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June 2016

# **SDN, NFV and Cloud**

## **An Overview of Current Trends in the Networking Industry**



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Software-Defined Networking



Network Function Virtualisation



Cloud Environments



Use Cases and Technologies

# 1. SDN

Software  
Defined  
Networking



# THE PROBLEM

What is SDN really trying to solve?

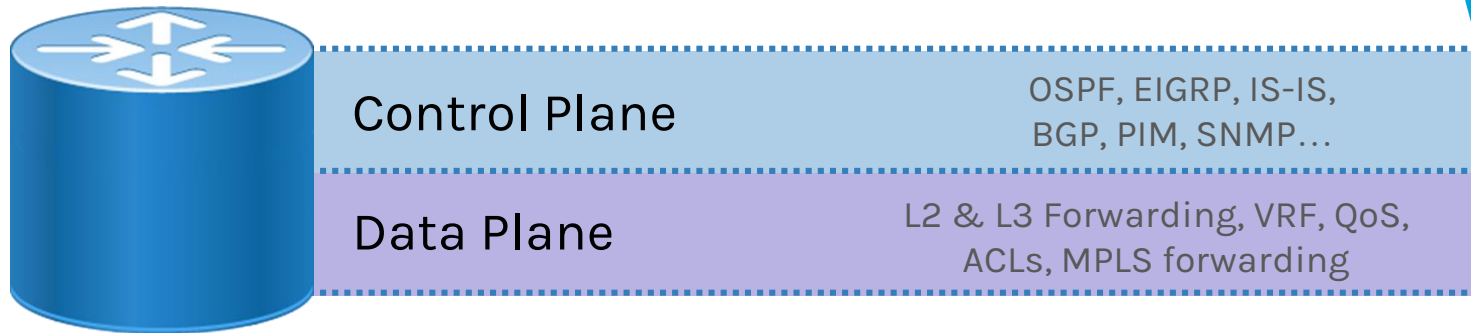
## Two Main **Issues**

- ▶ Networks are Device-Centric.
- ▶ Network Devices are Hard to Configure

# Networks are **Device-Centric**

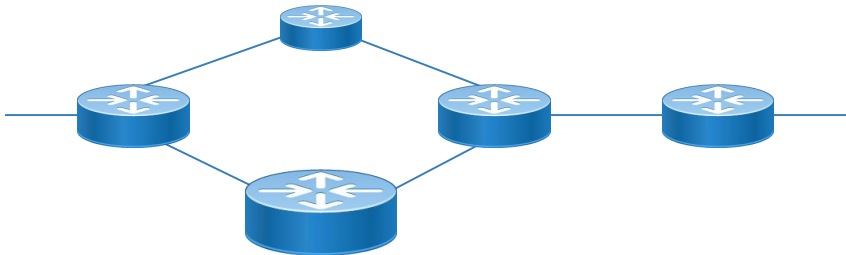
## ▶ Routers Today...

- ▷ Compute routes in CPU (RIB)
- ▷ Push best route to the hardware (FIB)
- ▷ Switch packets very fast based on destination address



# Networks are **Device-Centric**

- ▶ **Routers Today...**
  - ▷ Every device has its own view of the network
  - ▷ Every device makes an independent forwarding decision



# Networks are **Device-Centric**

## PROs

- ▶ Scale very well (BGP)
- ▶ Are self-healing
- ▶ Are reliable and predictable

## CONs

- ▶ Narrow hop-by-hop view
- ▶ Uncertainty beyond next hop
- ▶ Multiple levels of reconvergence
- ▶ All decisions based on “Destination IP”
- ▶ Very difficult to take into account other info
- ▶ Only fixed, non-adaptive metrics
- ▶ Difficult to extend or enhance
- ▶ In general, very hard to innovate



# Devices are **Hard to Configure**

- ▶ **Network Devices Today...**
  - ▷ Networks are configured device by device
  - ▷ Configuration is manual
  - ▷ Configuration via Command-Line Interface (CLI)
  - ▷ Hard to keep configuration consistent
  - ▷ Hard to maintain software version consistency

# Devices are **Hard to Configure**

## ▶ Network Devices Today...

- ▷ Very difficult to automate
- ▷ Lack of proper APIs and interfaces
- ▷ Existing config mechanisms very hard to consume by software
  - ▷ SNMP is very “Read” oriented, hard to configure things
  - ▷ CLI inconsistent across software versions
  - ▷ NMS tools forced to use telnet & screen scraping
    - ▷ Ugly
    - ▷ Inefficient
    - ▷ Error prone



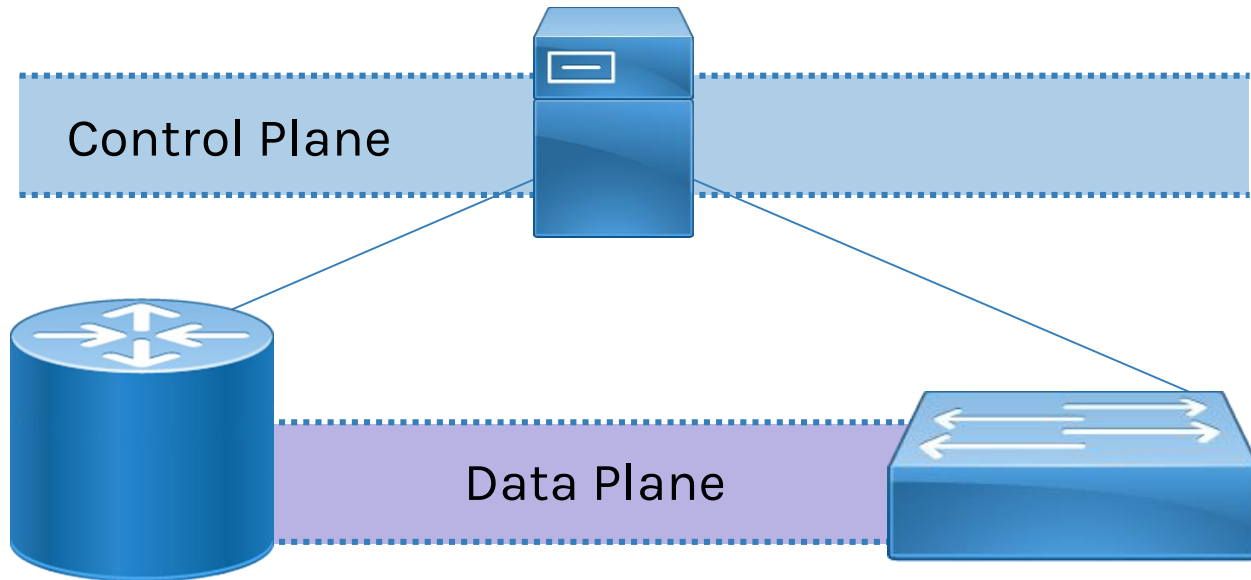
# POSSIBLE SOLUTIONS

How are we solving the problem?

# Software-Defined Networking

- ▶ **What is it?**
  - ▷ The latest cool thing in the networking industry
  - ▷ *“SDN is a new approach to designing, building, and managing networks that separates the network’s control (brains) and forwarding (muscle) planes to better optimize each”.*

# Routers and Switches



# Why **Separate** Both?

- ▶ **Faster Innovation**

- ▷ Control logic is not tied to hardware.
- ▷ HW and SW evolve independently.

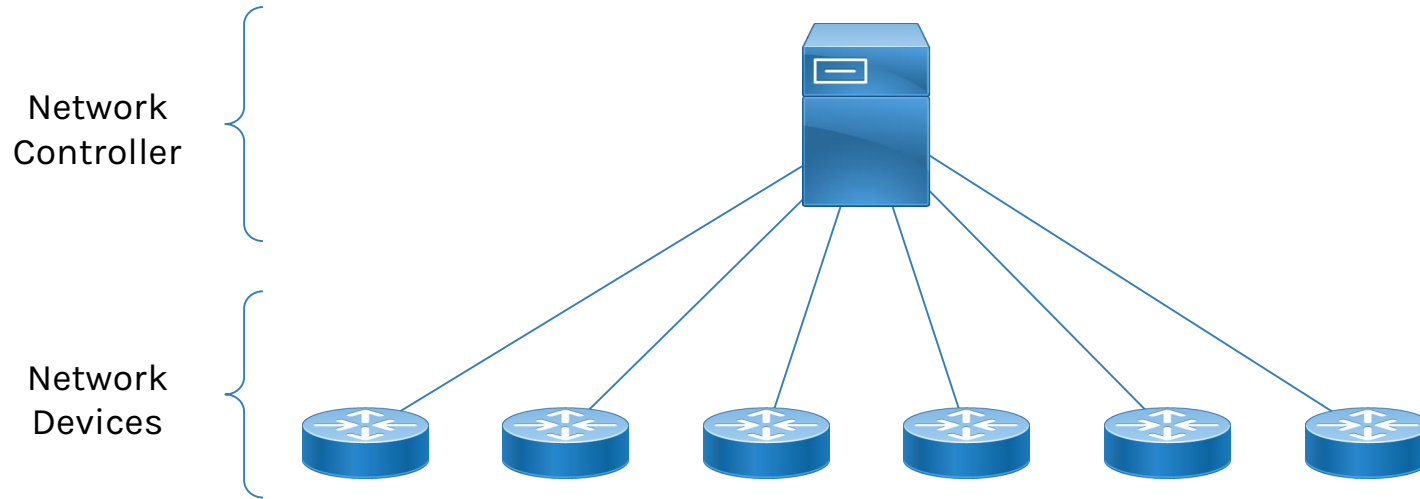
- ▶ **Network-wide View**

- ▷ Easier to observe the network and make decisions.

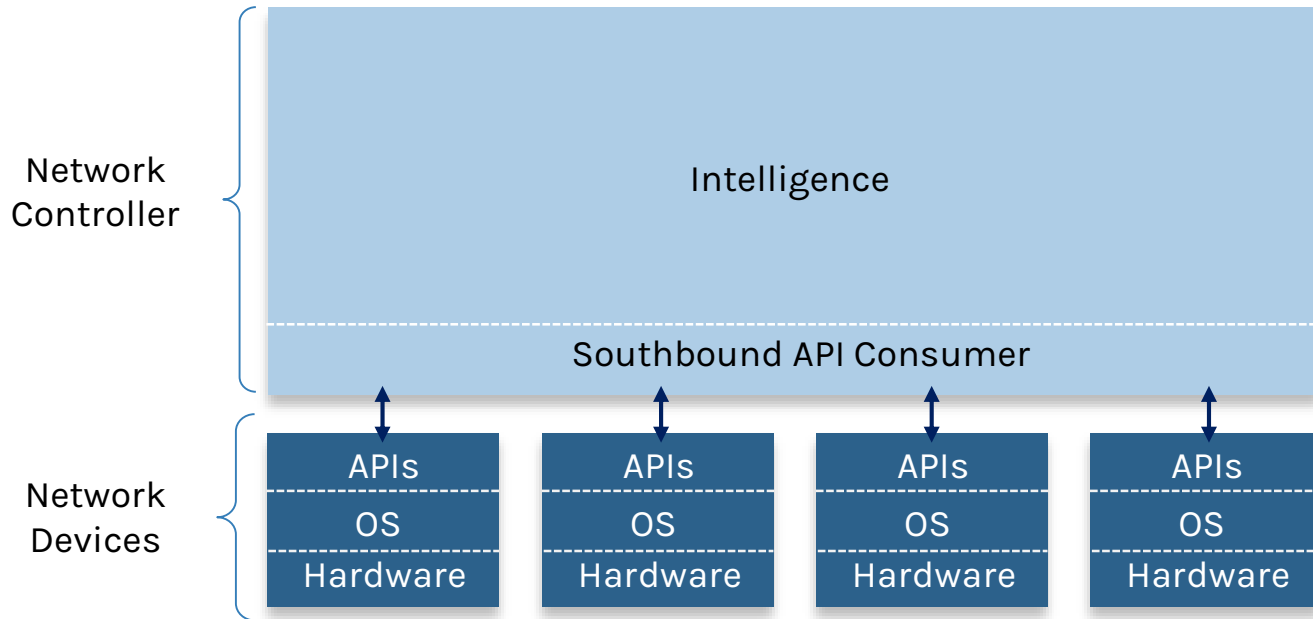
- ▶ **Flexibility**

- ▷ If the HW manufacturer doesn't want to implement the features I need, I can do it myself.

# SDN Architecture

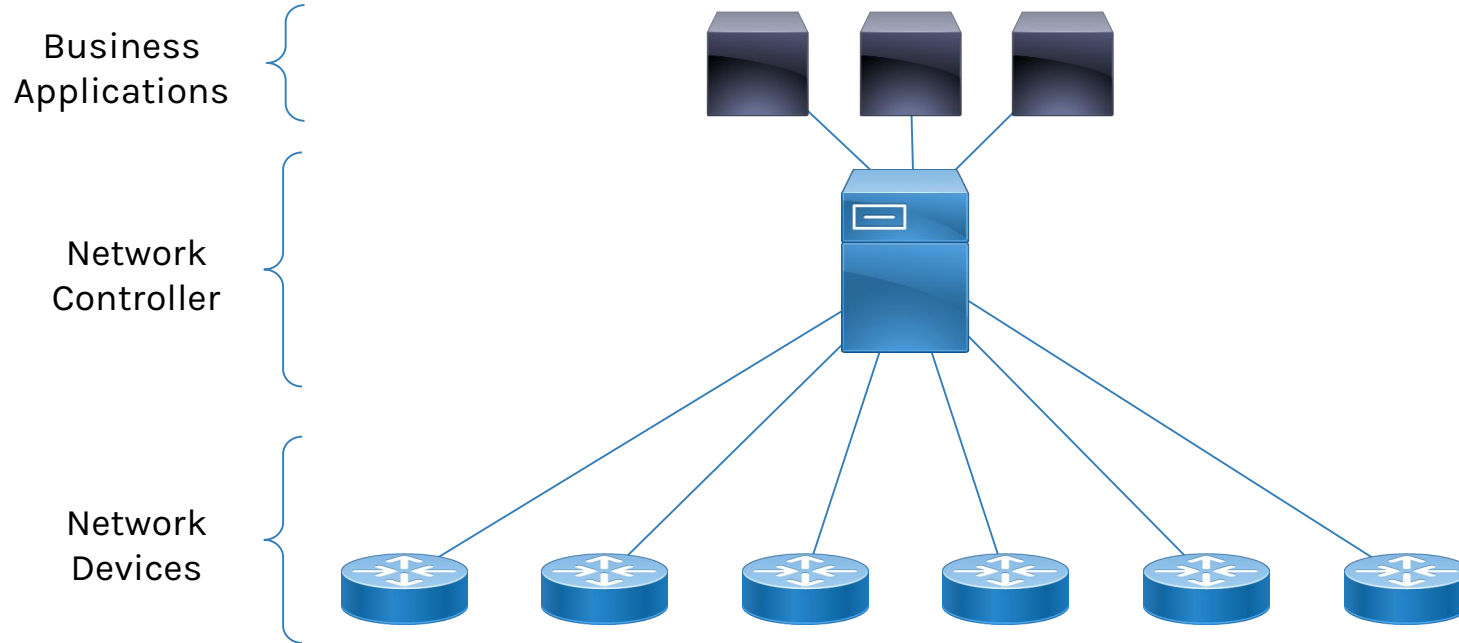


# SDN Architecture

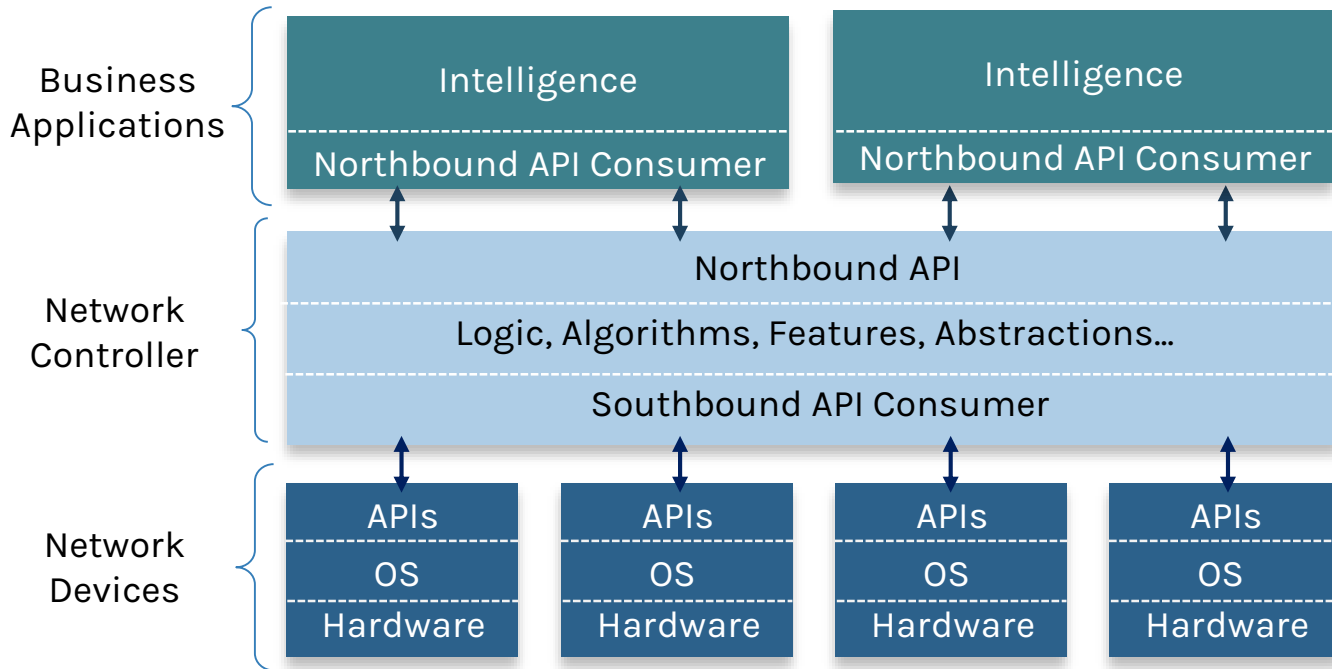




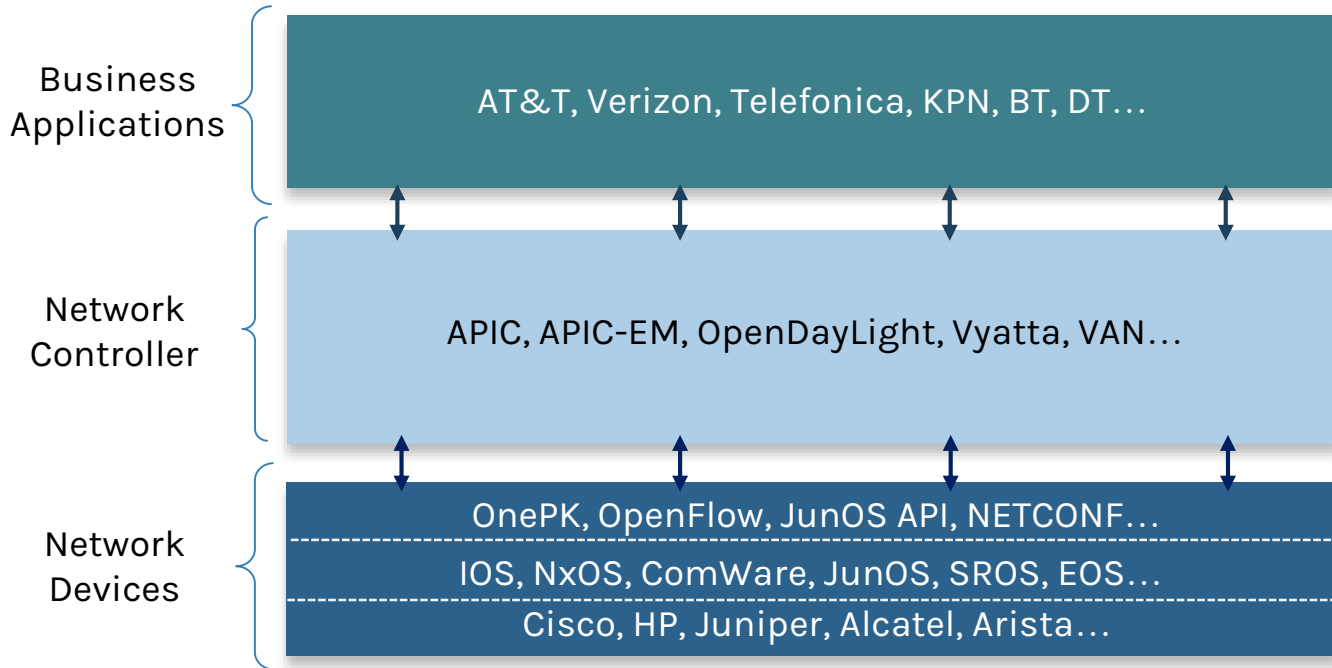
# SDN Architecture



# SDN Architecture

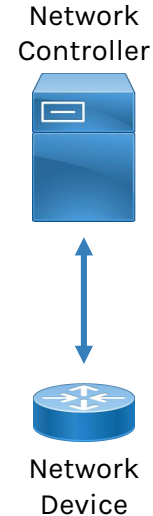


# SDN Architecture

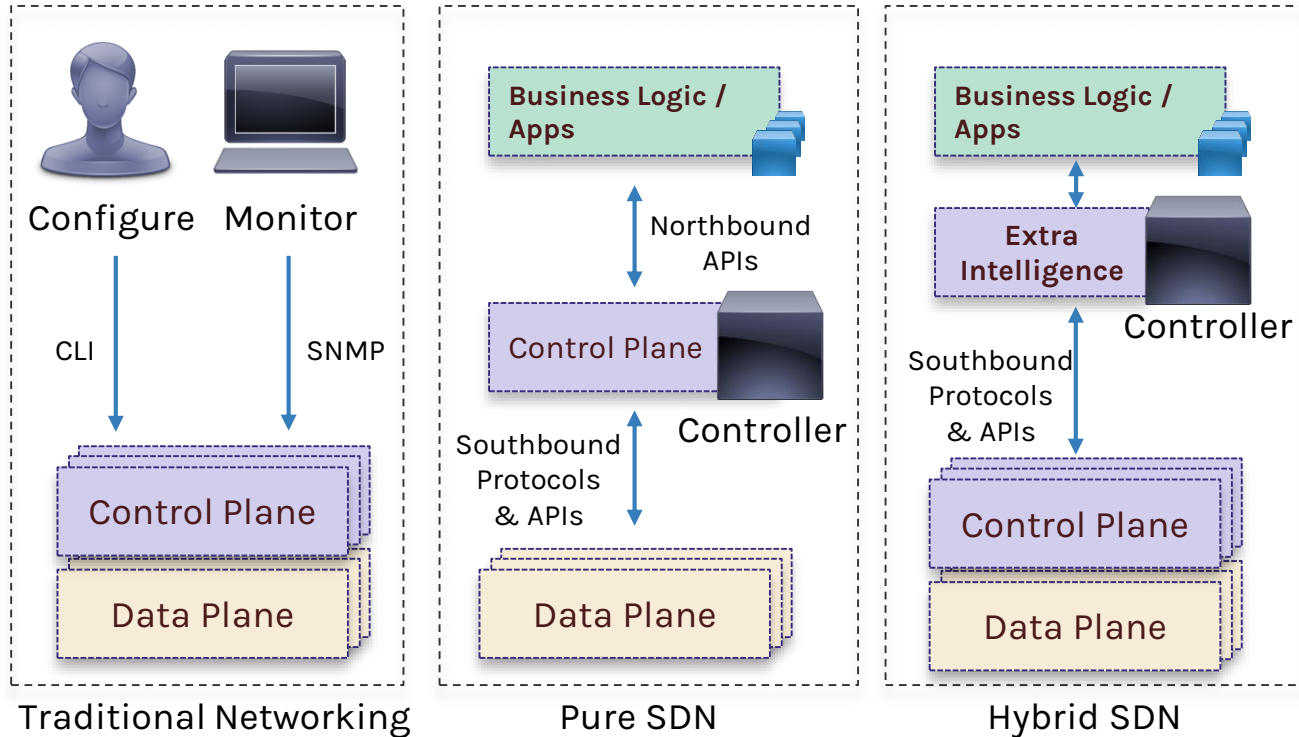


# Common Operations Available

- ▶ **Configuration**
  - ▷ Pull or push configuration to the device
- ▶ **Statistics**
  - ▷ Obtain real-time statistics
  - ▷ Notice relevant events on the network
  - ▷ Polling devices / Async Notifications
- ▶ **Traffic**
  - ▷ Divert or copy packets to the controller
  - ▷ Inject or re-inject (same or different interface)
  - ▷ Drop



# SDN Deployment Modes



A thick yellow diagonal stripe runs from the top right towards the bottom left, separating the white background on the left from the yellow background on the right.

# 2.

# NFV

Network  
Function  
Virtualisation



# THE PROBLEM

Why do we need Network Function  
Virtualisation?

## Two Main Issues

- ▶ Devices are heterogeneous and expensive.
- ▶ Devices are hard and slow to deploy.



# Heterogenous and **Expensive** Devices

- ▶ **Heterogeneous**

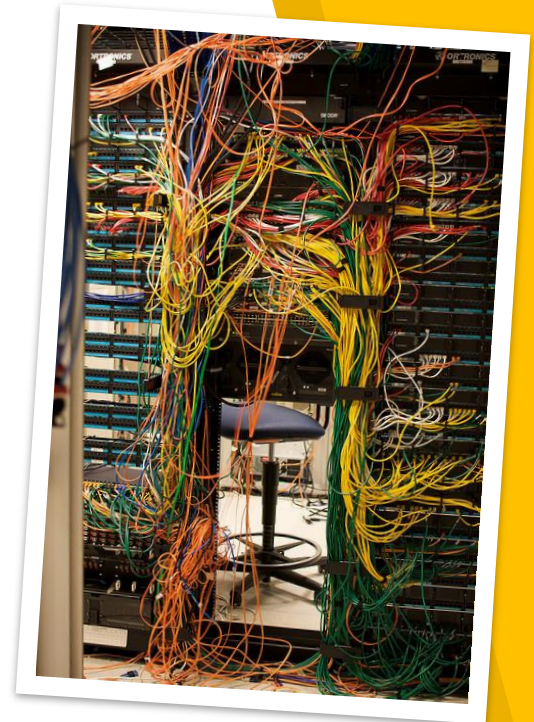
- ▷ Different vendors.
- ▷ Different form factors.
- ▷ Different deployment models.

- ▶ **Expensive**

- ▷ Vendors charge a premium for their special-purpose hardware.
- ▷ The fact that they are “physical” products increases cost per se.

# Devices **are Hard and Slow** to Deploy

- ▶ **New Services often require...**
  - ▷ Racking new devices.
  - ▷ Laying out new cabling.
  - ▷ Performing initial config manually.
- ▶ **Work at the Datacenter...**
  - ▷ Requires physical presence.
  - ▷ Qualified Engineers (different profiles)
  - ▷ Security & Safety procedures.
  - ▷ Maintenance windows.





# POSSIBLE SOLUTION

How are we solving the problem?

# Separate Function **from Hardware**

- ▶ **Run network functions in commodity HW**
  - ▷ Network functions implemented in Software.
  - ▷ Running on top of standard x86 platforms.
    - ▷ As Virtual Machines
    - ▷ Inside containers
    - ▷ Directly on the baremetal
- ▶ **Applicable for a number of functions**
  - ▷ Firewalls, IDS, Routers, Load Balancers, Proxies...

# Virtual Network Functions

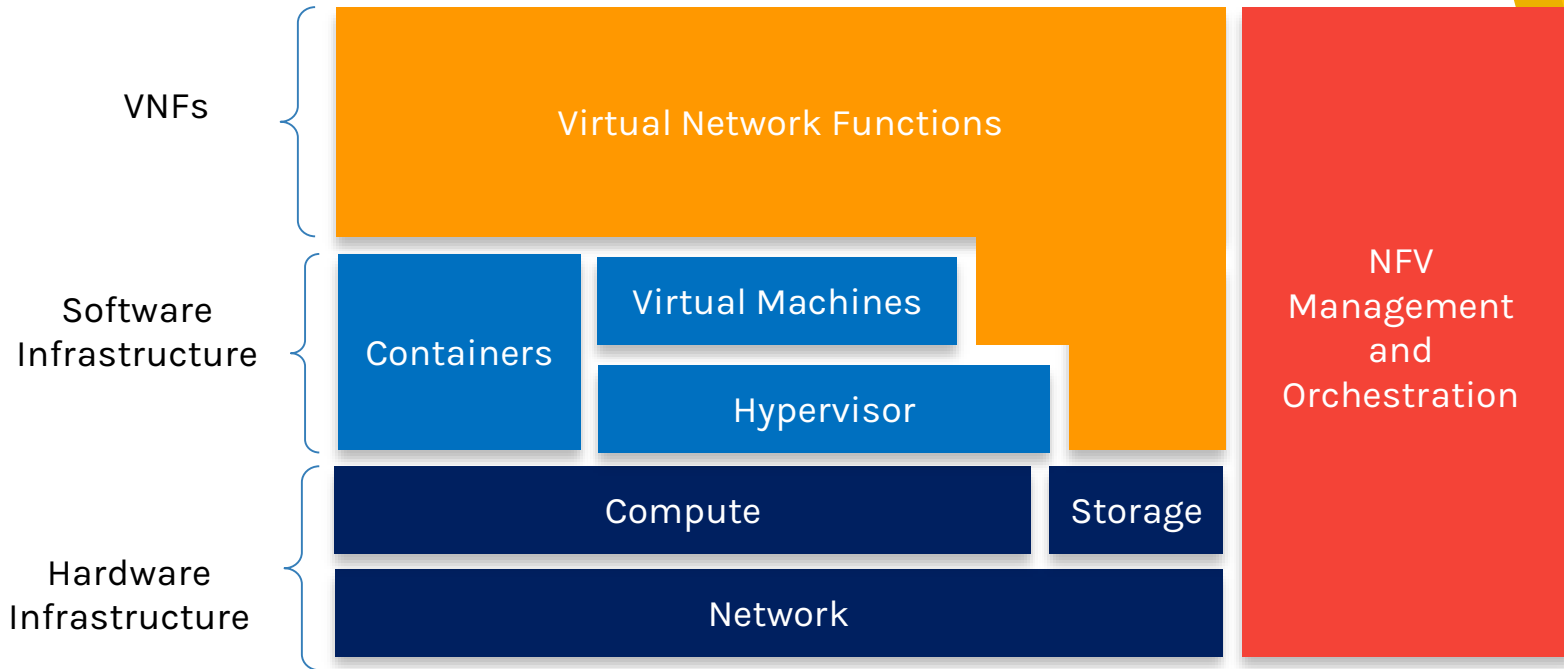
## PROs

- ▶ Homogenous Datacenter
- ▶ No need to deploy physically everytime.
- ▶ SW is generally cheaper than HW
- ▶ Faster to deploy new devices
- ▶ Cheaper redundancy
- ▶ Easier multi-tenancy

## CONs

- ▶ Performance limitations
- ▶ More complex traffic flows
- ▶ Harder to implement security controls

# NFV Architecture



# 3.

## Cloud

Public, Private  
& Hybrid Cloud  
Environments



THE

**PROBLEM**

What do we need the Cloud for?



## Two Main **Issues**

- ▶ Deploying IT services is difficult and slow.
- ▶ The cost of IT doesn't necessarily match the growth of the business.

## IT is Difficult and Slow

- ▶ **Professional IT is complex**
  - ▷ Requires highly skilled engineers, not always available.
  - ▷ In mature companies, there are a lot of politics involved (different departments, responsibilities, etc).
- ▶ **Markets change faster than ever**
  - ▷ Need to put new services on the market faster than the local IT can handle.

# Cost of IT **scales differently**

- ▶ **Big investments upfront**
  - ▷ IT infrastructure is expensive and must be paid upfront, even when there is zero revenue.
  - ▷ Scaling up when there is growth is slow.
  - ▷ Scaling down is almost impossible.
  - ▷ Environment is always either overprovisioned or underprovisioned.
- ▶ **IT needs to be more agile**
  - ▷ Need to grow and shrink dynamically as needed.
  - ▷ Pay as you grow.



# POSSIBLE SOLUTION

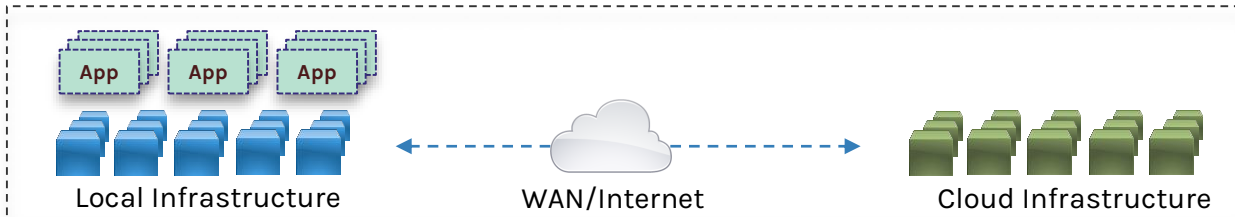
How are we solving the problem?

# Cloud Environments

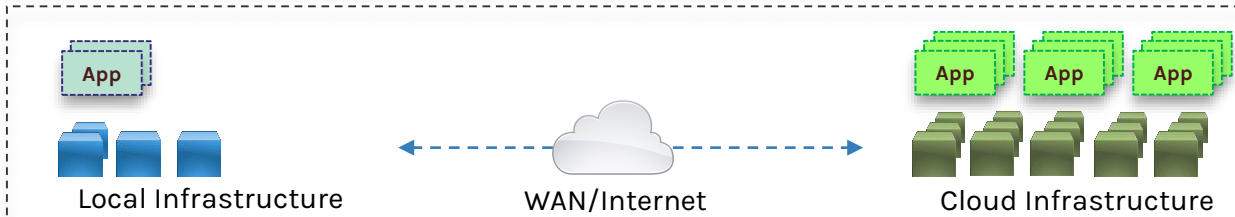
- ▶ **Run my IT on someone else's infrastructure**
  - ▷ Rely on specialised companies to provide the IT infrastructure needed.
  - ▷ Rely on their know-how.
  - ▷ Rely on their 24/7 support services.
  - ▷ Concentrate on business applications, not the rest of the stack.
  - ▷ Pay IT as an utility bill.

# Cloud Deployment Modes

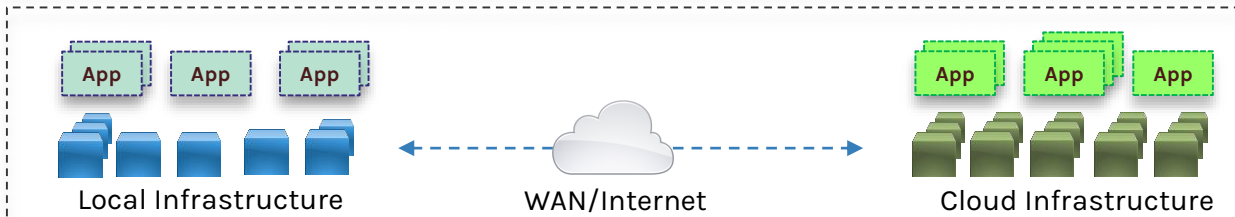
On-Premise



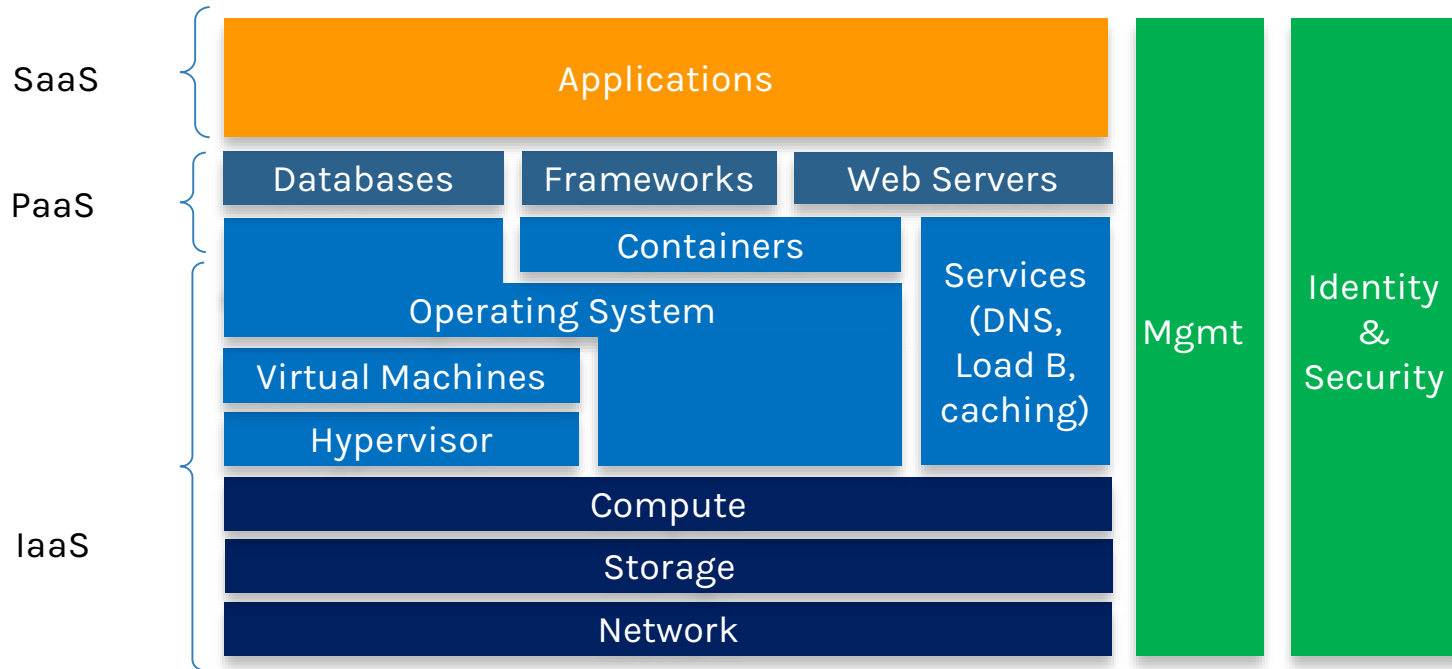
Public Cloud



Hybrid Cloud



# Cloud Offerings





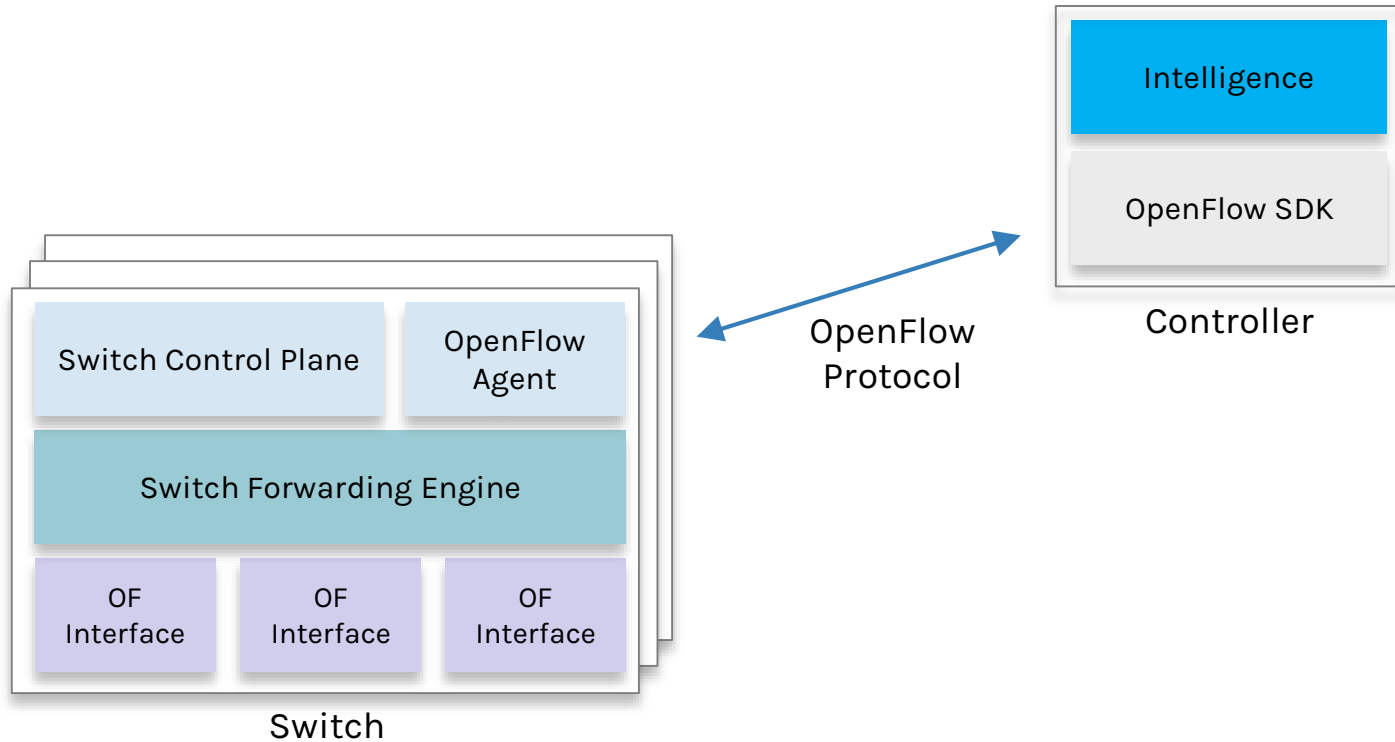
4.

# Use Cases

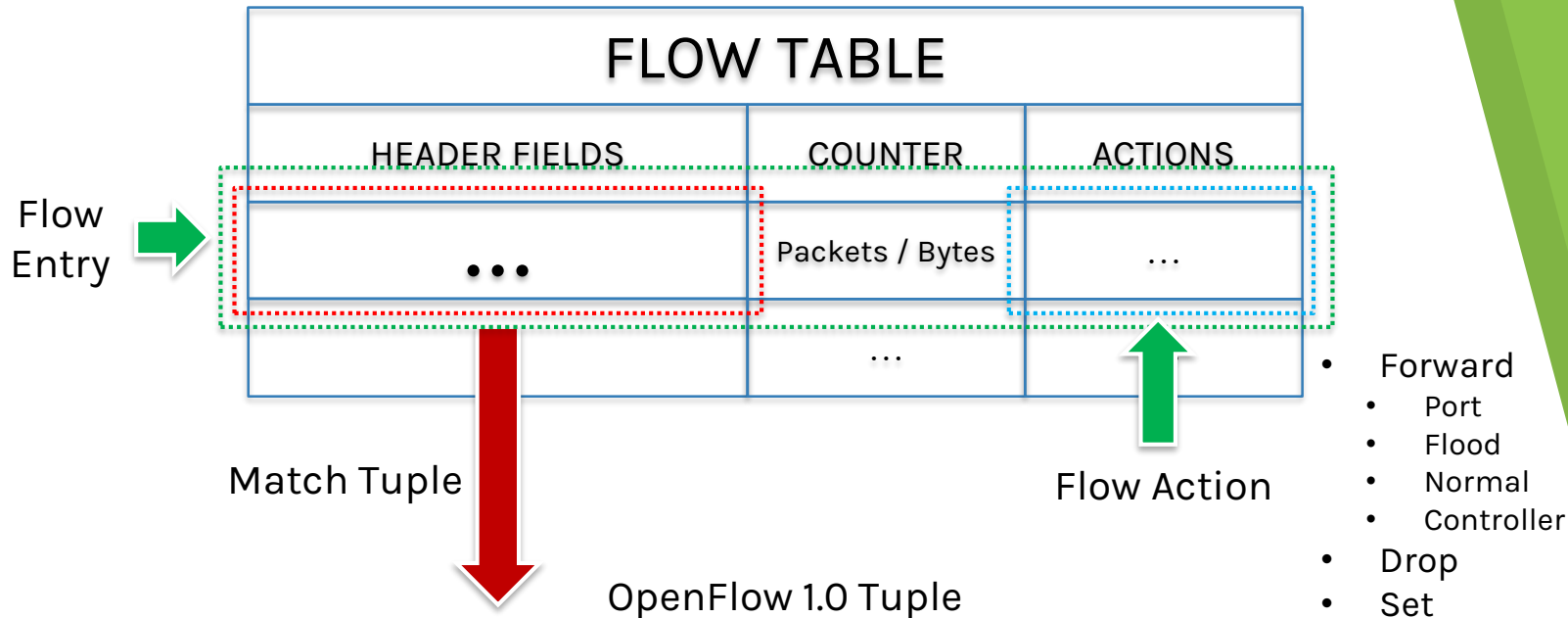
Use Cases and  
Real-life  
Technologies



# Programmable Forwarding: OpenFlow



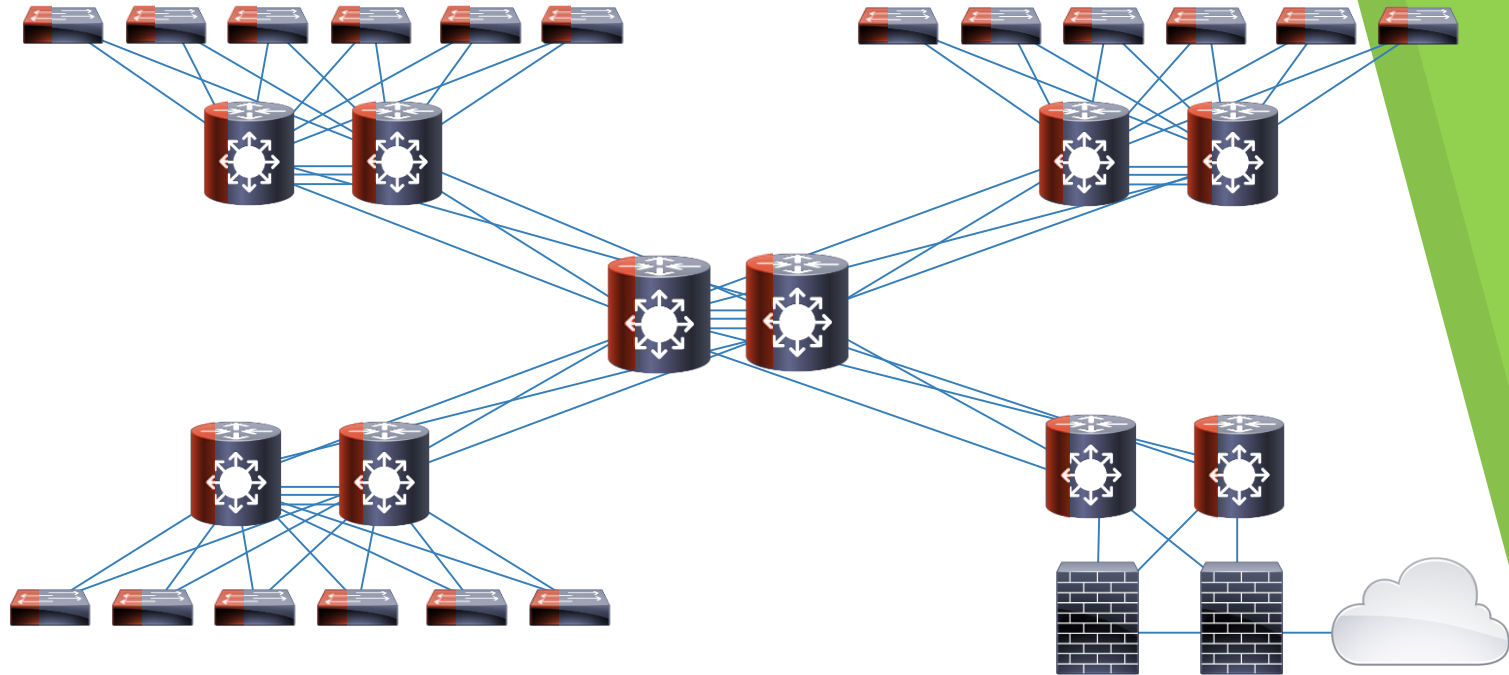
# Programmable Forwarding: OpenFlow



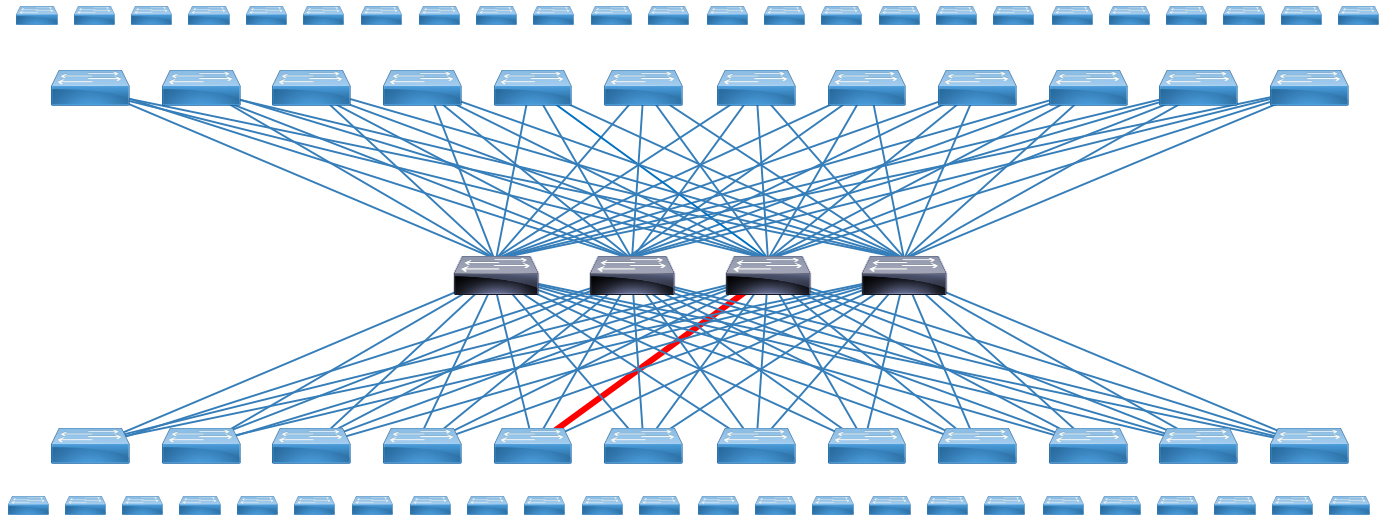
OpenFlow 1.0 Tuple

Ingress Port	Source MAC	Dest MAC	Ether Type	VLAN ID	VLAN Priority	IP SRC	IP DEST	IP Proto	IP TOS	TCP/UDP SRC	TCP/UDP DEST
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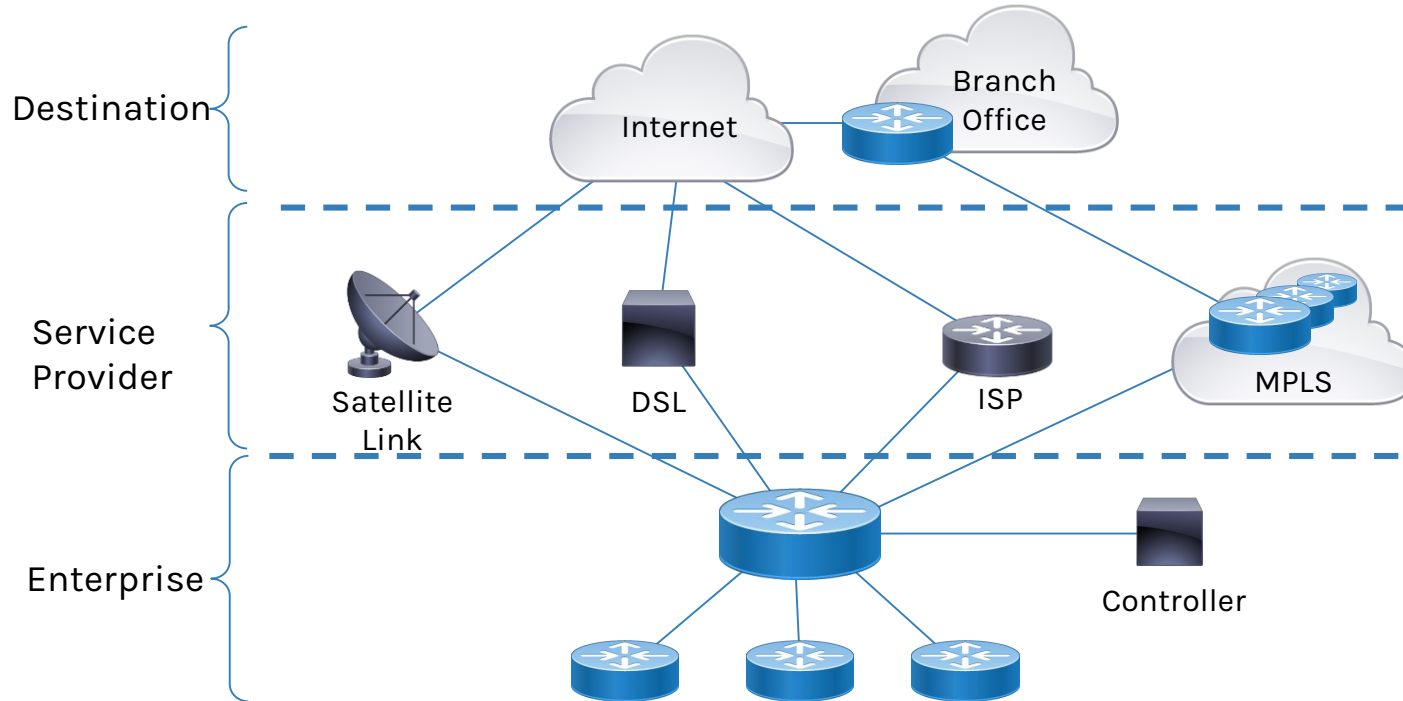
# Experiment in Production



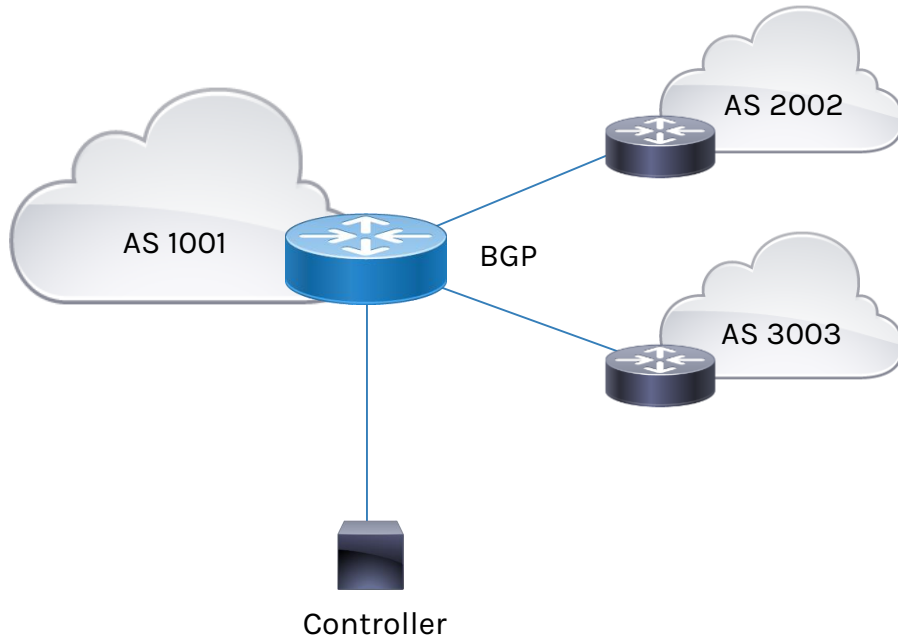
# Large **Scale** Provisioning



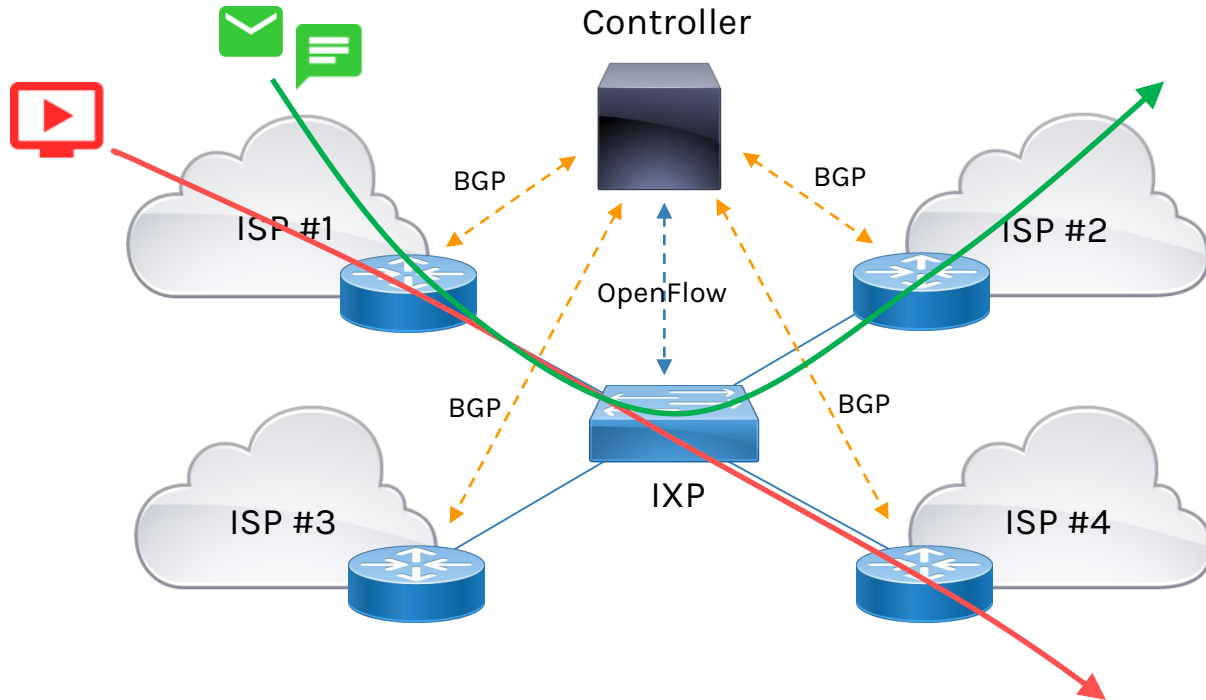
# Traffic Steering



# Traffic Steering



# IXP Enhancements

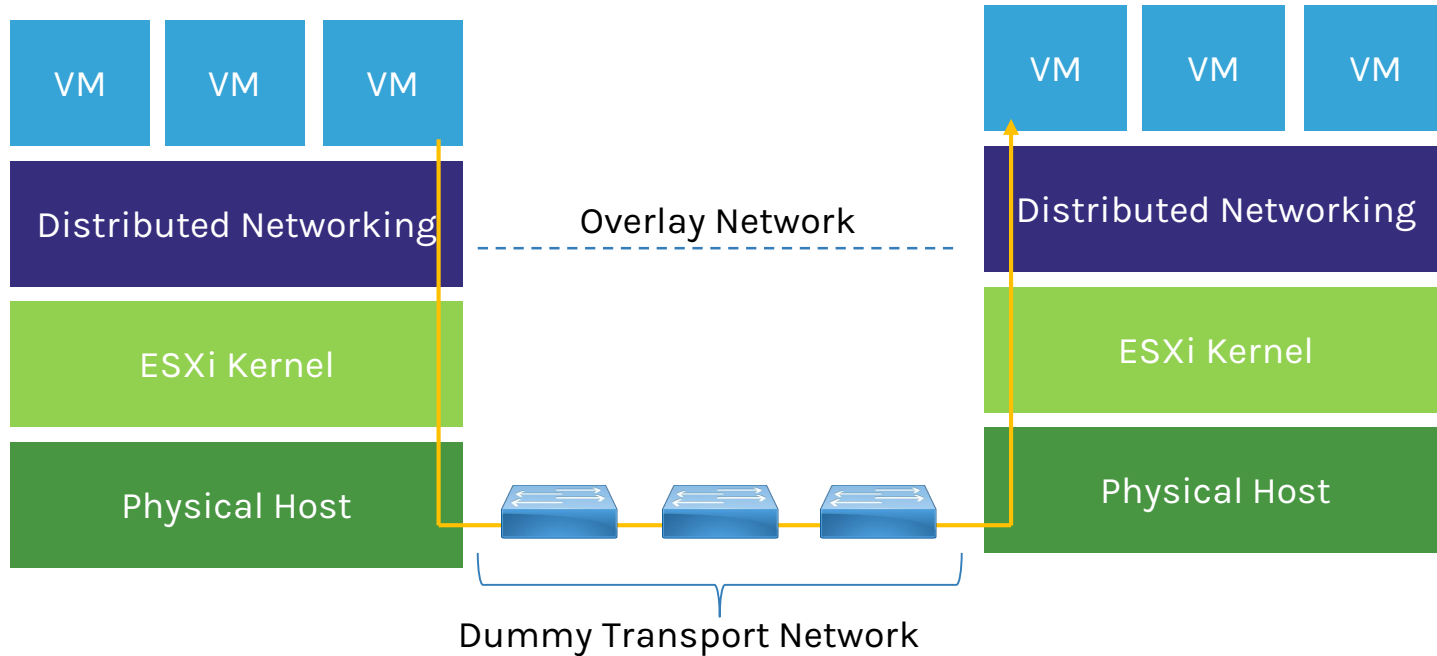


# WAN Optimisation

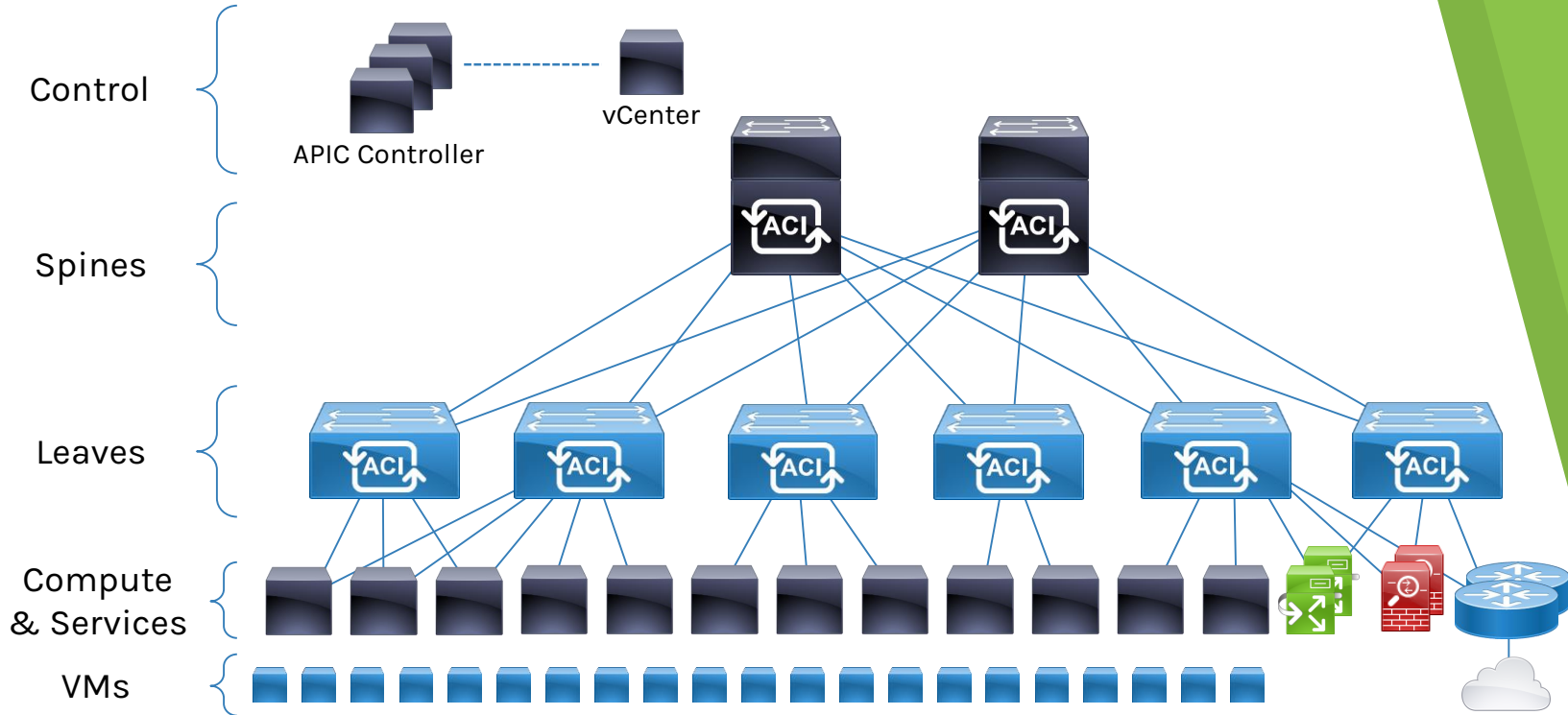




# VMWare NSX



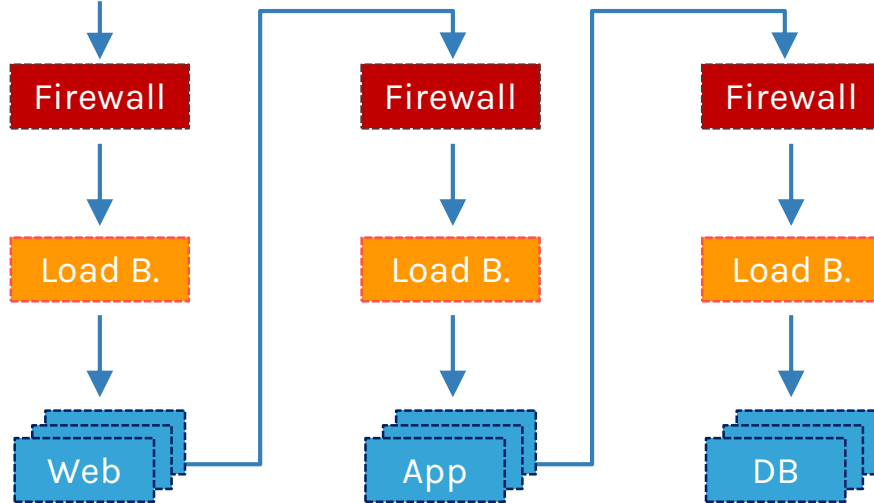
# Cisco ACI



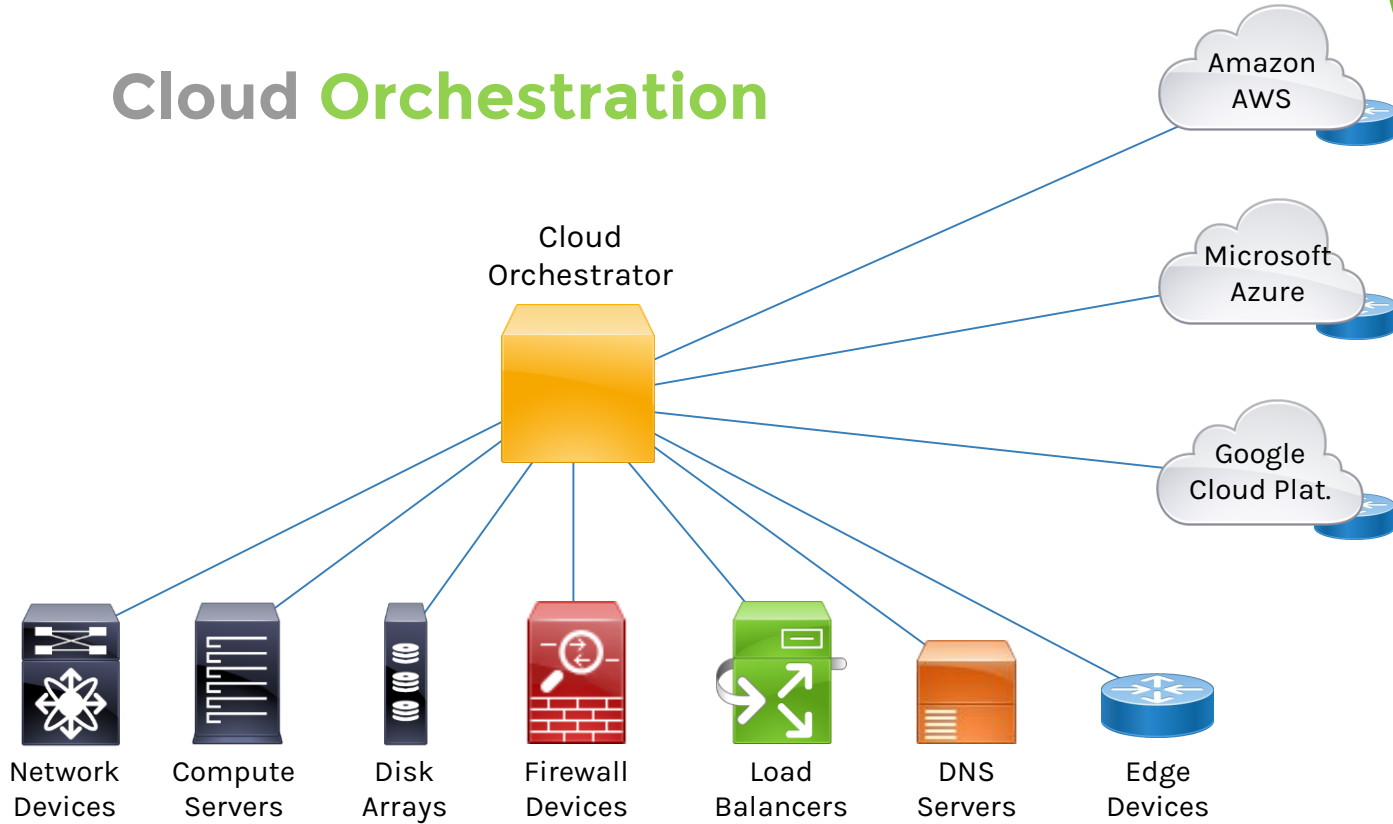
# Cloud Orchestration



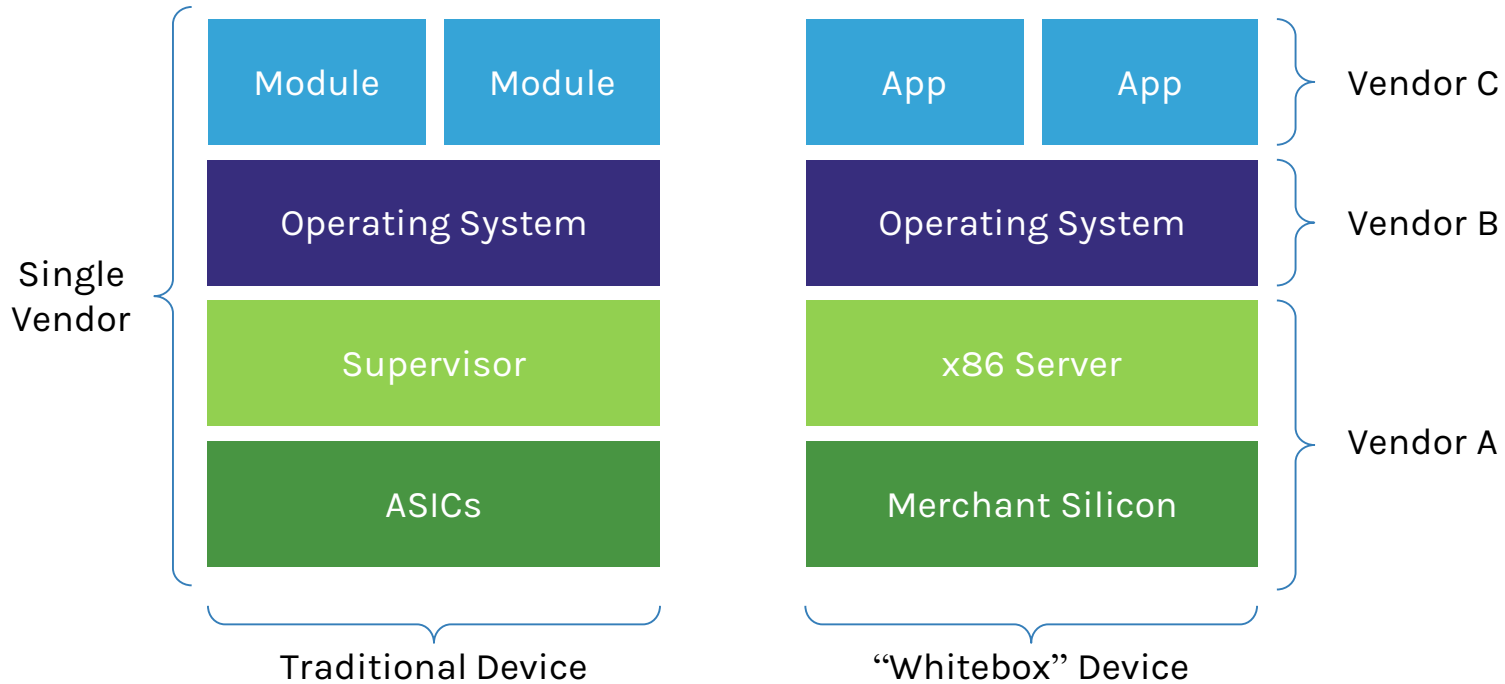
- ▷ **End Goal:**  
Deploy a new three-tier application.



# Cloud Orchestration



# Whitebox Networking



## Other **Tendencies**

- ▷ Flow Visualization
- ▷ Self-Configuring Networks
- ▷ Self-Optimizing Networks
- ▷ Network abstractions closer to the application
- ▷ Convergence to Ethernet end-to-end.
- ▷ Network Engineering teams bringing in SW Developers.
- ▷ Industry creating the standards, not the IETF.



**Thanks!**

**Questions?**



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