

Open Networking Ecosystem - 2

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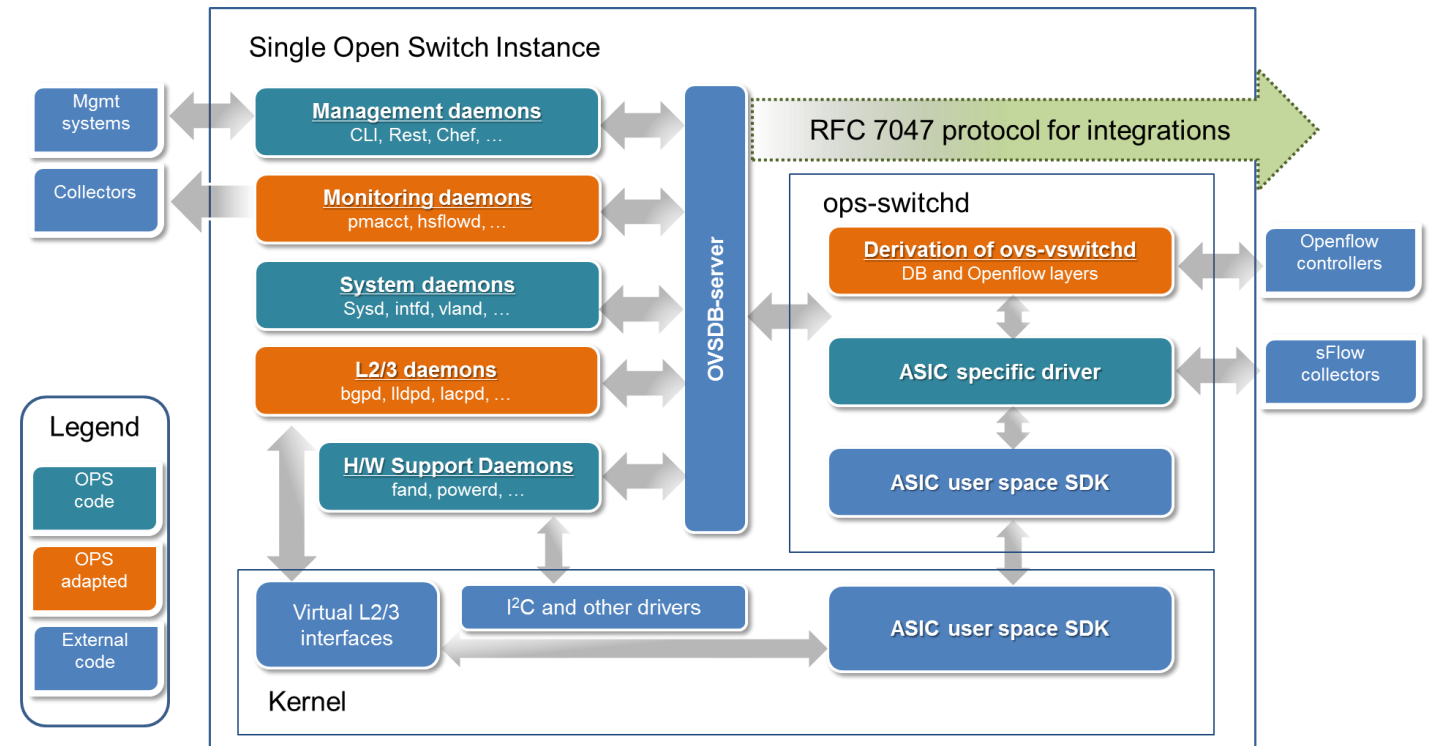
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❖ Network Switch Operating Systems

▪ OpenSwitch

- Linux based operating system originally developed by HP
 - ✓ For OCP compliant hardware
- Includes full L2/L3 switching functions
 - ✓ Routing / OpenFlow agents are included
- Members



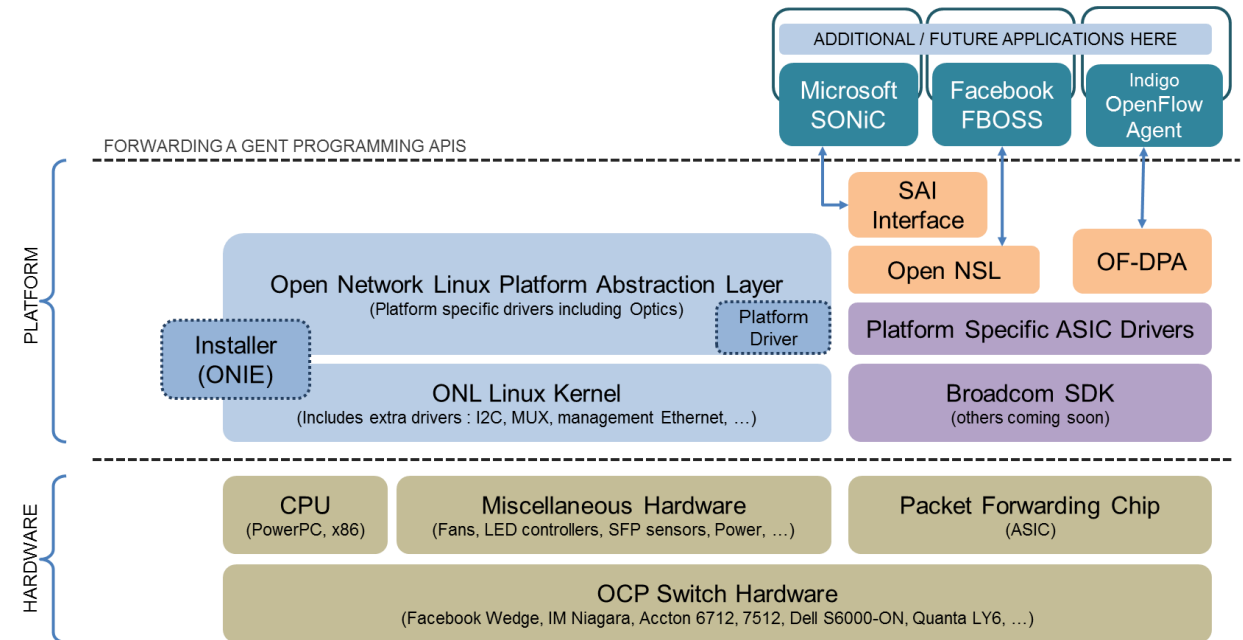
❖ Network Switch Operating Systems

▪ ONL (Open Network Linux)

- Linux distribution for "bare metal" switches
 - A collection of software packages, utilities, drivers, and abstractions to run on OCP Switch hardware
- Members



| Open Network Linux | OpenSwitch |
|---|---|
| Features / Functionalities | |
| - OpenPlatform Distribution for NOS - Routing / OpenFlow agents NOT included (only samples) | - Open NOS with full L2/L3 Switching functionalities - Routing/ OpenFlow agents are included |
| Target Hardware | |
| OCP (Open Compute) Switch, Bare metal (White Box) Switch | |
| Contributors | |
| Big Switch Networks, Pica8, Accton | HP Enterprise, Accton, Broadcom Intel, Qosmos, VMWare, Arista |
| License | |
| Eclipse Public License and GPL for Kernel | Apache License, v. 2.0 |



Source: "Open Network Linux: A Programmer's View", Big Switch Networks

❖ Programmable Data Plane Services



▪ DPDK

- A set of libraries and drivers for fast packet processing
- Enables faster development of high-speed data packet networking applications
- Supported processors
 - Intel x86, IBM Power 8, EZchip TILE-Gx and ARM

▪ FD.io



- Create a Platform that enables Data Plane Services that are:
 - Highly performant
 - Modular and extensible
 - Open source, Interoperable, Multi-vendor
- Usable in cloud, VMs, containers, bare metal and others

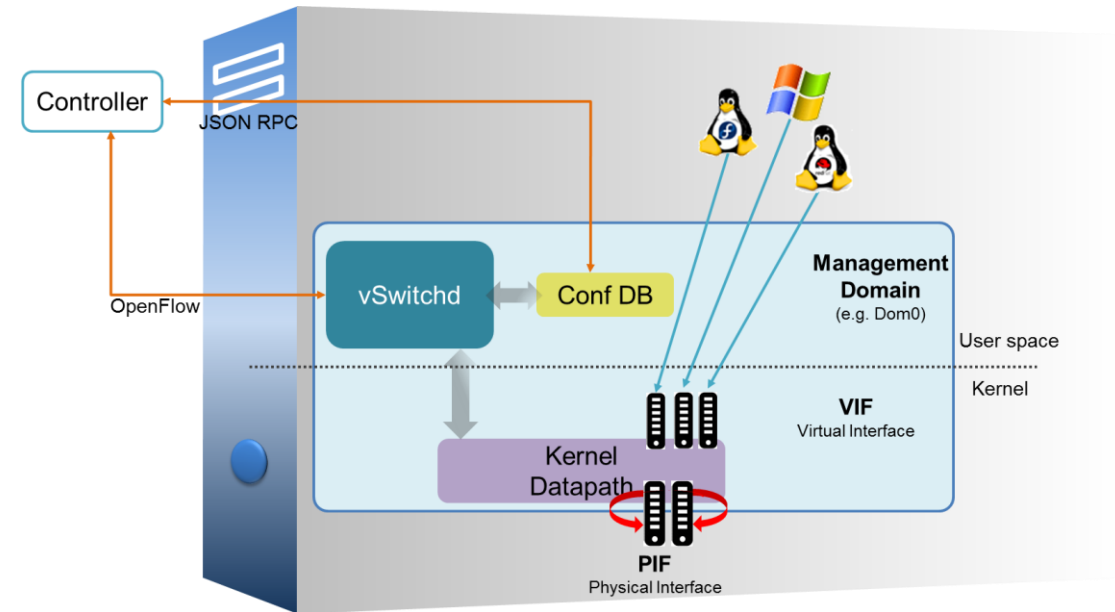
• Members



❖ Programmable Data Plane Services

▪ Open vSwitch (OvS)

- Open source **software switch** used as a **virtual switch** in virtualized server environments
- Leverages OpenFlow and Open vSwitch Database (OVSDB) management protocol
- Run on any Linux-based virtualization platform
 - KVM, VirtualBox, Xen
- Members

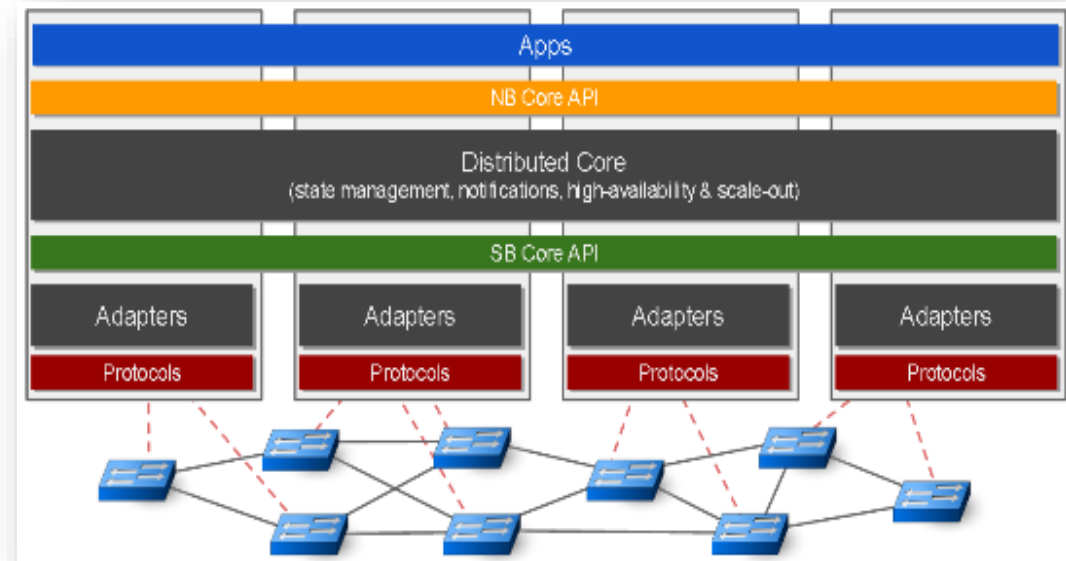


Source: <https://networkheresy.com/2011/06/06/an-extremely-brief-conceptual-introduction-to-open-vswitch/>

❖ Network Controllers

▪ ONOS (Open Network Operating System)

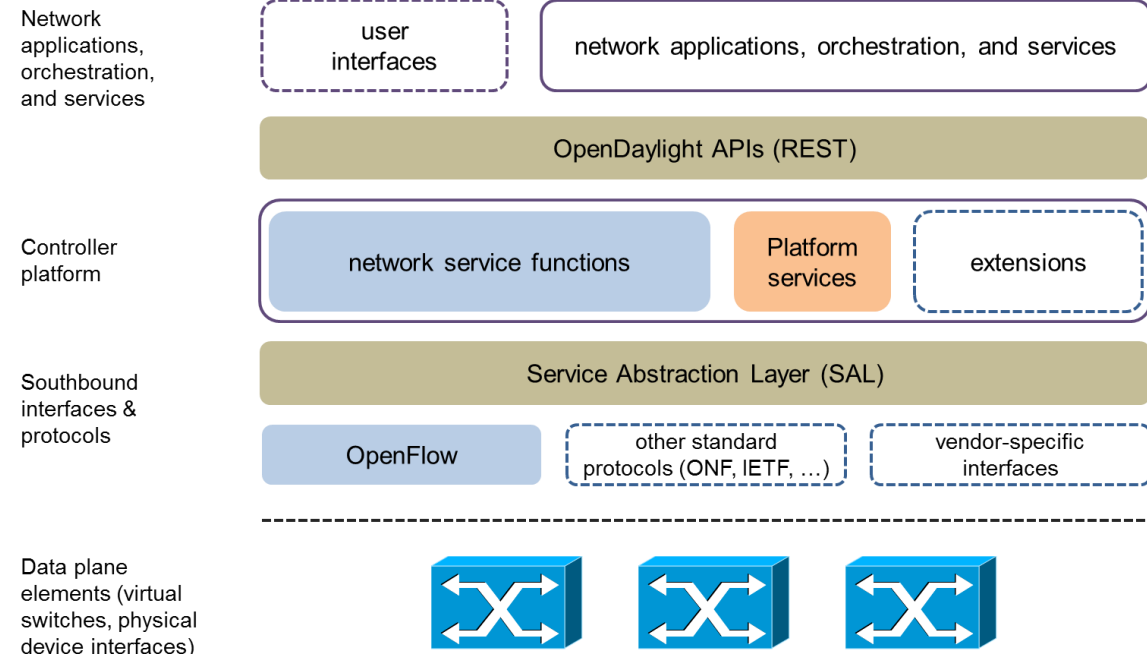
- Open source SDN network OS from ON.Lab
- The goal is to create a SDN OS for service providers (Carriers)
- **Distributed** Network OS
- Provides **scalability**, **high availability**, **high performance** and abstractions
- Members



❖ Network Controllers

▪ ODL (Open Day Light)

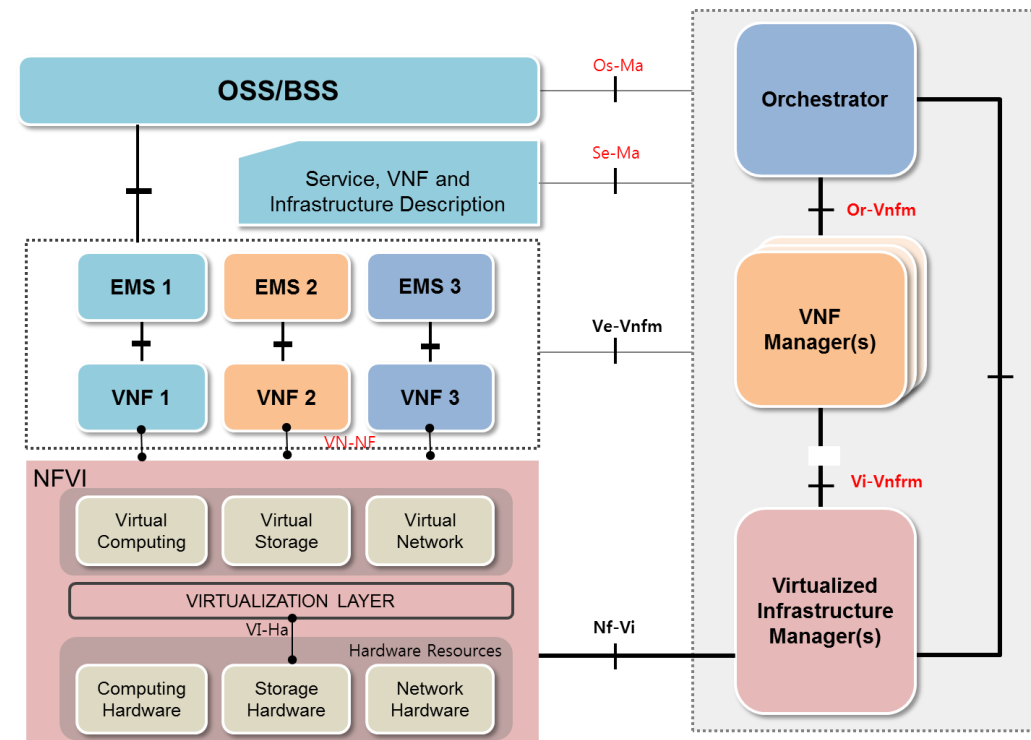
- A collaborative open source SDN controller project managed by Linux Foundation
- Most of the **global hardware & software vendors** are members
- Modular Open SDN platform for networks
- Provides a model-driven service abstraction platform
- Members



❖ Carrier Networking Functions

▪ OPNFV

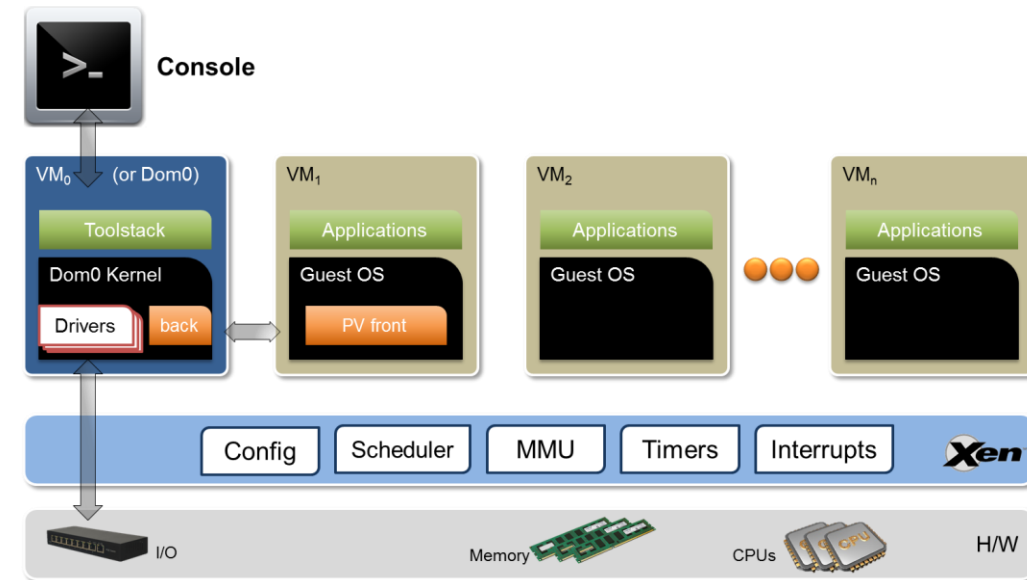
- A carrier-grade, integrated, open source platform
- Accelerates the introduction of new NFV products and services
- Brings together network functions across compute, storage and network virtualization in order create an end-to-end platform
- Members



❖ Virtual Machines

▪ Xen Project

- Hypervisor using a microkernel design
- Provides services that allow multiple OSes to execute on the same computer hardware concurrently
- Supports multiple guest operating systems
 - Linux, Windows, NetBSD, FreeBSD
- Supports multiple Cloud platforms
 - OpenStack, CloudStack
- Members



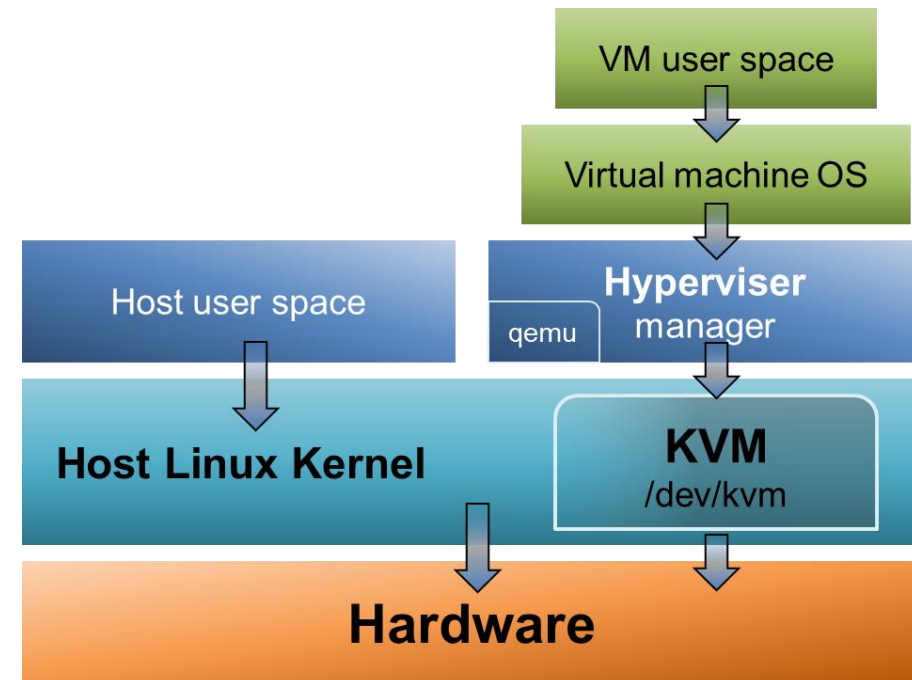
Source: https://wiki.xenproject.org/wiki/Xen_Project_Software_Overview

❖ Virtual Machines

■ KVM (Kernel-based Virtual Machine)



- Full virtualization solution for Linux on x86 hardware
- Merged into the Linux kernel mainline in kernel version 2.6.20
- Supports multiple guest operating systems
 - Linux, BSD, Solaris, Windows, Mac OSX
- Members



Source: <http://www.linuxnix.com/what-is-kvm-virtualization-in-linux/>

❖ Operating Systems



▪ Linux

- Best-known and most-used open source OS
- Assembled under the model of free and open-source software development and distribution
- Popular mainstream Linux distributions
 - Debian, Ubuntu, Linux Mint, Fedora, openSUSE, Arch Linux and Gentoo



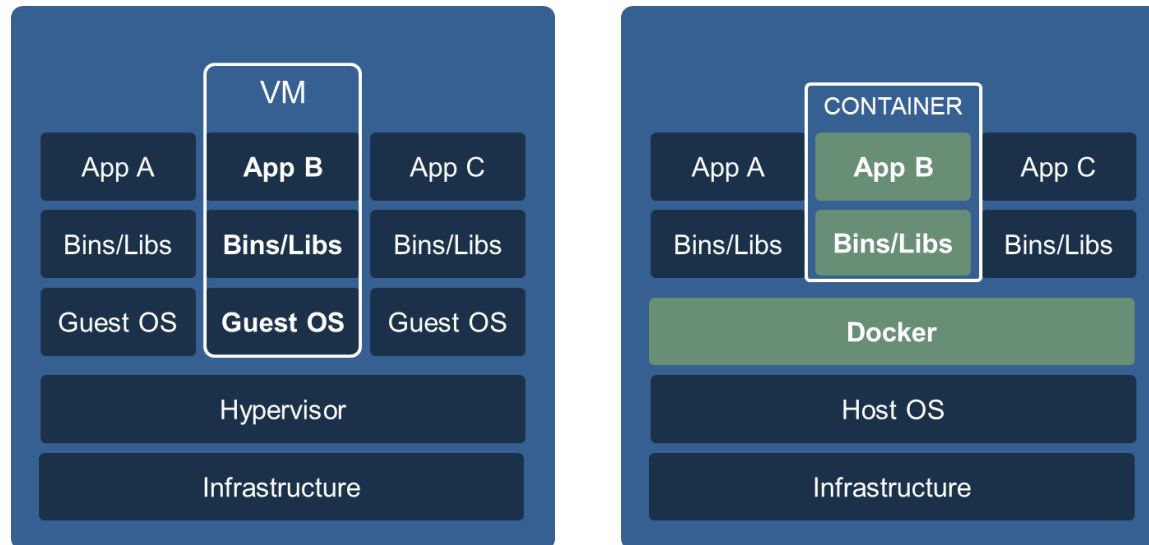
▪ FreeBSD

- OS for a variety of platforms which focuses on features, speed, and stability
- Major differences with Linux
 - Complete OS vs. a kernel and drivers only
 - BSD license vs. copyleft GPL

❖ Containers

▪ Docker

- Automates the deployment of applications inside software containers
- Provides an additional layer of abstraction and automation of OS-level virtualization on Linux
- Enables to package an application with all of its dependencies into a standardized unit for software development



Source: <https://www.docker.com/what-container>

| VMs | Containers |
|--|--|
| Entire OS installation | Multiple isolated user-space instances |
| Entire OS needed | Only libraries and components needed for application |
| VM runs using emulation or virtualization on host OS | Runs on the same kernel |
| Independent to host OS | Dependent to host OS (Linux) |
| Entire VM OS and disk images | Much smaller, easier to package |
| Longer to start | Faster to start |
| Security issues of running OS | Security limited to app |
| Inefficient use of resources | Efficient use of resources |

❖ VMs vs. Containers

■ Performance comparison

- The general result is that **Docker** is nearly identical to **native performance** and faster than KVM in every category

I/O

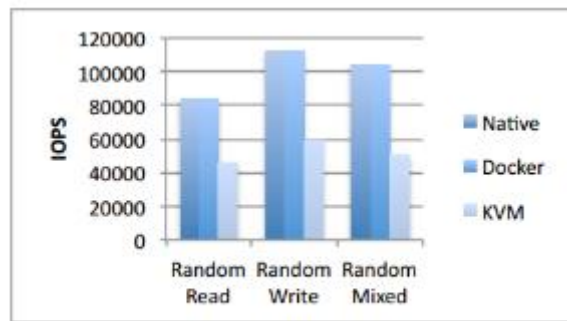
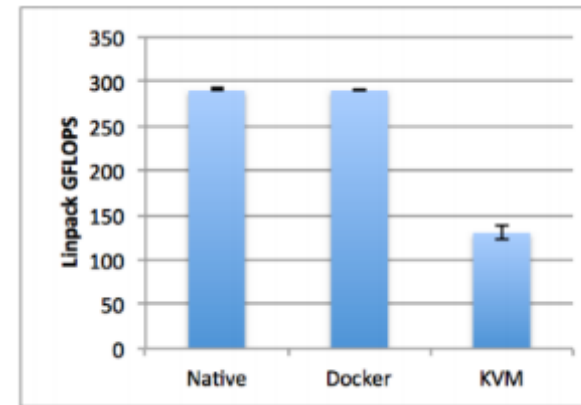
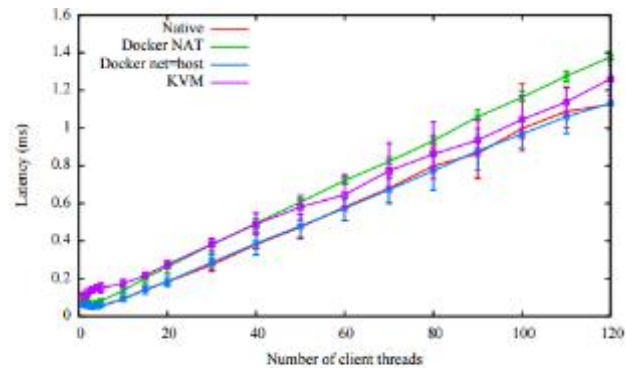
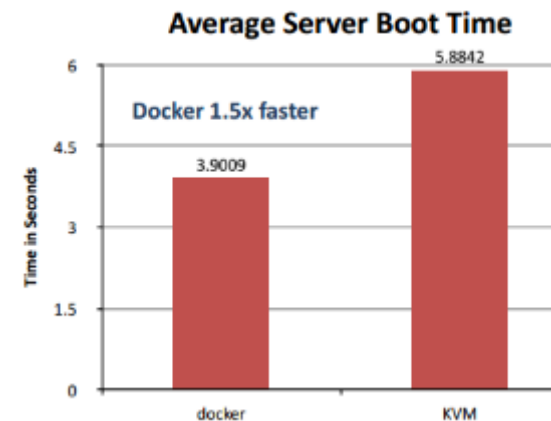


Fig. 6. Random I/O throughput (IOPS).

Network



CPU



Boot Time

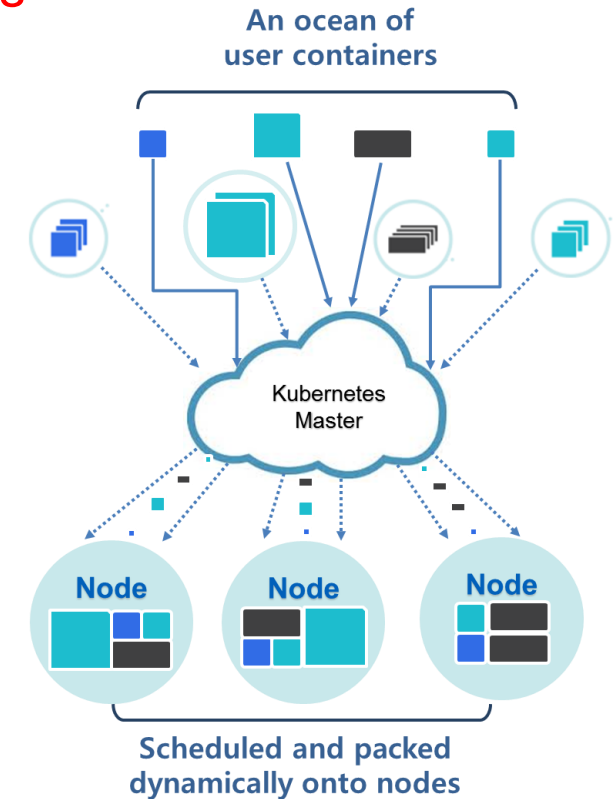
Source: IBM Research Report: An Updated Performance Comparison of Virtual Machines and Linux Containers, July 21, 2014. Passive Benchmarking with docker LXC, KVM & OpenStack, IBM

❖ VM/VI Managers



▪ Kubernetes

- Open-source platform for automating deployment, scaling, and operations of application containers across clusters of hosts
- Functionalities
 - Auto-placement, auto-restart, auto-replication, auto-scaling
 - Schedule across hosts
 - Container grouping
 - Load balancing
- Members



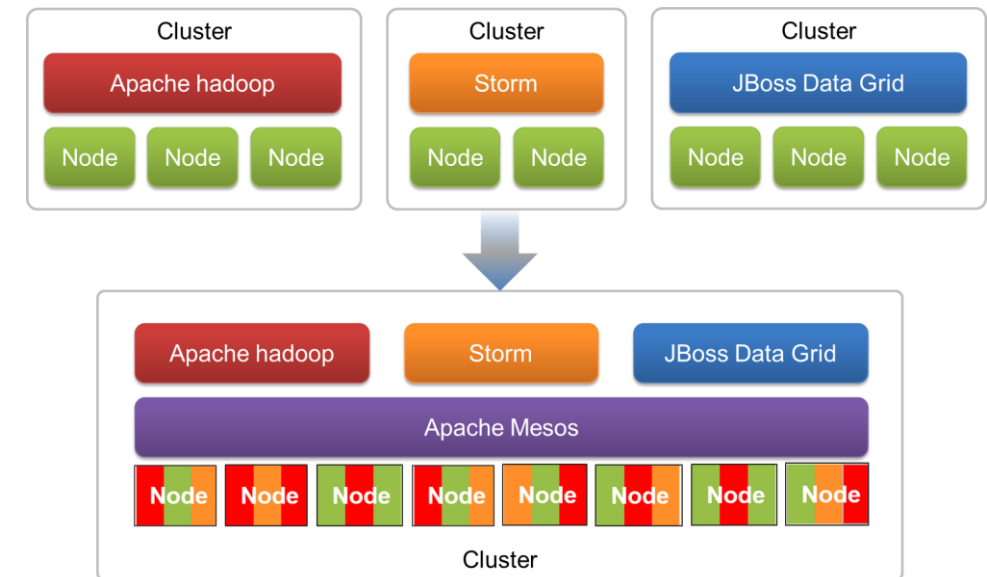
Source: https://cloudplatform.googleblog.com/2015_01_01_archive.html

❖ VM/VI Managers

▪ Apache Mesos



- Open source **distributed systems kernel**
- **Abstracts the entire datacenter into a single pool of computing resources**
- Mesos Framework
 - Job Schedulers: Aurora, Chronos
 - Container Orchestration / High Availability: Marathon
 - Continuous Integration: Jenkins, GitLab
 - Big Data: Hadoop, Spark, Storm, Kafka, Cassandra, Hypertable, MPI
 - Containers: Docker

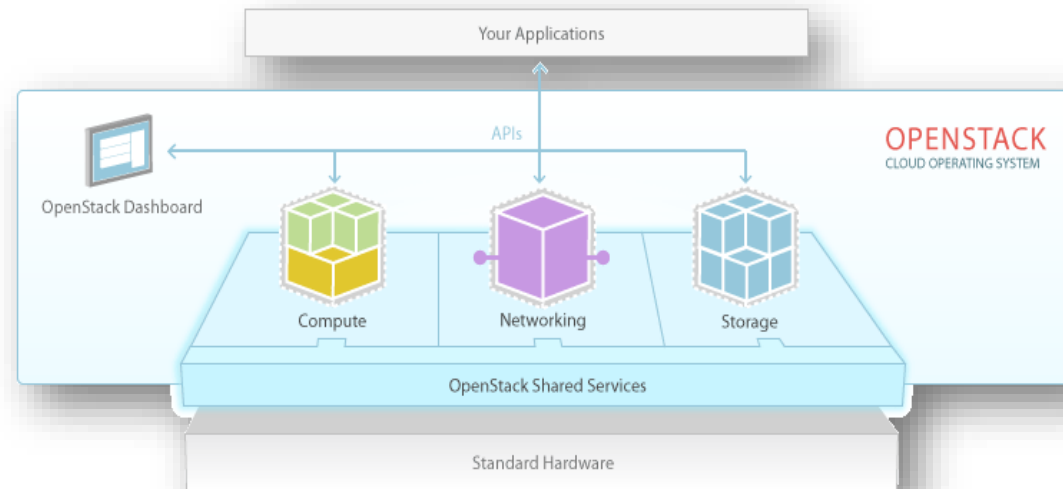


Source: <https://opensource.com/business/14/9/open-source-datacenter-computing-apache-mesos>

❖ VM/VI Managers

■ OpenStack

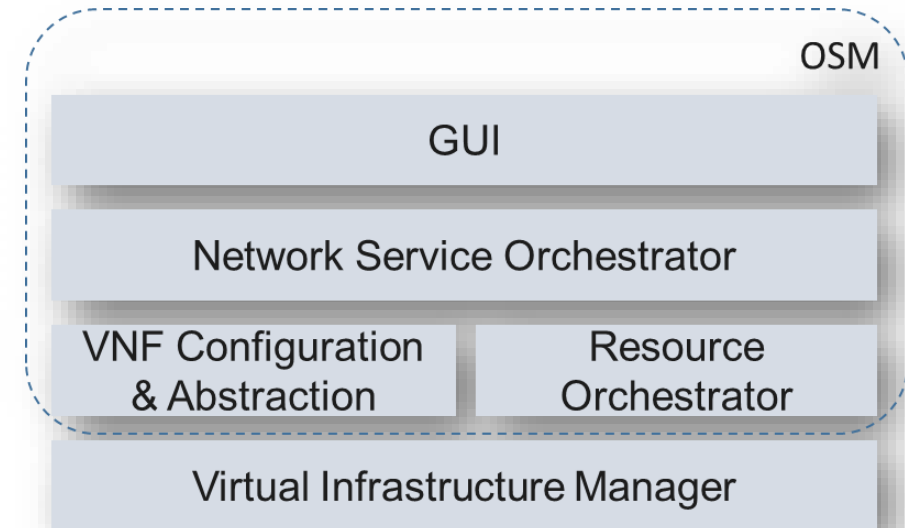
- Open source **software platform for cloud computing**
- Mostly deployed as an IaaS (like Amazon EC2)
- Controls large pools of compute, storage, and networking resources throughout a datacenter
- Core services
 - **swift** (object storage), **keystone** (identity), **nova** (compute), **neutron** (networking), **cinder** (block storage), **glance** (image service)



❖ Management & Orchestration

▪ Open Source MANO (OSM)

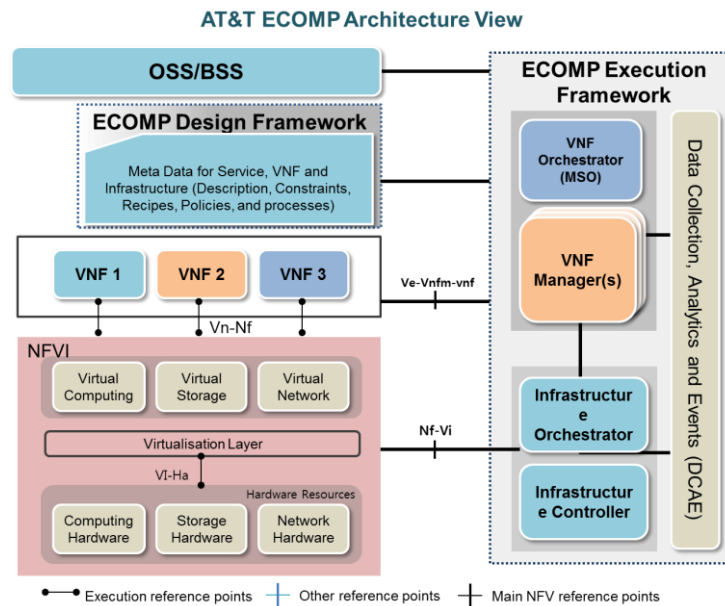
- Develop an **O**pen **S**ource NFV Management and Orchestration (**M**ANO) software stack aligned with ETSI NFV
- Features
 - End-to-end service fulfilment
 - Enhanced platform awareness extensions
 - SDN underlay control
 - Multi-site capability
 - Multi-cloud VIM capability
- Members



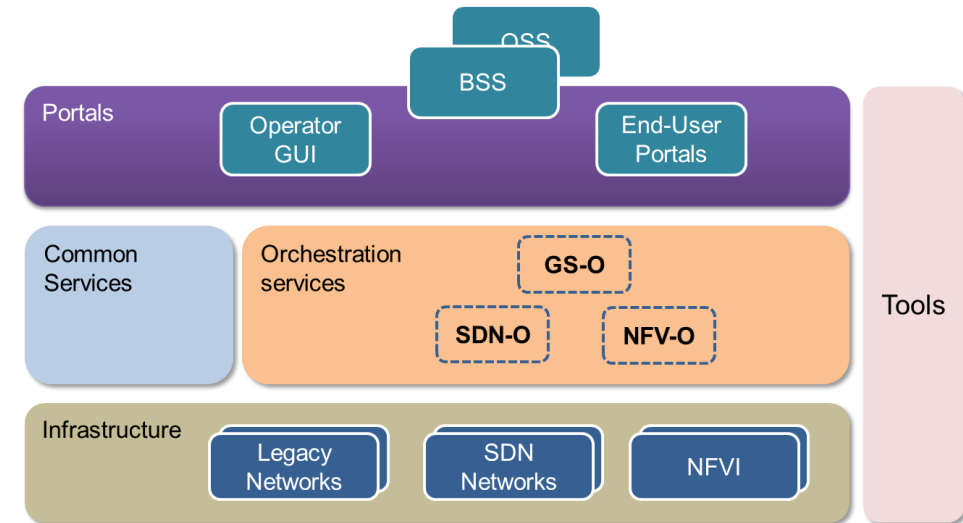
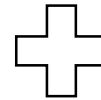
❖ Management & Orchestration

▪ Open Network Automation Platform (ONAP)

- Brings together top global carriers and vendors to allow end users to automate, design, orchestrate and manage services/virtual functions
- Collaboration of two open networking and orchestration projects
 - ECOMP and Open-O



Source: <http://passionateaboutoss.com/the-components-of-sdn-nfv-mano-oss/>



Source:
https://virtualizationreview.com/articles/2017/04/10/~media/ECG/VirtualizationReview/Images/2016/11/1116vrm_openo_architecture.png

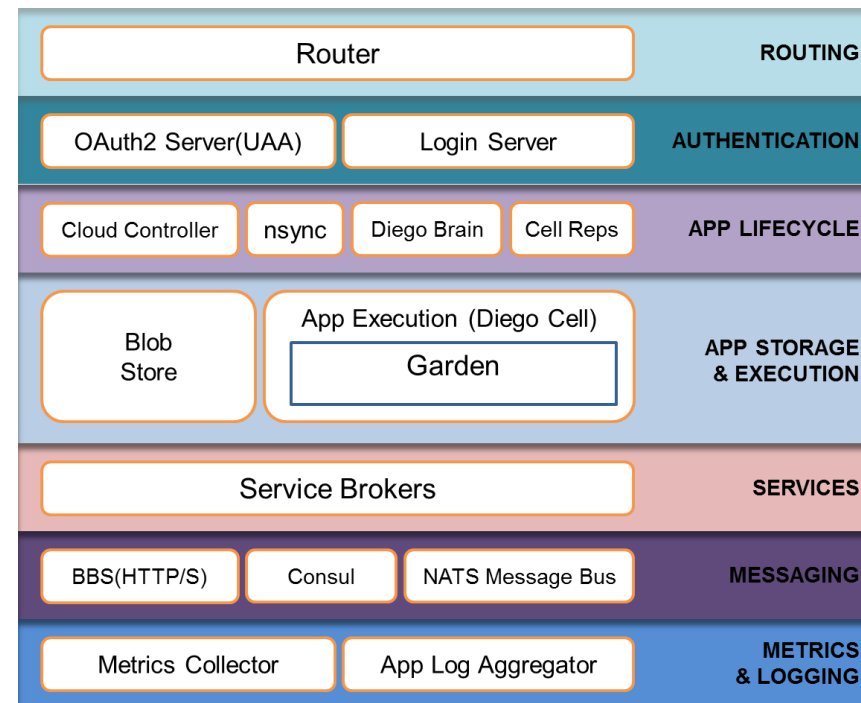
- Members (40, as of July. 2017)



❖ Application Platforms

▪ Cloud Foundry

- Open platform as a service, providing a choice of clouds, developer frameworks, and application services
- **Makes it faster and easier to build, test, deploy and scale applications**
- Runs on any cloud platform
- Members

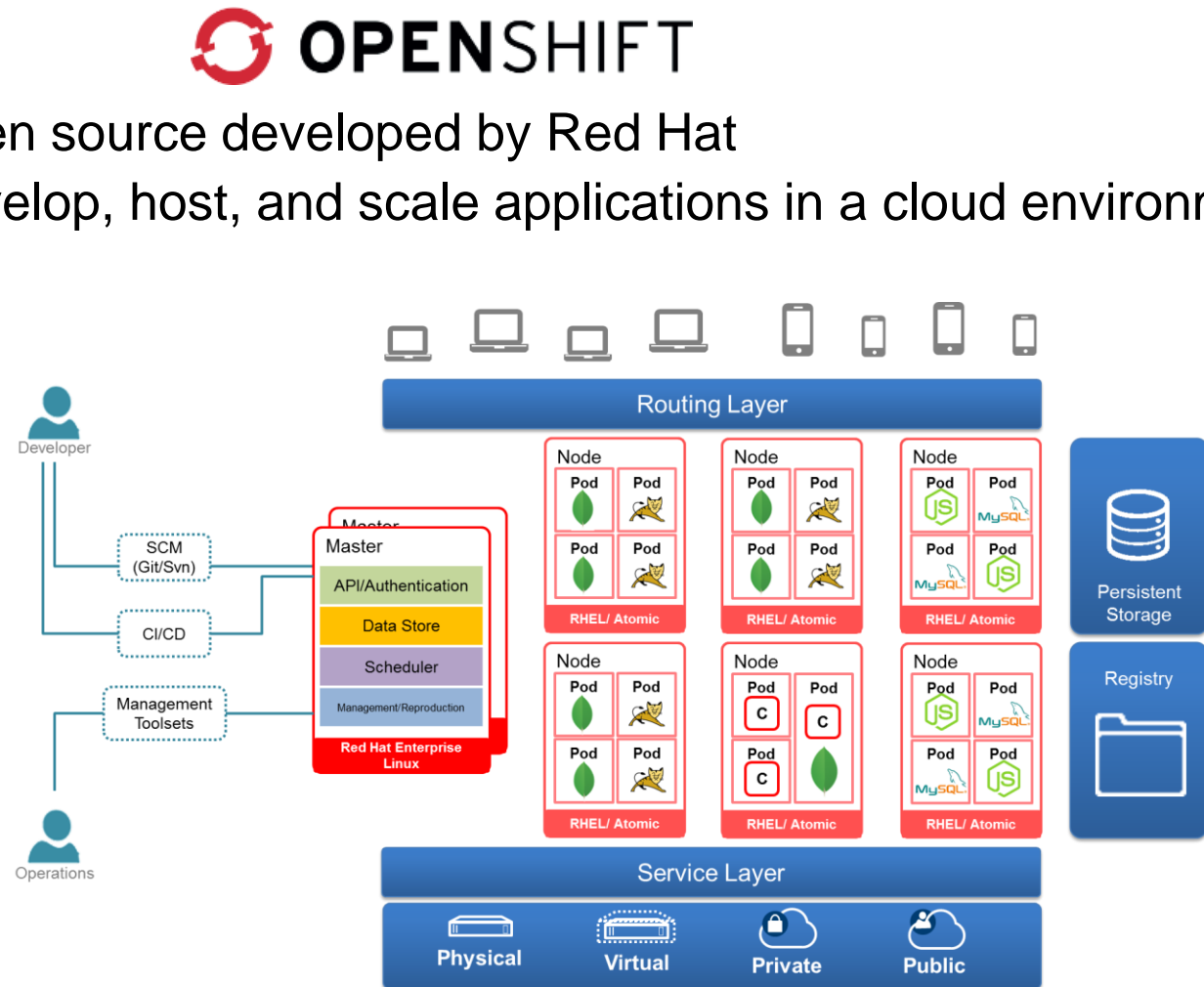


Source: <https://docs.cloudfoundry.org/concepts/architecture/>

❖ Application Platforms

▪ OpenShift

- Cloud Platform-as-a-Service open source developed by Red Hat
- Allows developers to quickly develop, host, and scale applications in a cloud environment
- Members



Source: <https://blog.openshift.com/openshift-enterprise-3-evolving-paas-future/>

❖ Programming Frameworks

■ Node.js

- Cross-platform runtime environment for developing server-side web applications
- Event-driven architecture capable of asynchronous I/O
- Designed to build scalable network applications



■ Django

- Web framework, following the MVC(Model-View-Controller) architectural pattern
- Written in Python
- Goal
 - Ease the creation of complex, database-driven websites
- Reusability and pluggability of components
- Rapid development



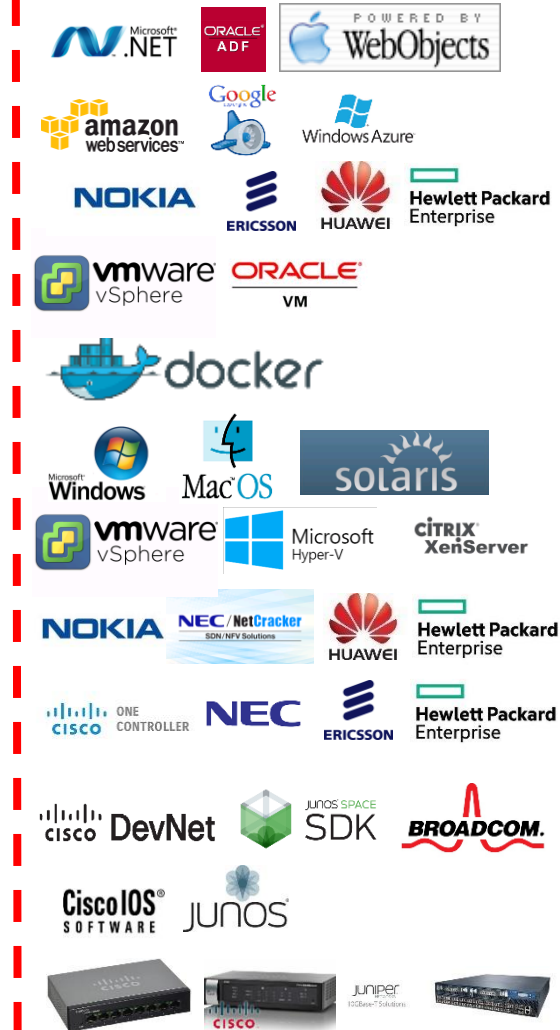
❖ Open Source vs. Commercial Solutions

| |
|------------------------------|
| Programming Frameworks |
| Application Platforms |
| Management & Orchestration |
| VM/VI Managers |
| Containers |
| Operating Systems |
| Virtual Machines |
| Carrier Networking Functions |
| Network Controllers |
| Programmable Data Plane |
| Network Switch OS |
| Hardware |

Open Source

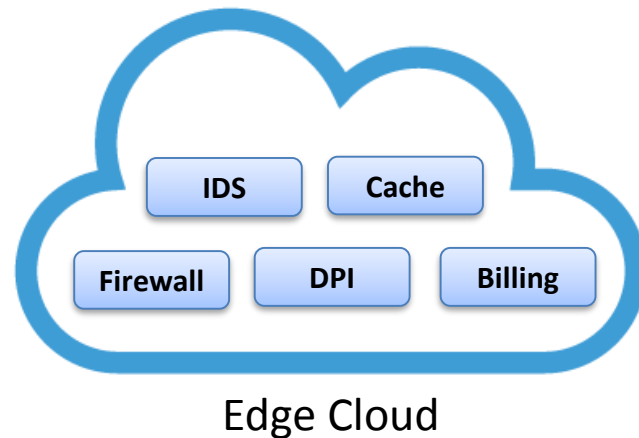


Commercial












❖ A simple scenario for Open Networking Ecosystem

- Phase 1 – Infrastructure building & NFV Development



Network Switch

| | |
|-----------------------|---|
| Frameworks |  |
| Application Platforms |  |
| VM/VI Managers |  |
| OS |  |
| Virtual Machines |  |

| | |
|----------------|---|
| Data Plane |  |
| Switch OS |  |
| P4 ASIC |  |
| OCP Switch H/W |  |

❖ A simple scenario for Open Networking Ecosystem

- Phase 2 – Network & Service Configuration

