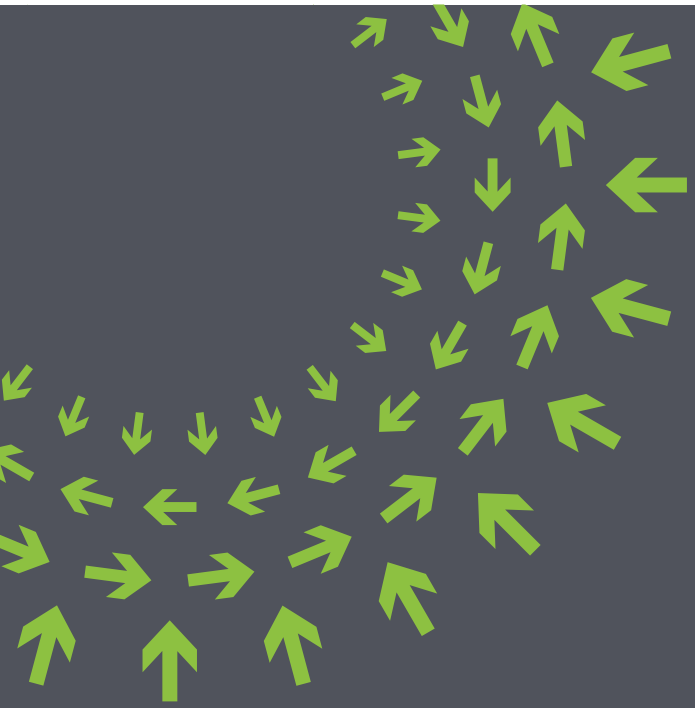

Solution Brief

The Open Compute Project (OCP) and OPNFV are at the forefront of open source networking integration

Disaggregated hardware and software leads to new opportunities across the open source networking stack

KEY OPNFV BENEFITS:

- Integration of open source networking stack
- Testing of specific reference architectures
- Upstream contribution of carrier-grade features

KEY OCP BENEFITS:

- A choice of proven efficient and scalable designs
- Lower CAPEX and OPEX expenditure
- Interoperable, multi-vendor architecture

AREAS OF COOPERATION:

- OPNFV Plugfests
- NFV POCs

"The Open Compute Project has been quite successful at disaggregating traditional IT gear and creating vanity free ingredients. It is now time to carefully select the ideal hardware and software ingredients to re-integrate into efficient solutions. The work being done by OPNFV is a key piece of that re-integration, bringing together the best open source software projects together with the best choices of open source hardware, to enable network functions virtualization. By integrating and testing a set of reference architectures on top of efficient, scalable cloud hardware, OPNFV is removing all the roadblocks to NVF adoption and transformation of the telecom infrastructure." -BILL CARTER, CHIEF TECHNOLOGY OFFICER, OCP

"It's exciting to see the principles of open source software development come to hardware and we believe that OCP is very well positioned to have a significant impact in the space. We look forward to deepening collaboration with OCP while we explore new horizons for NFV deployments, performance, features, and footprint." HEATHER KIRKSEY, EXECUTIVE DIRECTOR, OPNFV

NFV AND OPEN SOURCE

Network functions virtualization, or NFV, is a once-in-a-generation disruption that will completely transform how networks are built and operated.

Instead of the current practice where network services are built using physical network appliances with largely manual deployment, configuration, monitoring and management, NFV creates network services using virtual network functions (VNF) along with fully automated lifecycle management. NFV will also have an impact on enterprises and governments, as it enables smart cities, manufacturers, utilities, connected cars, efficient branch office connectivity, and other advanced services.

Open source has revamped how enterprises build out their IT systems and it is expected by many that it will do the same for NFV. In this fast moving world, open source is supplementing standards as a way of minimizing vendor lock-in. Open source offers numerous additional benefits ranging from improved interoperability through open APIs, increased innovation velocity, end user ability to influence roadmaps, faster troubleshooting, reduced cost, and 100% code transparency. Given these reasons, there is a clear preference for open source technologies in NFV deployments.

INTRODUCING OPNFV

Open Platform for NFV (OPNFV) is an open source project that facilitates the development and evolution of NFV components across various open source ecosystems.

Through system level integration, deployment and testing, OPNFV creates a reference NFV platform to accelerate the transformation of enterprise and service provider networks. Formed in 2014, OPNFV is now a technical project in Linux Foundation Networking (LFN).

The OPNFV project is organized around three key pillars:

- **Integration:** OPNFV integrates a variety of open source projects to address specific NFV requirements.
- **Testing:** OPNFV tests the entire stack across parameters such as functionality, performance and stress.
- **New Features:** The OPNFV community develops carrier-grade features for several of the open source project it integrates. These features are all contributed upstream to respective projects.

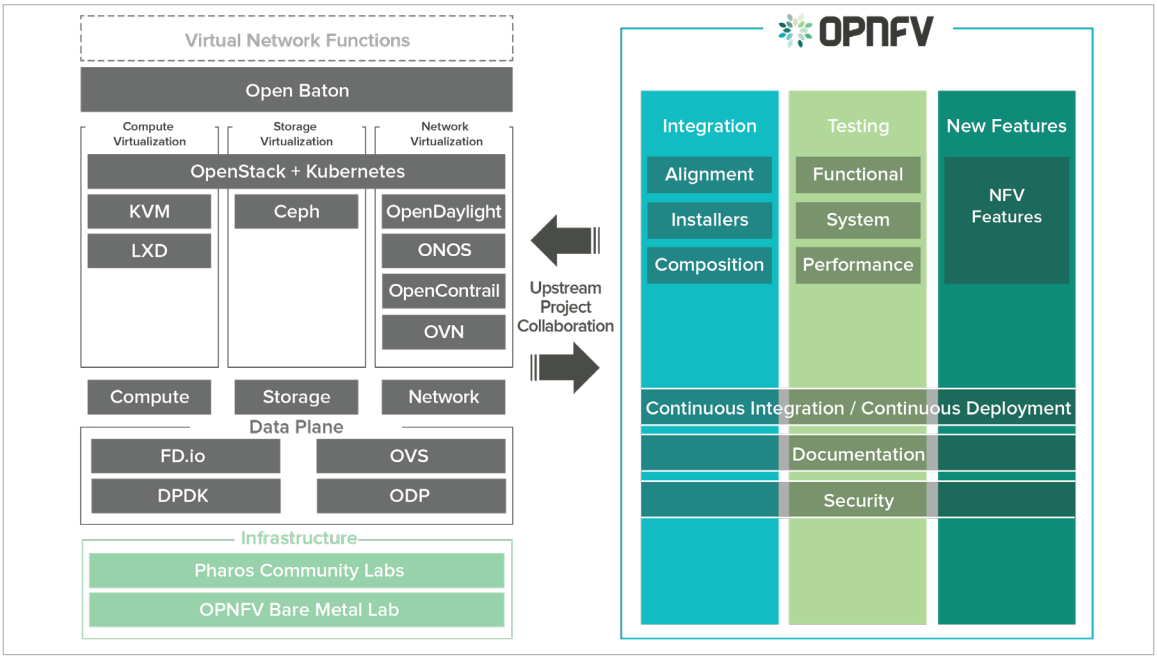

Figure 1: OPNFV Euphrates Release

INTRODUCING OCP

The Open Compute Project (OCP) is a collaborative open source community focused on redesigning hardware technology to efficiently support the growing demands on compute infrastructure.

It was created in 2011 when Facebook shared its cutting-edge designs with the public along with Intel, Rackspace and Goldman Sachs. OCP's goal is to spur innovation through collaboration, and specifically to design, use and enable a mainstream supply chain of the most efficient designs for scalable computing. To achieve this goal, the Foundation has several active projects and thousands of collaborators bringing new technology and products to the market. To assure these products and technologies are delivering on the promise, all OCP contributions are reviewed by OCP's Incubation Committee (IC), a group of senior technical leaders from the cloud industry. This IC requires every new technology, specification, or product to demonstrate at least three of four core OCP tenets: i) efficiency, ii) scalability, iii) openness, and iv) impact.

The OCP community has broad reach, with projects focused on compute servers, storage servers, networking equipment, racks and entire datacenter technology. Additionally, there are projects focused on hardware management, high performance computing, telco and compliance and interoperability. In 2018, OCP launched a Security project to define and deliver more secure hardware platforms with attestation, secure boot and hardware root of trust features. OCP also launched an Open Systems Firmware project with a goal of open sourcing and improving platform initialization and boot.

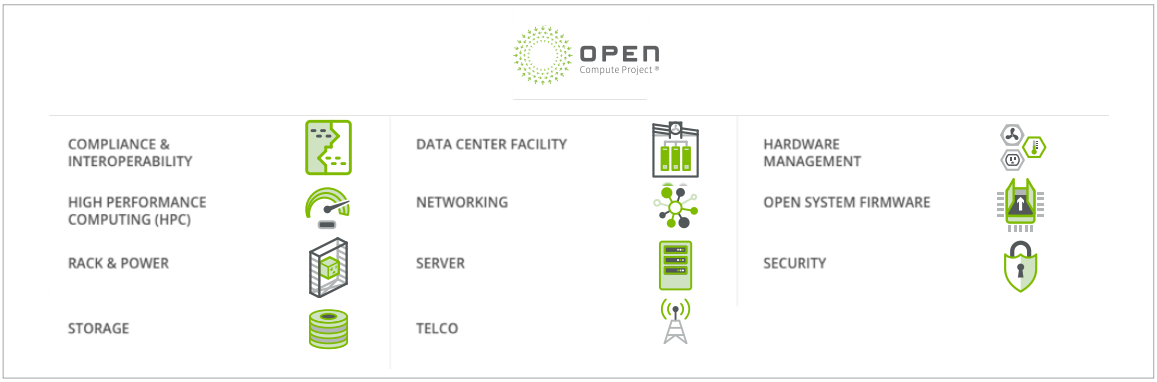

Figure 2: OCP Projects

A number of OCP designs are suitable for NFV. Given that NFV environments vary in terms of space, power, cooling constraints, union policies, NEBS and other regulatory requirements, the diversity of OCP designs is useful in choosing the right design for the right need.

OCP Project	Relevant Designs	Description
Server	Compute Sleds	2 socket and 1 socket compute nodes, supporting a variety of silicate architectures (Intel, AMD, ARM, POWER, NVIDIA, Qualcomm). These compute sleds support general purpose, video transcoding, artificial intelligence and mobile edge computing.
	Open Rack Compatible shelf/sleds	21" rack designed for 600mm x 1200mm tile layout while providing 15% more volume and frontal area. Supports wide range of power feeds and tiles.
	Carrier Grade (CG) 19" shelf/sleds	Front access, modular sleds compatible with the EIA-310 rack. Supports extended environment demands typical of the central office.
	EIA310 Rack Servers	Stand-alone 19" rack servers for legacy environments that cannot use a new rack-level design
	Mezzanine NIC cards	10/25/40/50/100G Ethernet NIC cards
Storage	Storage Sleds for OpenRack and CG 19"	High density direct-attach and networked JBODs for M.2, NVMe, SSD, HDD devices
Network	10/25/40/50/100G Ethernet Switches	Bare-metal open networking switch hardware, ONIE install environment
Rack & Power	EIA-310 Compatible & 21" Open Rack	Complete racks with rack-level power systems with options for AC and DC distributions and in-rack battery backup
H/W Mgmt	Management Profiles (IPMI, Redfish), Rack level mgmt controllers	Consistent management across all OCP devices from any supplier of OCP equipment
Telco	Edge products and Central Office requirements	PON, 10gb PON, and OLT devices devices

Table 1: List of OCP Designs Relevant for NFV

OCP projects provide several concrete benefits for NFV:

Reduced capital expenditures (CAPEX)

- Eliminates over-provisioning of power and compute resources (e.g. CPU cores, memory)
- No-frills design without unnecessary components
- Disaggregated rack-level solution with common power
- Shared storage
- Multi-vendor supply chain
- Aggregated power rectifiers reduce cost while maintaining resiliency

Reduced operational expenditures (OPEX)

- Tool-less hardware servicing
- Maintenance from the front-side allows for strict hot-aisle containment
- 15% more frontal area and more volume results in efficient cooling and higher operating temperature allowing for power utilization efficiency (PUE) in the sub-1.1 range
- Lower weight allows for easier handling
- Simplified and standardized firmware updates
- Sled design allow for up to 3 servers in a 2RU, increasing real-estate efficiency
- Aggregates the power rectifiers to assure higher utilization, resulting in better efficiency
- 3-phase-to-DC conversion assures phase balanced loads on the utility

TCO reduction over life of the IT equipment

- Server refresh and storage refresh on independent timelines and aligned to technology transitions and business demands
- All power rectifiers and bus bars follow data center best practices

Interoperability

- Compute and storage sleds from many suppliers work in multi-sourced racks
- No vendor lock-in

OPNFV AND OCP JOINTLY ENABLE NFV TRANSFORMATION

The virtualization of network functions has resulted in a disaggregation of hardware and software.

There is strong interest in open source projects for both layers. OCP provides an open source option for the hardware layer, and OPNFV integrates OCP along with other open source software projects into relevant NFV reference architectures.

Given this alignment, OCP and OPNFV have been working together on a number of activities such as plugfests and PPC Demos.

OPNFV Plugfests

After each major release, the OPNFV community typically conducts a plugfest. The event is open to all, members and non-members alike, open source and proprietary product vendors, users and academic institutions. The goal of the plugfests is to try new integration, deployment and testing initiatives in a compressed "hackathon" style timeframe. With access to project technical leads and other experts onsite, plugfest participants have been able to make substantial progress in just one week.

Three previous plugfests—plugfest #4 in Portland in December 2017 (based on the OPNFV Euphrates release), plugfest #3 in Paris in April 2017 (based on the OPNFV Danube release) and plugfest #2 in Durham, New Hampshire in December 2016 (based on the OPNFV Colorado release)—included activities that utilized both OPNFV software and OCP hardware. The OCP hardware from Nokia and Lenovo included:

- **Open Rack:** 41OU, 21” Open Rack V2, 2 power zones with own power shelves, 12.5 VDC busbar for power distribution
- **Power shelf:** 6 PSUs, 12.5kW capacity, dual 3P 208/230VAC 50/60Hz input, 12.5 VDC busbar output
- **Compute shelf:** 2RU shelf with 3 compute node bays
- **Server nodes (3 per compute shelf):** Dual socket 2RU ⅓ shelf server node, 16x DDR4 RDIMM modules, mezzanine card slot for dual-port 1/10/25G NIC, 2 x PCIe, 1 x 3.5” or 6 x 2.5” storage, 1x mSATA/M.2 SSD
- **Storage nodes:** 2RU full width unit, 30 hot swappable 3.5” HDD drives, fully redundant
- **Switches:** 10/25/40/50/100G 1RU high-density bare-metal switch
- **Ethernet NICs:** Dual-port 25G Ethernet NIC

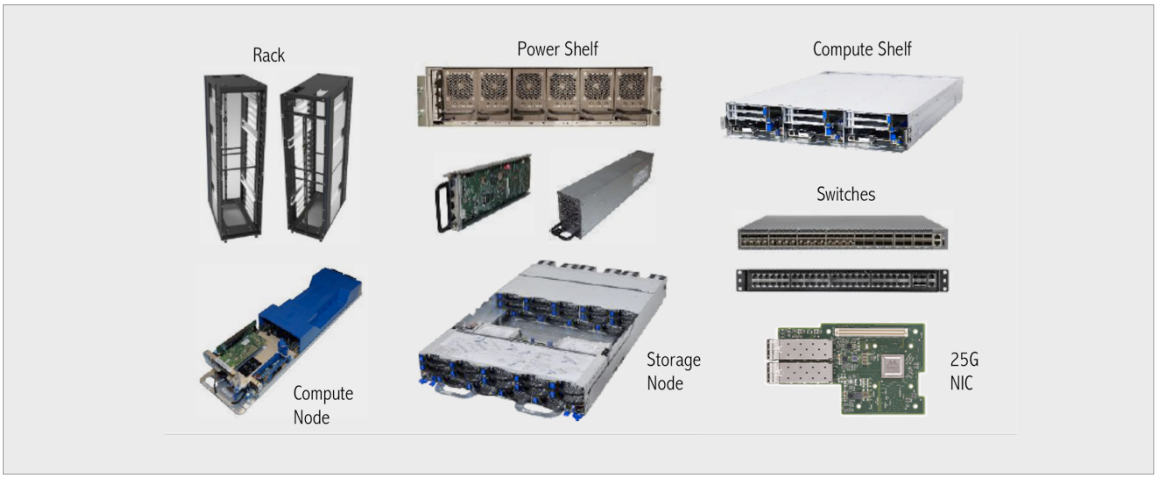

Figure 3: Nokia OCP Hardware Used During OPNFV Plugfests

The following are some of the OPNFV projects and third-party (proprietary or open source) technologies that were integrated with the above OCP hardware:

- **Functest:** Validation and functional testing of OPNFV projects
- **Yardstick:** Performance validation and testing
- **SnapsOO:** Middleware framework to abstract OpenStack APIs
- **Dovetail:** OPNFV compliance testing project
- **OVS-DPDK:** Dataplane acceleration technology that combines Open vSwitch with DPDK
- **Netronome SmartNIC:** SR-IOV testing
- **Power-as-a-service:** Measure energy consumption of scenarios/VNFs
- **VNF onboarding:** Onboarding and testing of the Radisys vMRF VNF

OPNFV VCO Proof of Concept Demo

Communication service providers (CSPs) use central offices (CO) or cable hubs to offer enterprise, residential and mobile users access to network services. By using industry standard servers and network equipment along with NFV and SDN software, network operators are transforming COs to bring agility, innovation and an improved customer experience to end users while slashing CAPEX and OPEX. The OPNFV community created two virtual central office (VCO) demos using OPNFV along with OpenDaylight SDN controller, OCP hardware, open source/proprietary VNFs and service assurance software. Lenovo OCP hardware was used for controller, compute and storage nodes.

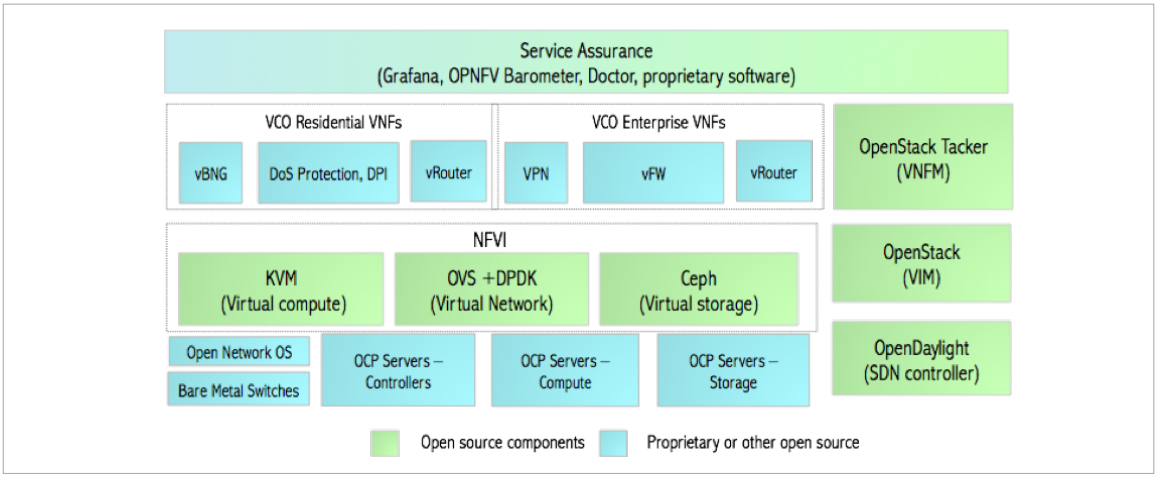

Figure 4: VCO Demo Reference Architecture

OPNFV USERS AGREE

In a recent Heavy Reading Survey, CSPs were asked, "In addition to OpenStack and SDN controllers (e.g., OpenDaylight, ONOS, OpenContrail), which upstream projects are most important to the success of OPNFV?"

OCP was at the top of the list, with over 50% respondents saying it was the most important project for the success of OPNFV.

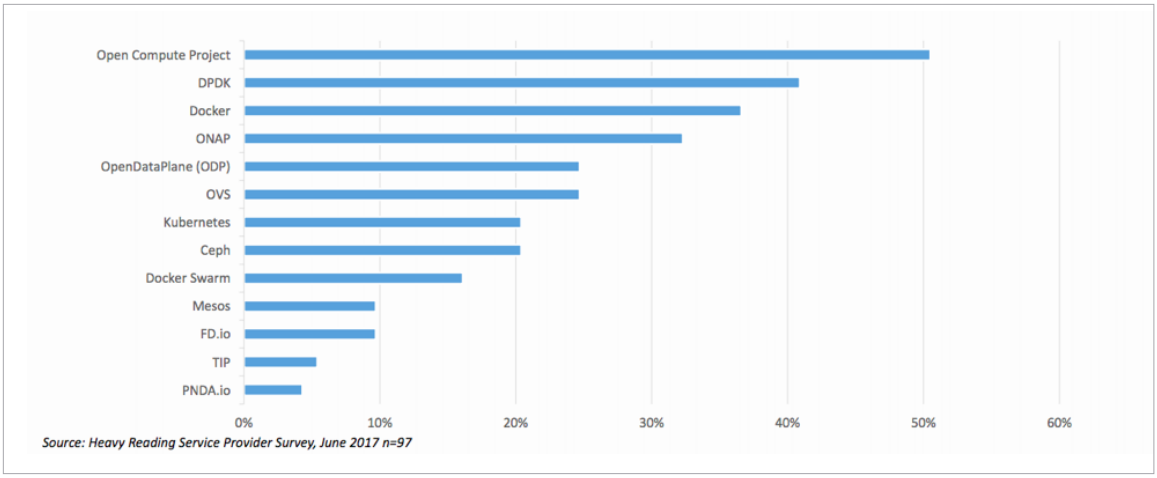

Figure 5: Heavy Reading June 2017 Survey Results

NEXT STEPS

Both the OPNFV and OCP communities look forward to increasing the level of cooperation with the goal of enabling a faster and more successful NFV transformation for CSPs. Some potential areas of collaboration in the future are:

- Deeper engagement at OPNFV plugfests
- Inclusion of Open GPON vOLT in future VCO PoCs and other projects such as uCPE, G.Fast DPU, 400V DC power feeding architecture and MicroOLT vOLT projects as they evolve from draft to approved
- Telco-centric Redfish profile
- Creation of OPNFV Pharos labs based on OCP hardware

There are numerous open source projects catering to the NFV network transformation. Bringing together a full open source software networking stack with leading open hardware designs provides the networking ecosystem with cost-effective, cutting edge infrastructure for their next-generation networks.

REFERENCES

OPNFV

OCP

OPNFV plugfest #4 report

OPNFV plugfest#3 report

OPNFV plugfest#2 report

OPNFV VCO demo

Heavy Reading survey slides