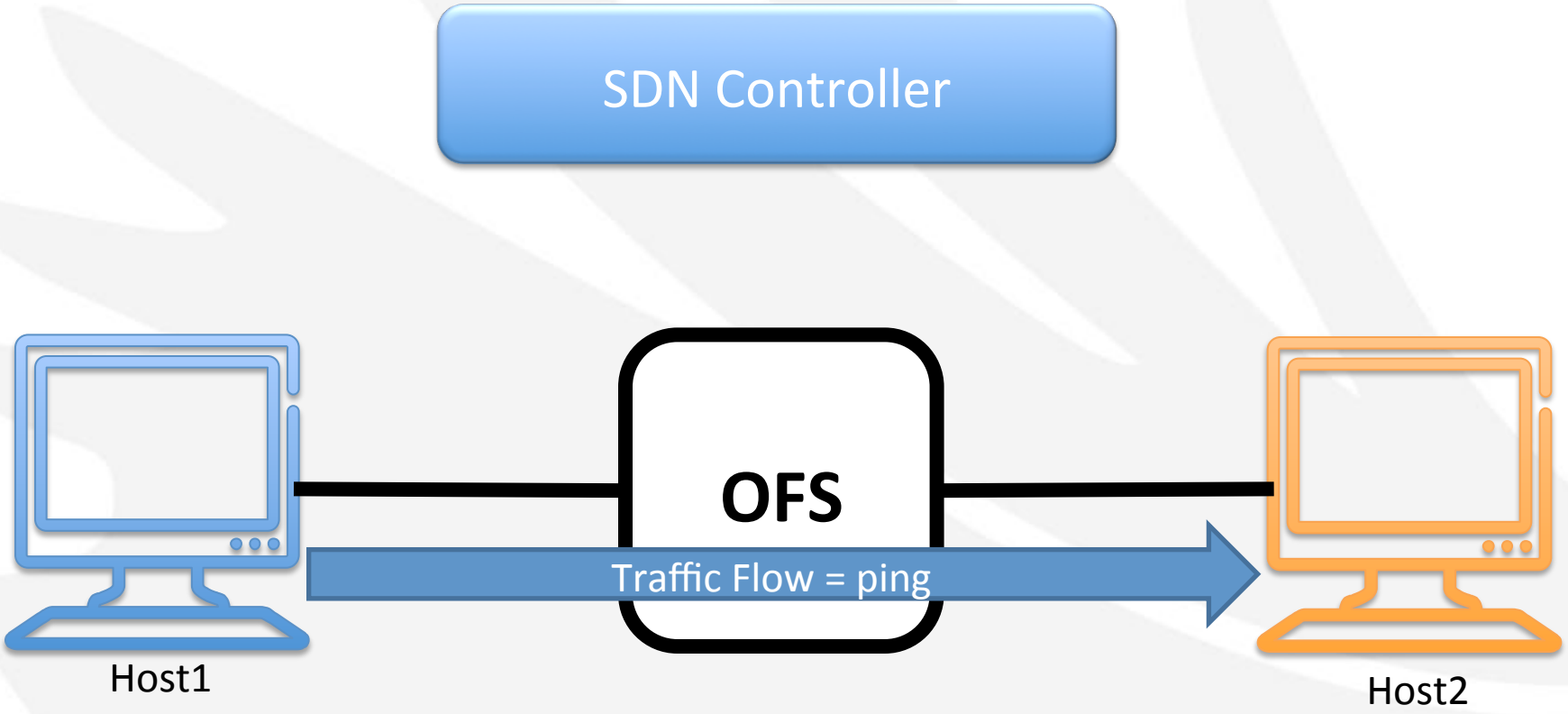
Source: OpenFlow Switch Specification. Version 1.5.1 (Protocol version 0x06)

OpenFlow Switch – Flow Tables

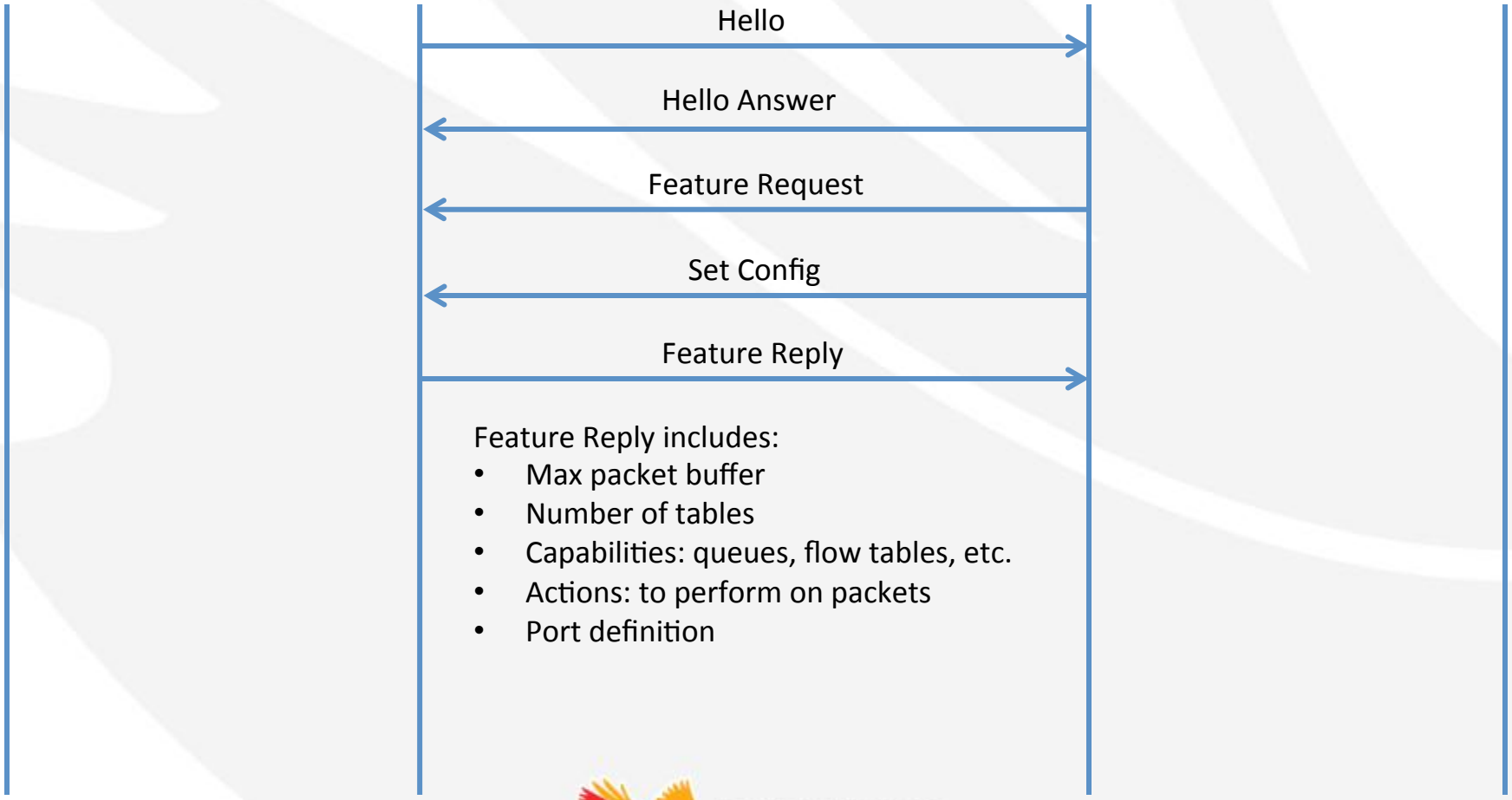


Source: OpenFlow Switch Specification. Version 1.5.1 (Protocol version 0x06)

OpenFlow Switch – PING



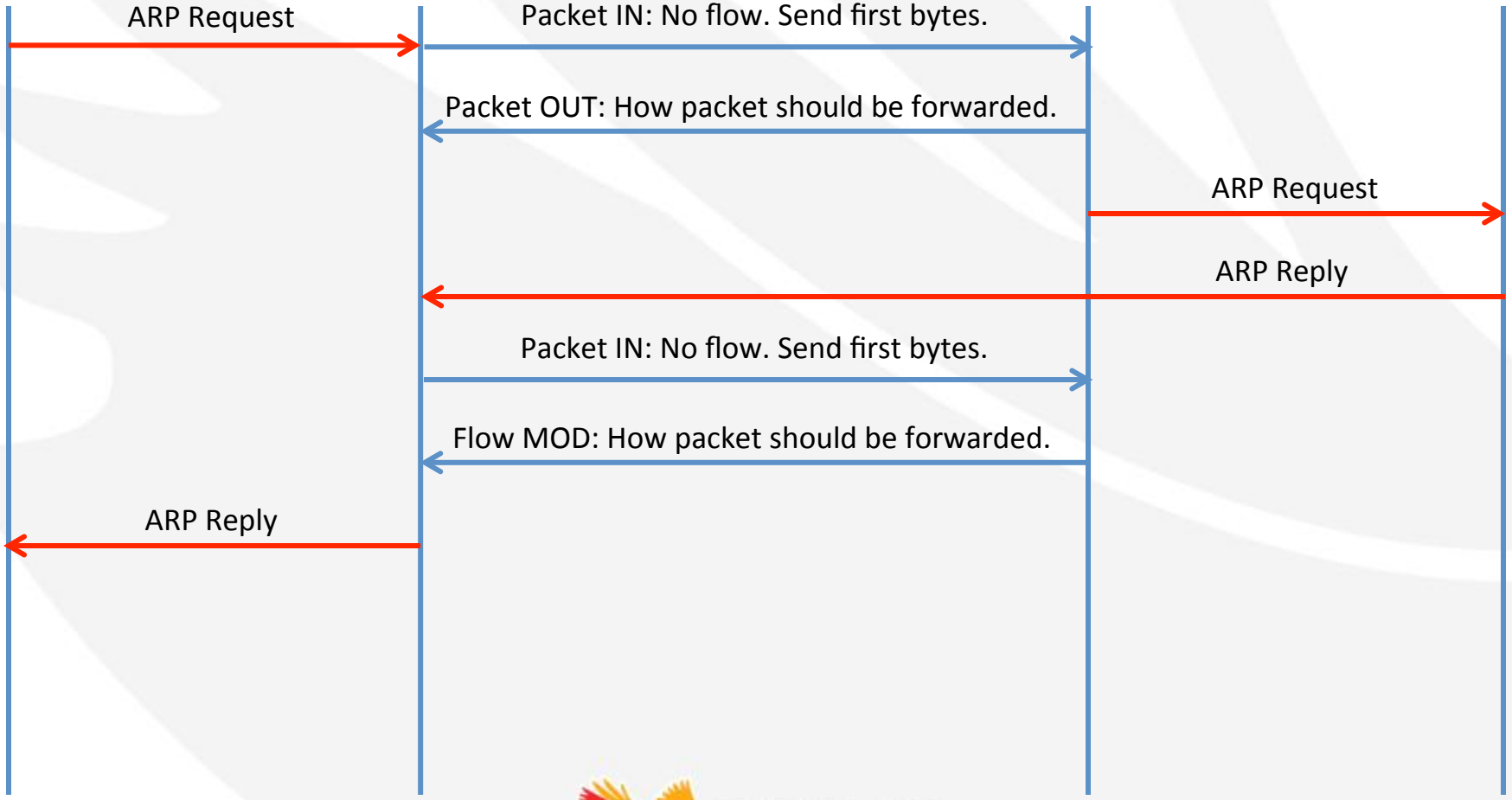
OpenFlow Switch – Initialization Phase



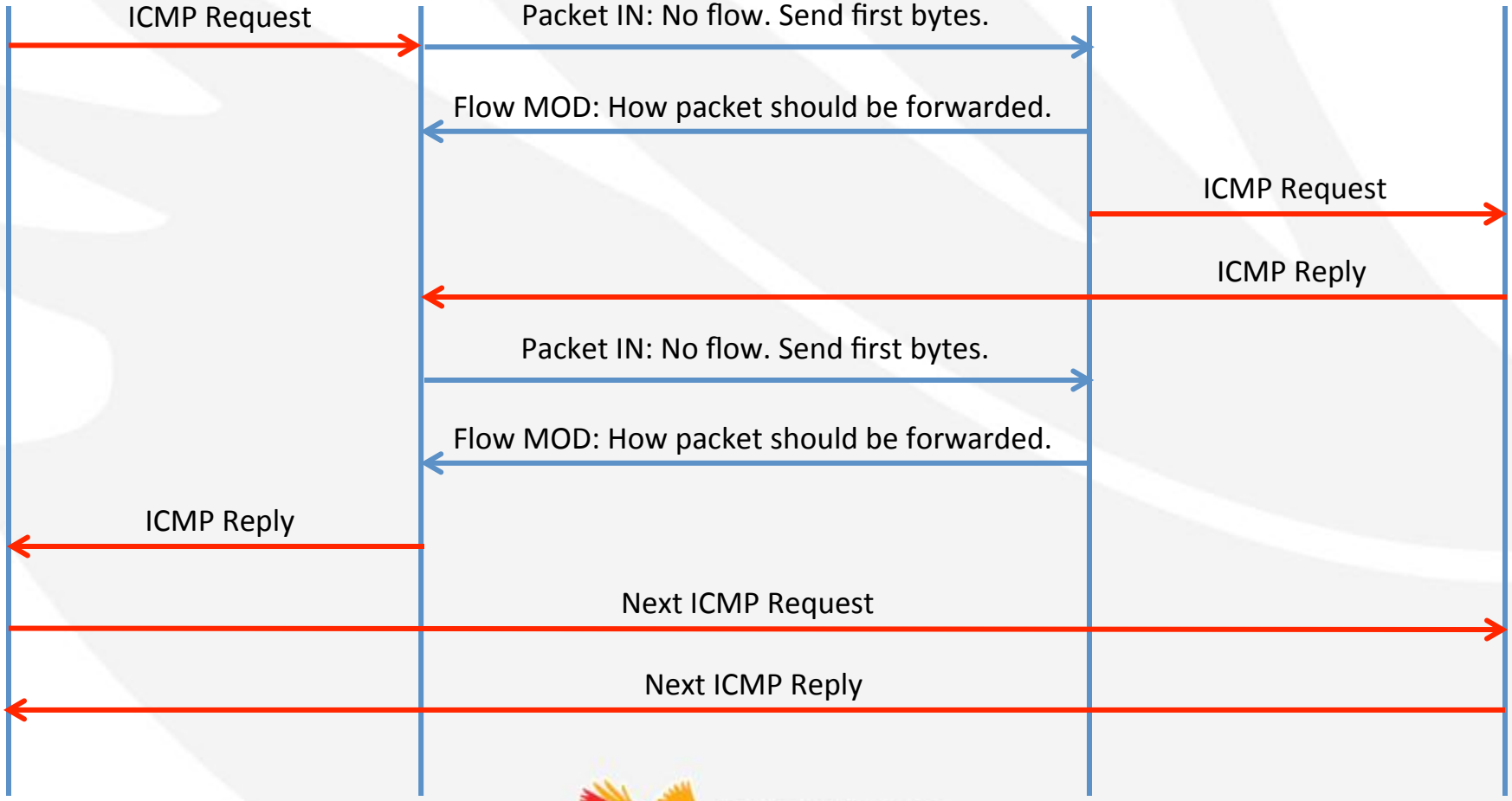
Feature Reply includes:

- Max packet buffer
- Number of tables
- Capabilities: queues, flow tables, etc.
- Actions: to perform on packets
- Port definition

OpenFlow Switch – ARP Flow



OpenFlow Switch – ICMP Flow



Network Function Virtualization

WHAT IS NFV?

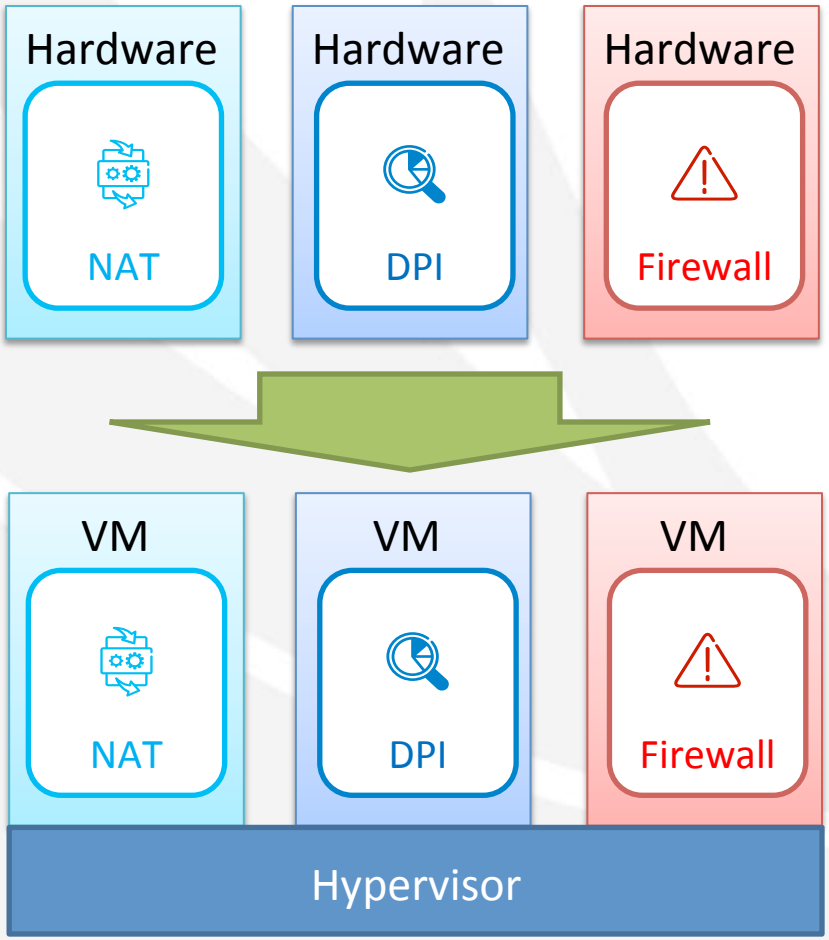
What is NFV?

- ETSI initiative (November 2012)
- Aims to transform the way that network operators architect networks
- Addresses hardware dependence:
  - Consolidates many network equipment types onto industry standard high volume servers
  - Implementation of network functions in software

Source: Network Functions Virtualisation – Introductory White Paper, ETSI

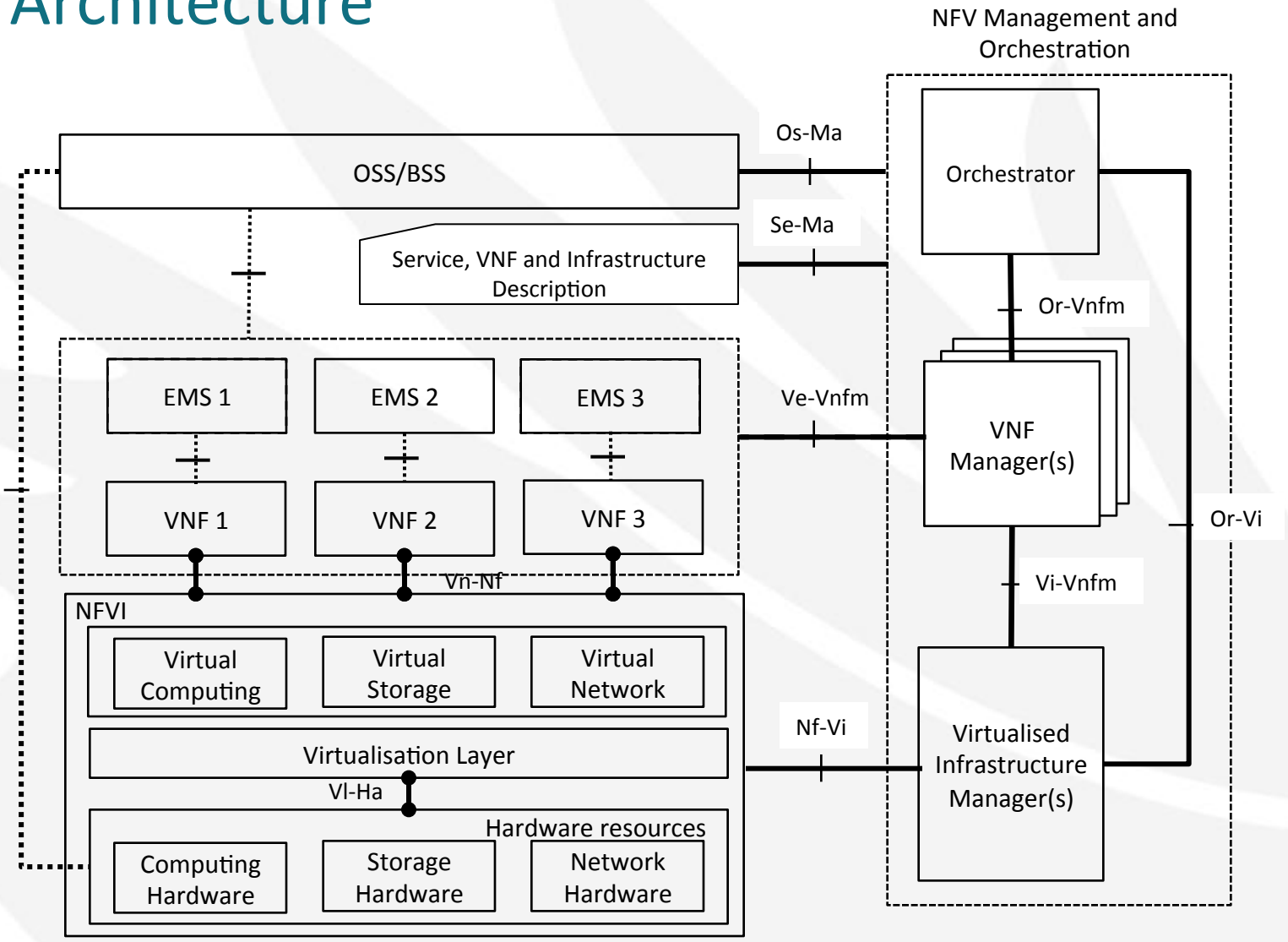
NFV Benefits

- Reduced equipment costs and reduced power consumption
- Reduction in variety of equipment for planning & provisioning
- Increased velocity of TTM
- Optimizing network configuration and/or topology in near real time



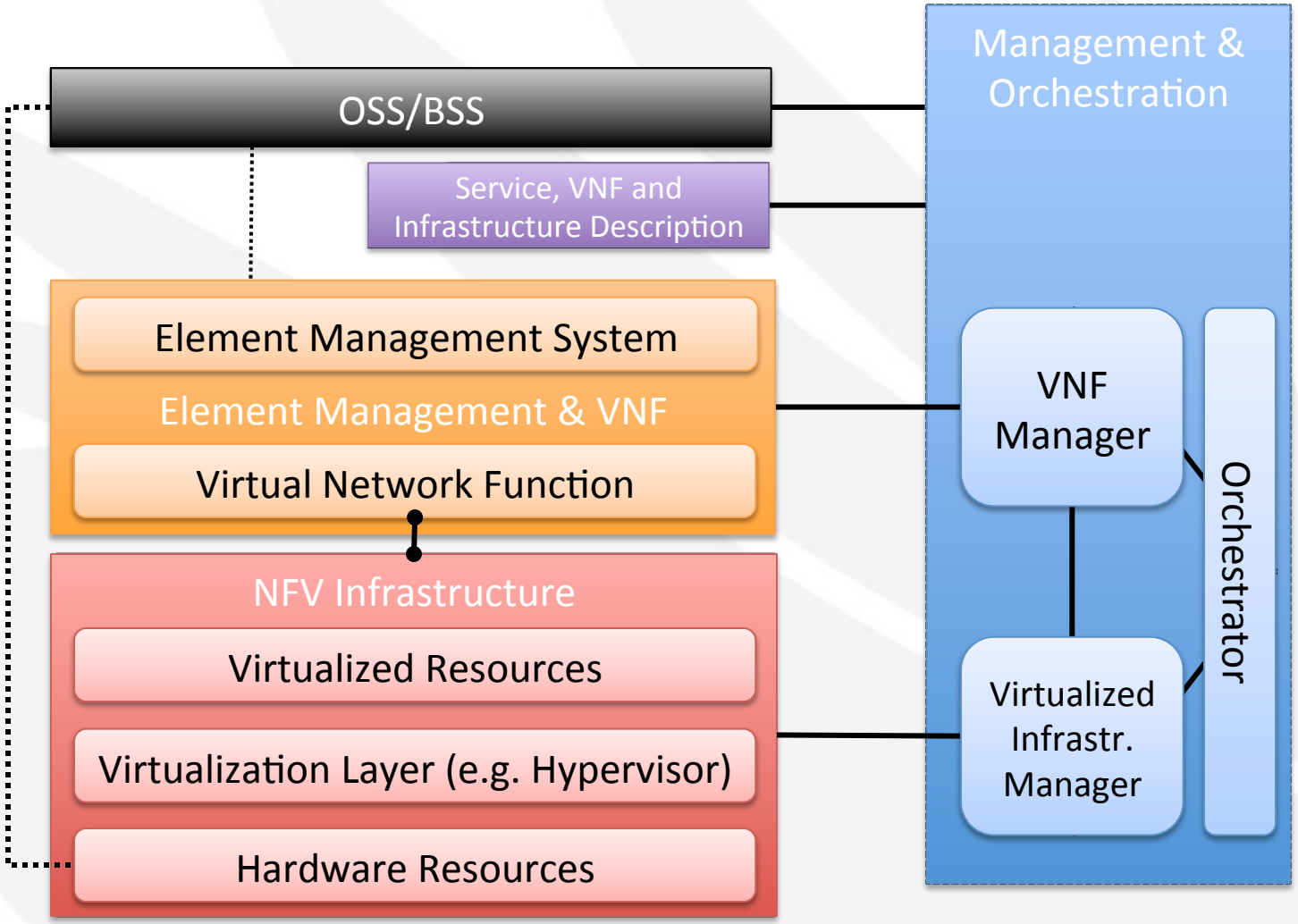
Source: Network Functions Virtualisation – Introductory White Paper, ETSI

NFV Architecture



Source: [Network Functions Virtualisation (NFV); Infrastructure Overview](), ETSI GS NFV-INF 001 V1.1.1 (2015-01)

Simplified NFV Architecture



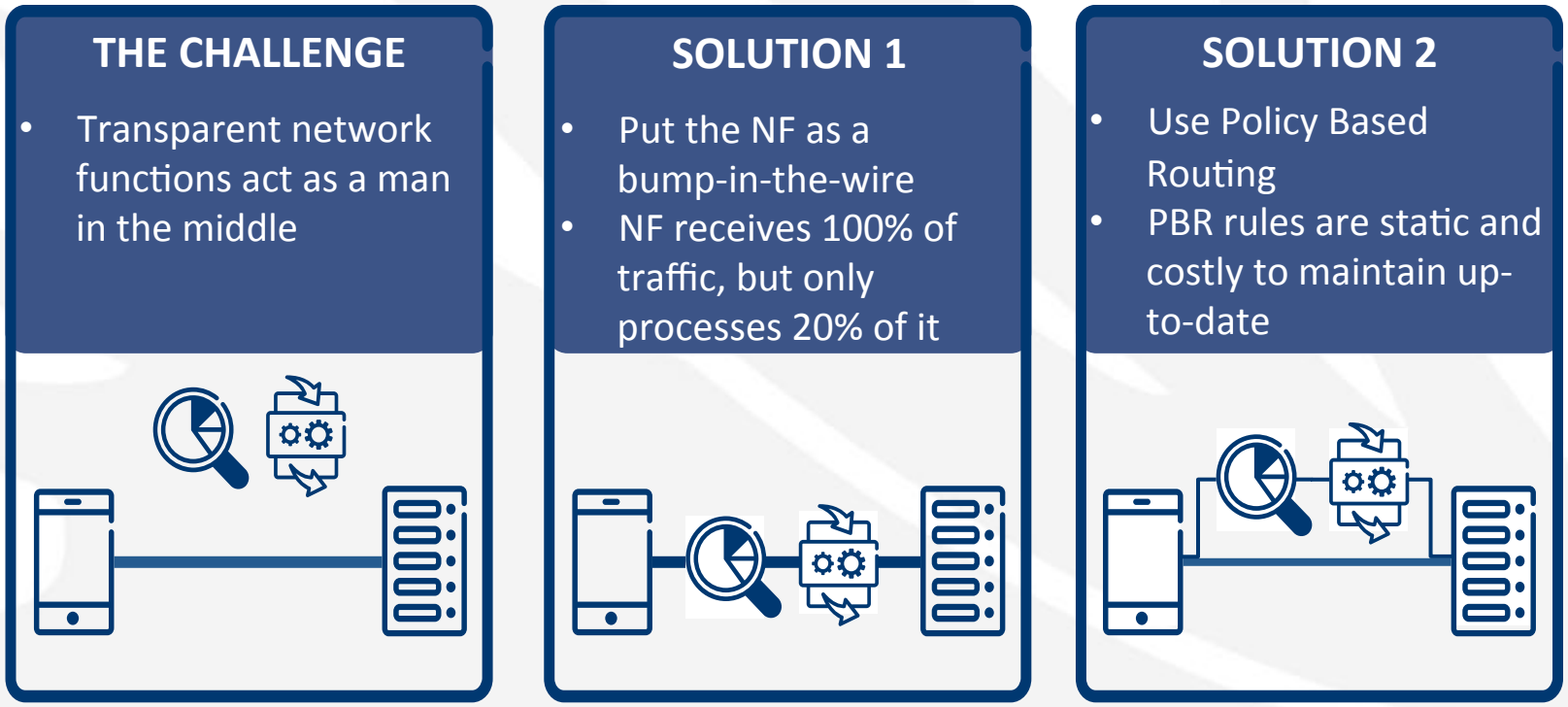
NFV Initiatives

- OPNFV (Open Platform NFV – Linux Foundation)
- OpenNFV (HP)
- NFV on OpenStack (Mirantis)

SDN and NFV

SERVICE CHAINING

Traditional Networks Challenge

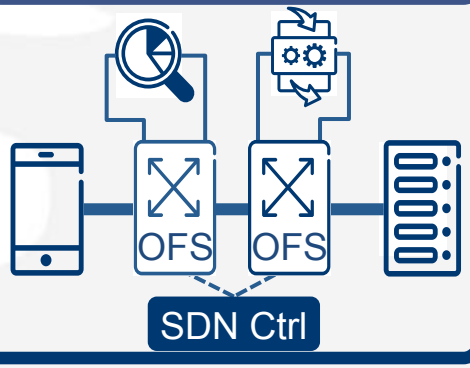


Often Inefficient, or Subscriber-Unaware & Static

SDN Solution – Service Chaining

THE SOLUTION

- Use SDN/OpenFlow to intelligently steer traffic
- Central control



FULL AWARENESS

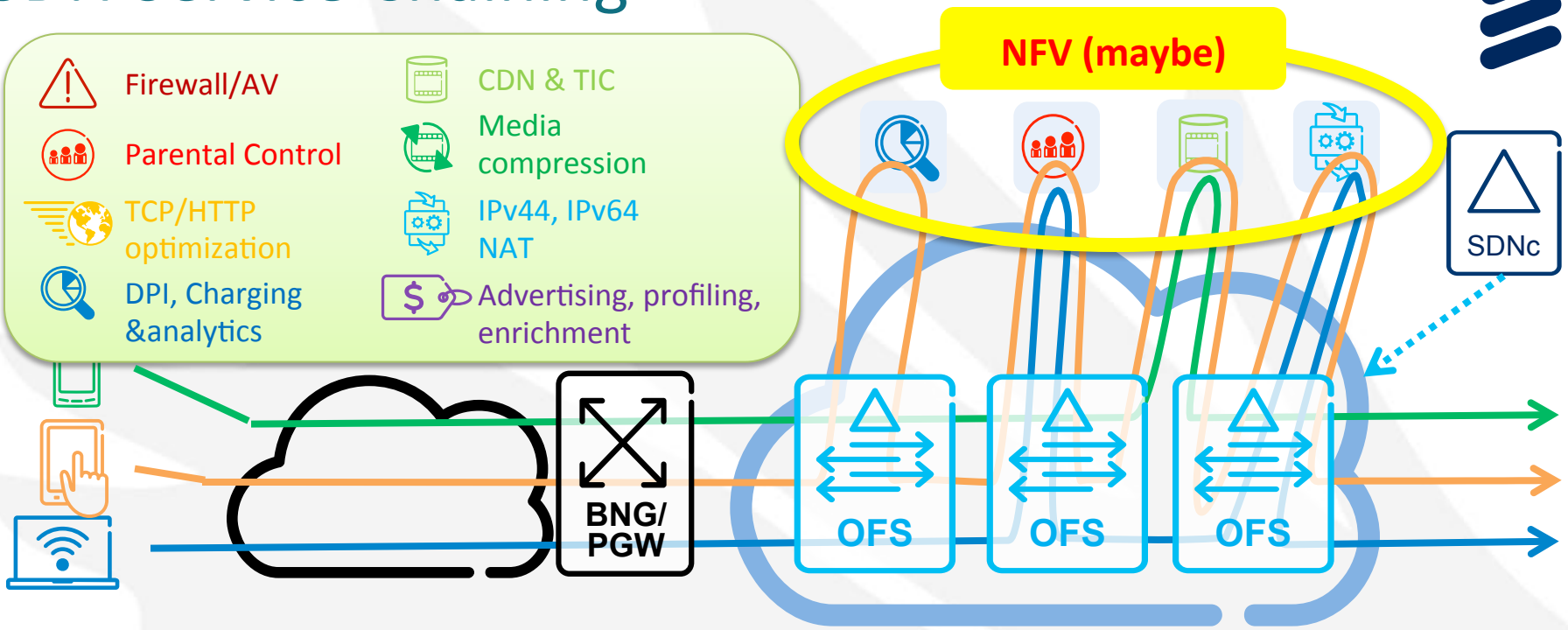
- Subscriber aware
- Destination aware
- Application aware
- Performance aware

THE RESULT

- Service Deployment in Minutes
- Operational Simplicity
- Carrying live traffic today

Personalization | **Faster Time to Market** | **Multi tenancy**

SDN Service Chaining



Lower CAPEX costs	•VAS dimensioned just for the subscribers/traffic that needs it
Lower OPEX costs	•Formal network verification & centralized troubleshooting
Faster Time to Market	•Opportunity for new functions
Multi tenancy	•Virtualization and Abstraction (MVNO's, VPN's)

SDN and NFV

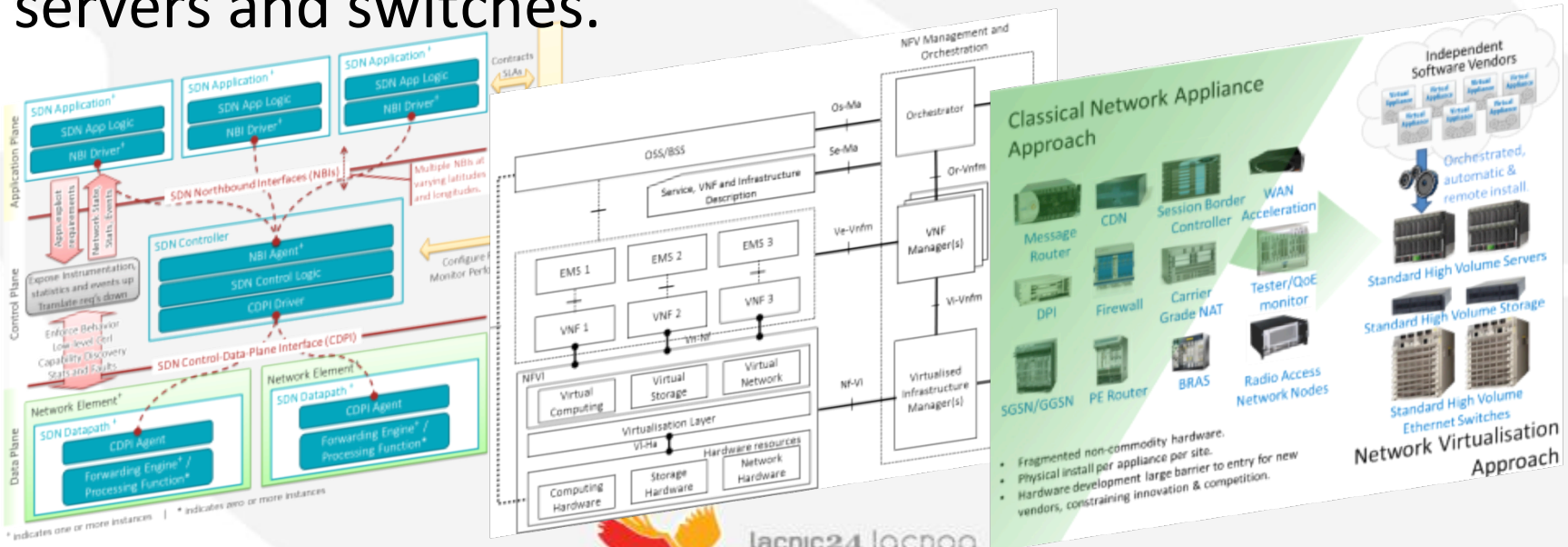
CONCLUSIONS

SDN and NFV – Advantages

- Efficiency
  - Simplify network & operations
- Speed
  - Fast deployment of new services
- Innovation
  - Implement new business models

SDN and NFV – Highlights

- A defined architecture implemented through open standards.
- NFV is highly complementary to SDN, but not dependent on it (or vice-versa).
- SDN aligns closely with NFV objectives to use commodity servers and switches.



Introduction to SDN and NFV

QUESTIONS?

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SDN and NFV

IETF WORKING GROUPS

IETF SDN Working Groups

- Interface to Routing System (I2RS)
  - Defines an interface for policy manipulation of routing control
- Service Function Chaining (SFC)

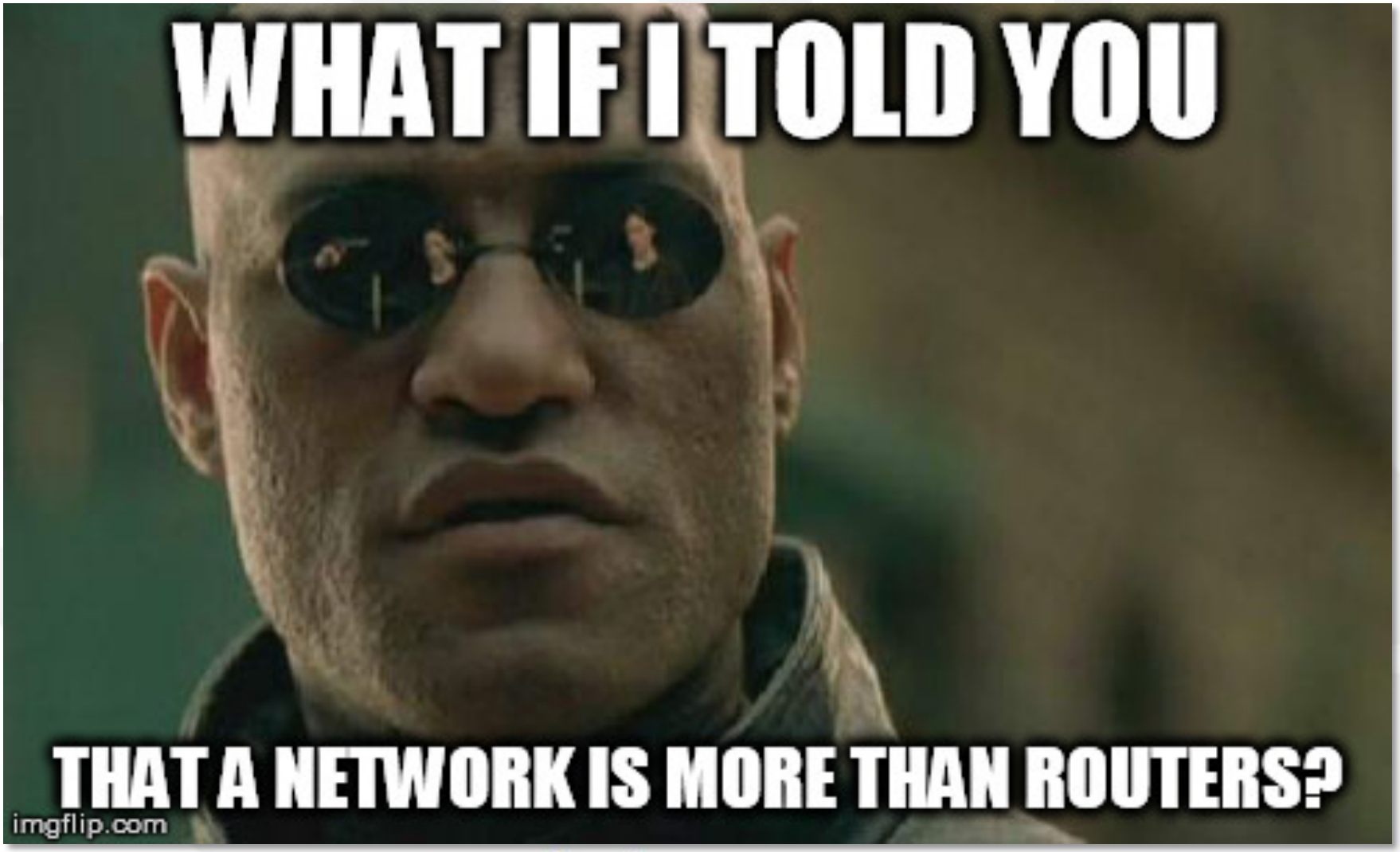
- Other related groups in IRTF
  - NFVRG – supporting research into the protocol implications of virtualizing network functions
  - SDNRG – supporting research into newer SDN ideas

SDN – Food for Thought

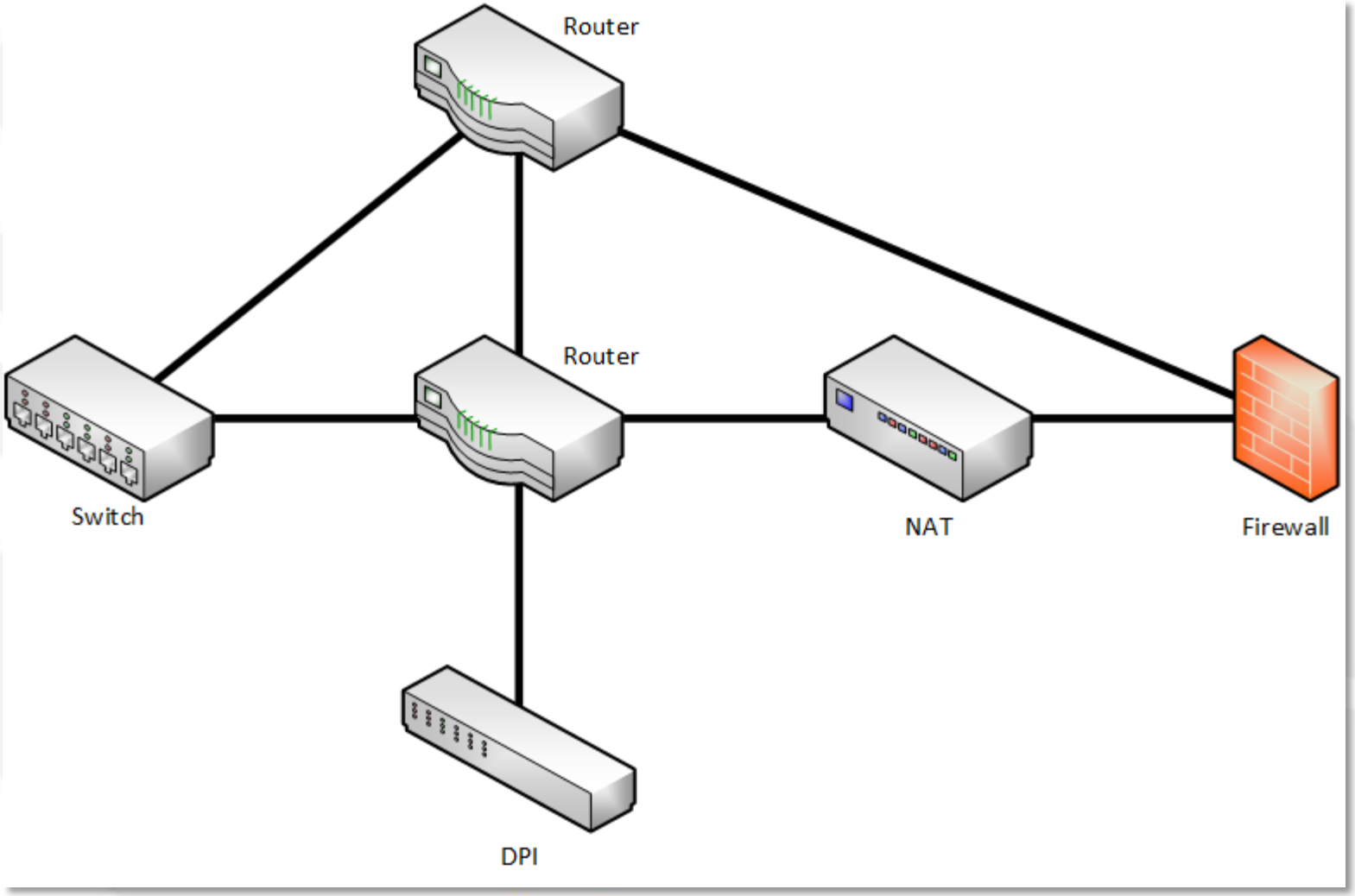
- "**Central controller** (or centralized visibility or central policy engine) is not centralized control plane."
  - "Centralized Control Is Not Centralized Control Plane" by Ivan Pepelnjak, blog on June 16, 2015.

- "… a more appropriate wording of the basic tenet of SDN is that it replaces the distributed control plane with a **centralized management plane**."
  - "SDN, NFV and all that" by Yaakov Stein, IETF Journal, vol. 11, Issue 1, July 2015

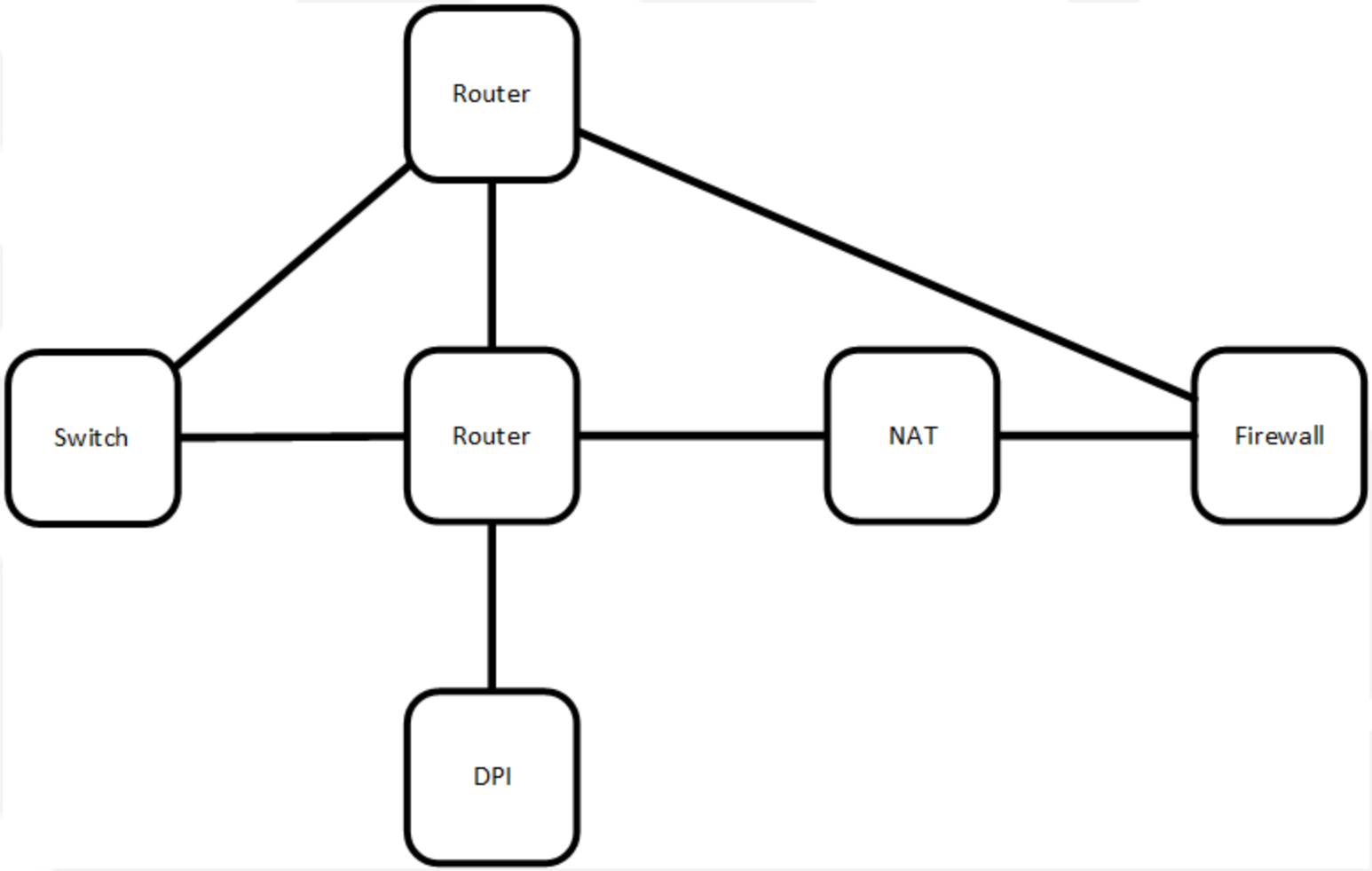
But ..


WHAT IF I TOLD YOU
THAT A NETWORK IS MORE THAN ROUTERS?
imgflip.com

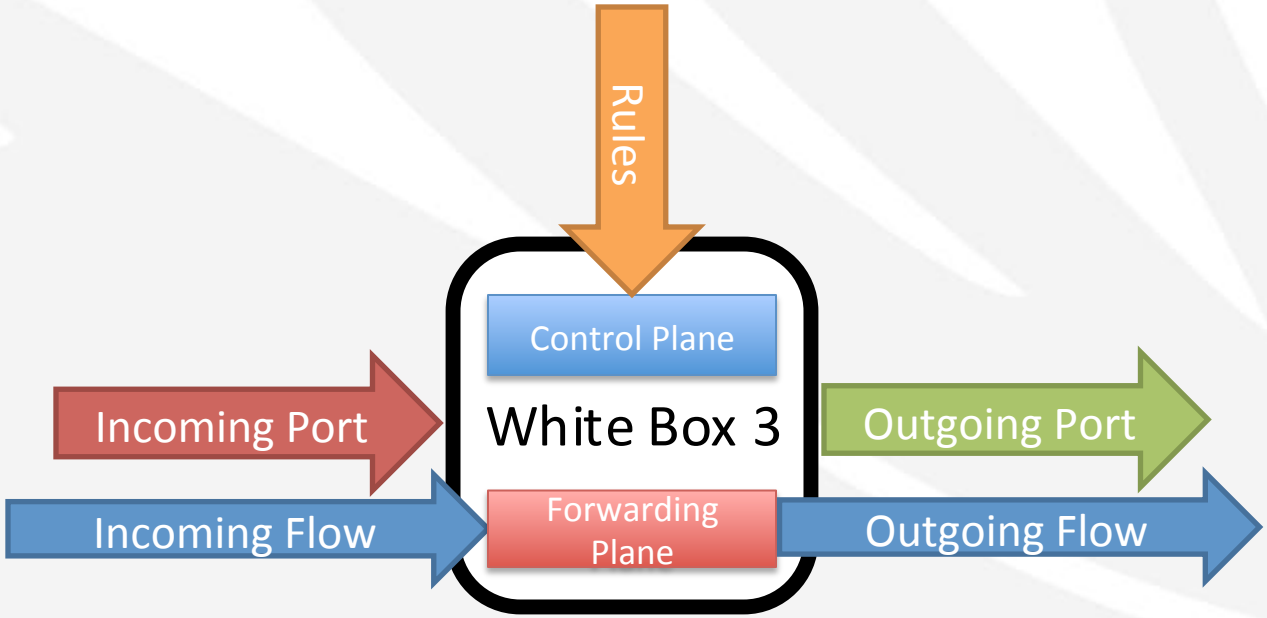
A Network is more than Routers!



It’s a set of boxes …



Actually, very simple white boxes



Can be controlled by an SDN Controller