Open Source Project Spins Up A Virtual Central Office

The OPNFV community comes together to build a VCO demo using OpenDaylight with residential and enterprise services in just 3 weeks

KEY OPEN SOURCE PROJECTS:

- Open Compute Platform (OCP)
- OpenDaylight
- OPNFV
- OpenStack

RAPID DELIVERY OF DEMO:

- 28 volunteers
- 10 companies
- 3 weeks

DEMOS CREATED:

- Residential VCO
- Enterprise VCO

SHOWN AT OPNFV SUMMIT:

- Keynote stage Demo
- Booth Demo

Azhar Sayeed, Red Hat, walks booth visitors through the VCO Community Booth in Beijing.

"CableLabs is focused on access network virtualization to enable programmability, flexibility, and cost savings. Our NFV/SDN reference platform - SNAPS, is based on OPNFV and we are looking ahead to support various types of network services related to 5G and DOCSIS. We are exploring an end-to-end distributed compute architecture including edge compute nodes located at the cable head-end to deliver an optimal user experience for low latency / high bandwidth applications. We see vCO (or virtualized cable head-end) as a key evolutionary step for future cable networks."

- TETSUYA NAKAMURA, CABLELABS

PROBLEM STATEMENT

Communication service providers use central offices (COs, also known as cable hubs or cable head-ends by cable operators) to offer enterprise, residential and mobile users access to network services.

COs are generally located within a few miles of the user, and are therefore prevalent, with more than ten thousand COs in the United States alone. Thus, COs interconnect access/aggregation networks to metro/core networks for users of cable, fiber, wireless and other access technologies.

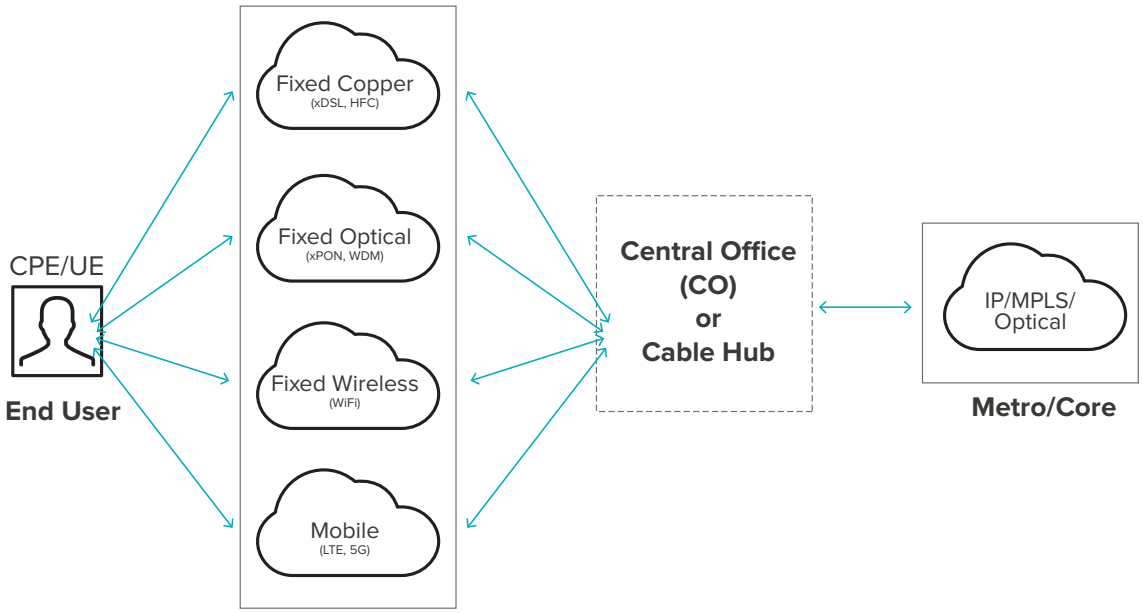

Figure 1: Role of CO/VCO

Today, network services in a CO are created using purpose-built proprietary hardware. This greatly limits agility and innovation, since it takes several months to purchase and configure new equipment; and once purchased, to be profitable, as the service cannot be decommissioned until the financials cross a break-even point. Moreover, these expensive and usually oversized hardware (since services are architected for peak traffic) contribute

to a high capital expenditure (CAPEX) for operators. Given that the interfaces are rigid and non-standard, this equipment requires special training and manual management, which contributes to high operational expenditures (OPEX). Specifically, in the case of enterprise users, the need to ship and configure multiple boxes on-site contributes to even more CAPEX and OPEX. Finally, the rigidity of the current approach is ill-suited to bring next generation multi-access edge computing (MEC) services such as augmented/virtual reality (AR/VR), connected cars, smart cities, immersive video experience, tactile internet and internet of things (IoT).

VIRTUAL CENTRAL OFFICE

The solution to the above problem is to bring Network Functions Virtualization (NFV) and software defined networking (SDN) technologies to the CO.

By using industry standard servers along with NFV and SDN software, network operators can bring agility, innovation and improved customer experience to end users while slashing CAPEX and OPEX.

To achieve these goals, the Virtual Central Office (VCO) solution for this Proof of Concept follows three important architecture principles: First, OpenDaylight as a common controller for both the virtual network overlay and the physical network fabric underlay. Next, OpenStack as a common platform, for both NFV Infrastructure and VIM, to ensure an orchestrator agnostic framework. And finally, the consolidation of control plane functions into the virtualized infrastructure and the distribution of the data plane into the network fabric. With this in mind, a VCO can bring a wide range of services to end users, including:

Residential VCO Services — For residential users, a VCO can offer virtualized services such as Broadband Network Gateway (vBNG), router, firewall, MEC services (see above), video optimization, VoIP, VPN and additional services, such as email/web hosting, parental controls, cloud storage, security, virus scanning, and cloud backup.

Enterprise VCO Services — For enterprise users, a VCO can offer services such as virtual router, virtual firewall, WAN acceleration, software defined WAN (SD-WAN), VPN, DNS, PBX, intrusion detection/prevention system (IDS/IPS), CDN, IPSEC, AD/LDAP, content filtering, WLAN and more.

Mobile VCO Services — For mobile users, a VCO can offer services ranging from cloud radio area network (C-RAN), MEC (see above), voice over LTE (VoLTE), IoT, components of vIMS/vEPC to network slicing. Although Mobile services were not included in the original OPNFV VCO Demo described below, the VCO architecture is designed to handle those services, and are being considered for the next OPNFV community demo.

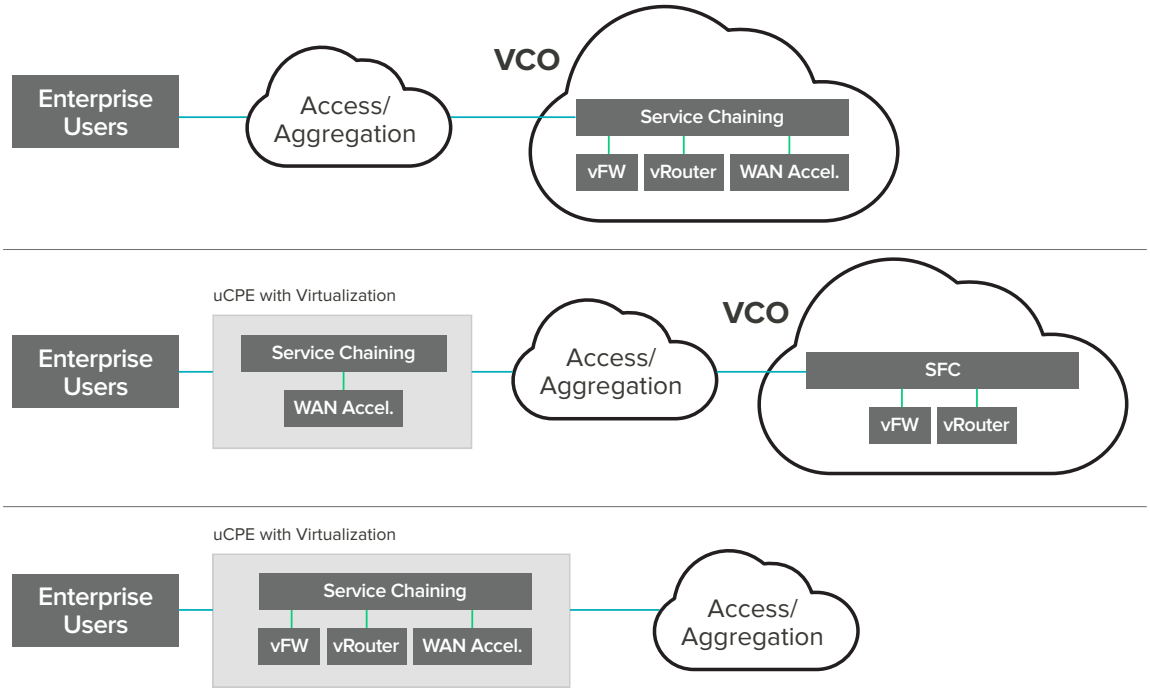

Figure 2: Role of CO/VCO for Enterprise Users

Unlike mobile and residential, in an enterprise use case, there are different VNF deployment options. In the first option, called thin vCPE (virtual customer premise equipment), the on-premise equipment is simply a network interface device (NID), and all virtual functions are in the VCO. In the second option, there is a programmable vCPE device (also called thick vCPE or universal CPE) at the customer site to host VNFs, with ancillary VNFs in the VCO. In both the thin and the thick vCPE deployment models, the VCO serves an important role.

THE OPNFV
COMMUNITY VCO DEMO

The genesis for the demo was a VCO Proof of Concept (PoC) from the OpenDaylight project showing how to build a VCO using OpenDaylight as the SDN controller.

Conceptually the all the parts were there, but next big proof was to actually build and showcase an operational demo in a way that would get the industry's attention. Seizing an opportunity to operationalize the concept ahead of the OPNFV Summit, the OPNFV and OpenDaylight communities quickly came together — volunteering lab space, hardware, software, and many project hours for integration, testing, and demo preparation with a common vision. Importantly, both use cases (residential and enterprise) would run on an identical reference architecture based on OPNFV, the open source project and community that integrates and tests a number of open source projects across the networking stack and contributes carrier grade features upstream to those projects.

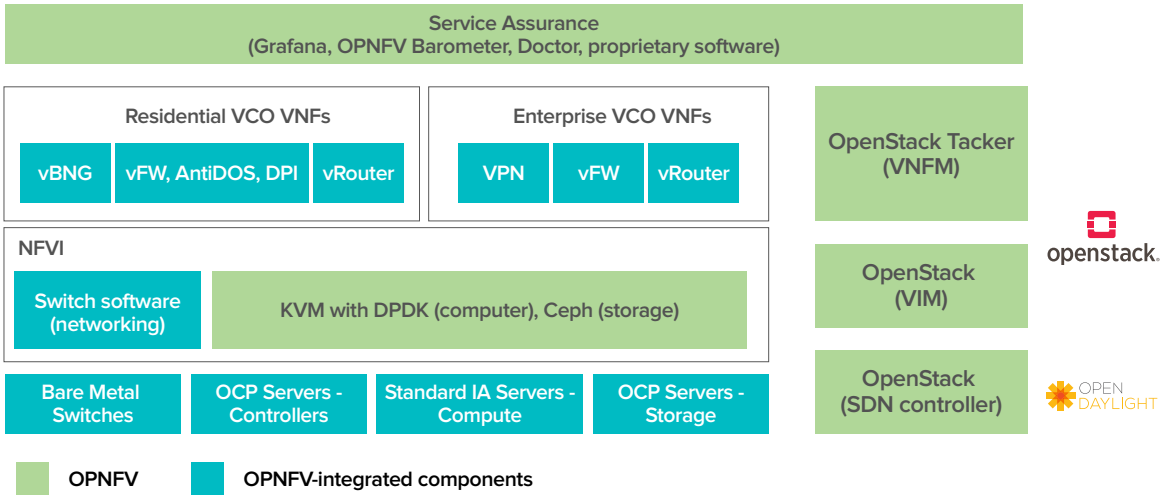

Figure 3: VCO Demo Reference Architecture

The reference architecture consisted of the following elements, configured with high-availability:

NFV infrastructure (NFVI)

- The NFVI hardware consisted of Open Compute Project (OCP) servers by Lenovo and Nokia, Lenovo standard Intel servers, Mellanox network interface cards and Mellanox bare metal switches. OCP is an open source hardware project focused on redesigning server, storage and networking technology for enterprise and telecom data centers. The hardware for the demo included Intel® RDT technologies to monitor and control the utilization of shared resources (e.g. memory bandwidth).
- The NFVI software consisted of Red Hat OpenStack Platform (for compute, storage and networking virtualization), RedHat Ceph Storage, and Cumulus Linux open network operating system running on the bare metal switches.

Management and Orchestration (MANO)

- The Virtualization Infrastructure Manager (VIM) used an OPNFV Danube scenario (a scenario is integration of specific components) consisting of OpenStack and OpenDaylight SDN controller: OpenStack™ managed virtual compute, virtual storage and virtual networking via OpenDaylight. OpenDaylight configured the underlay network including WAN links using EVPN, overlay network (OVS), and VNFs. OpenDaylight is a project, leading SDN controller, and a modular open platform for customizing and automating networks. OpenStack is a project whose software controls large pools of compute, storage, and networking resources throughout a datacenter.
- A full blown NFV Orchestrator (NFVO) layer was not used; instead Ansible was utilized for on boarding of VNFs. Note: another option for this could be OpenStack Tacker as a VNF Manager (VNFM).

Virtual Network Functions (VNF)

- The residential VCO demo consisted of the following VNFs: vBNG by Cisco and Ericsson; virtual firewall (vFW), deep packet inspection (DPI) and AntiDOS by F5 Networks; and open-source virtual router VyOS.
- The enterprise VCO demo consisted of a VPN using OpenVPN, a virtual firewall by F5 and an open-source virtual router with VyOS VNFs.

Service Assurance

- The demo also utilized OPNFV Barometer — a monitoring project that uses collectd to capture statistics from the NFVI and sends it to higher level service assurance and fault management systems.
- Grafana, a visualization dashboard to view various monitoring data and metrics, was also used.
- The demo also included service assurance software from NetScout (nGeniusOne) that identifies systemic problems end-to-end before they impact service.

DEMO RESULTS

The demo was successfully executed, and is unique in several ways:

- Unified SDN controller: The entire data center fabric and OVS control was through a unified OpenDaylight controller that included new tenant-level EVPN functionality.
- Modular: The demo is designed to be modular where any component can be replaced by an alternative. For example, Tacker could be replaced with another orchestrator such as ONAP or OSM.
- Access virtualization: The demo sets the foundation for introduction of virtualized access layer such as vOLT, vCMTS or SD-WAN in the future.

Once the VCO stack components were installed and deployed in Lenovo's lab in Raleigh, North Carolina, the demo for the stage as well as the booth were built to be unveiled at the OPNFV Summit. After some very late nights of testing, the demo was shown on stage—including a live VPN tunnel through the great firewall between the lab and the local branch CPE onsite servers—during the Day 1 morning keynotes and throughout the event at the OPNFV community booth. The demo successfully showed an end-to-end business service providing local breakout traffic to the internet and a remote VPN connectivity to the virtual router in the central office. The demo was very well received with the most common questions around how a demo this complex was built in just three short weeks.

The residential VCO demo showed how a customer using a fiber service could get network connectivity using vBNG, DPI, DoS Protection and vRouter VNFs connected in a service function chain (SFC). The demo progressed by showing VNF onboarding, user authentication and ultimately network connectivity. Additionally, the demo executed a successful defense to a DoS attack and implemented a policy that blocked the user from social networks websites.

Figure 4: Residential VCO Demo

The enterprise VCO demo similarly showed a local branch on the stage connecting to VNFs in the VCO and gaining network access and associated services such a firewall.

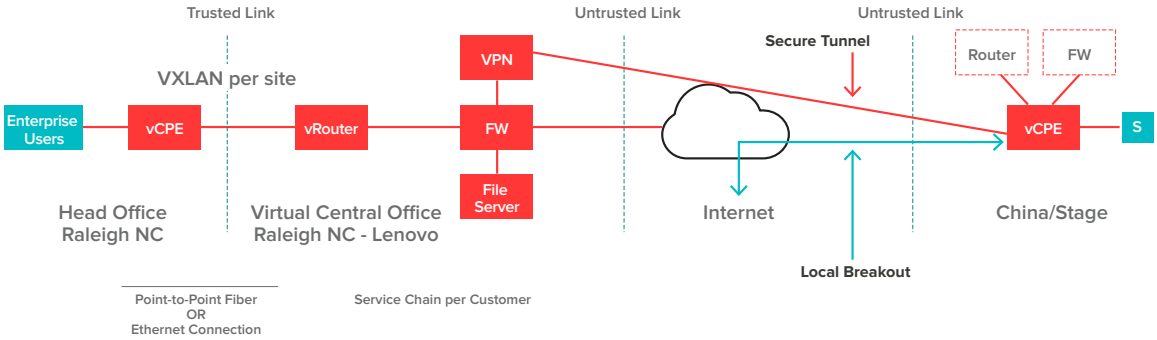

Figure 5: Enterprise VCO Demo

But it is not enough to simply deploy services. These services need to be monitored and appropriate actions need to be taken in response to specific events for end-to-end service assurance. The demo included this critical aspect as well. The NFVI layer was monitored using OPNFV Barometer. Metrics such as CPU load, memory utilization, I/O utilization, network load, OVS performance, etc. were collected and sent to the Grafana visualization dashboard and the NetScout service assurance software.

Since the OPNFV Summit, the demo has been shown at other industry events such as the CableLabs Summer conference and Huawei Connect; the demo videos on YouTube and TelecomTV have received 1,500+ views, and has been the subject of over a dozen meetings between demo architects and CSPs across the globe.

Moving forward, the VCO project aims to build an OpenDaylight-based reference architecture which could be combined with other projects to create solutions that support the delivery of residential, business and mobile services. A VCO 2.0 demo that includes mobile services is under development for 2018.

SUMMARY

CSPs are looking to modernize their central offices, apply NFV and SDN principles, and gain agility in terms of creating and deploying services and cutting both OPEX and CAPEX.

This proof of concept and associated reference architecture achieve this through delivering services as closely as possible to the customers by leveraging computing capabilities at the edge. This demo established the feasibility of the VCO concept for both enterprise and residential use cases through open community collaboration across the networking stack. Network providers working now transform their networks with programmability, software-defined infrastructure, and use of open source will find redesigned COs an area of competitive advantage.

COMMUNITY PARTICIPATION

The VCO demos were made possible by active community participation by the following companies:

RESOURCES

VCO Keynote Demo: https://www.youtube.com/watch?v=TRqbW8YYyWA&t=1048s

VCO Booth Demo: http://www.telecomtv.com/articles/opnfv-summit/poc-opnfv-community-demo-virtual-central-office-15783/

VCO Whitepaper: https://www.opnfv.org/wp-content/uploads/sites/12/2017/09/OPNFV_VCO_Oct17.pdf

VCO Demo Lab Setup: https://wiki.opnfv.org/display/OSDD/OPNFV+VCO+Lab+Setup