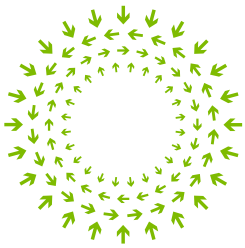
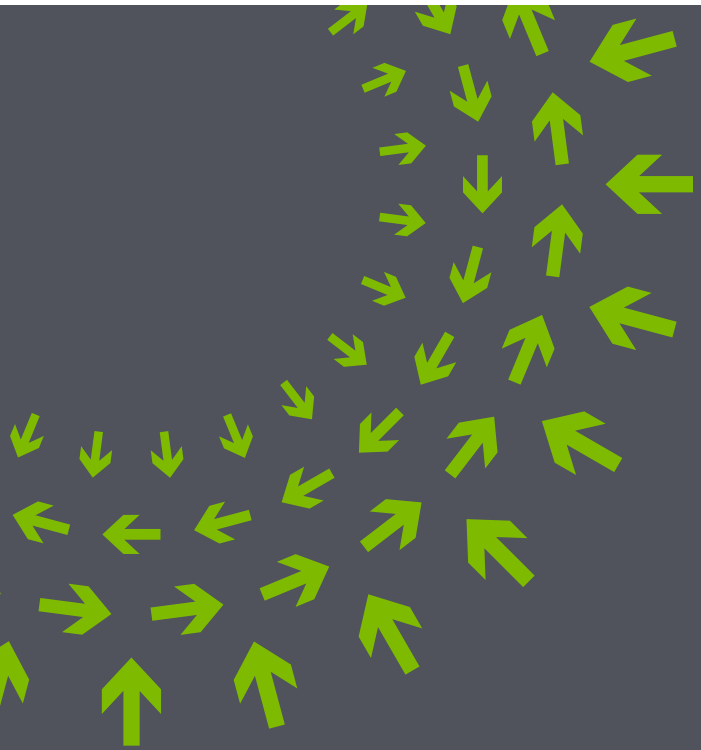
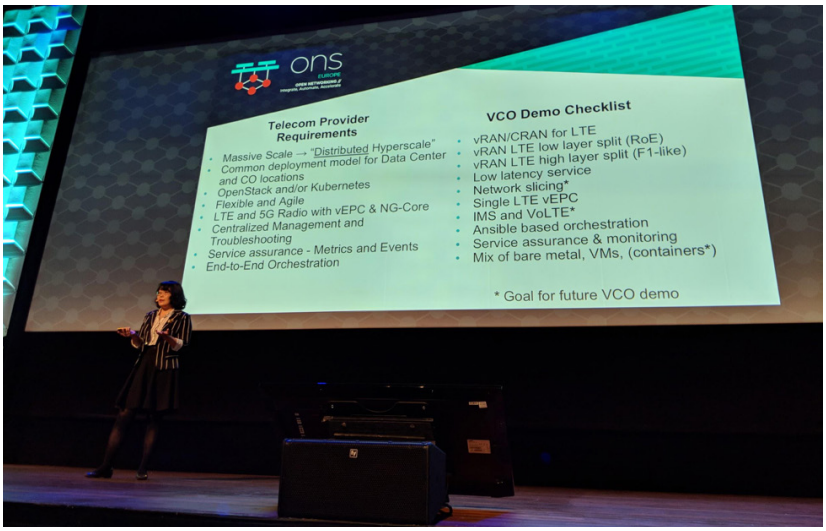


OPEN Compute Project®

Open Source Community Extends Virtual Central Office to Mobile Use Case

Multiple open source communities and organizations collaborate to bring mobile services to the edge





Fu Qiao, China Mobile, explains edge cloud requirements during ONS Europe in Fall 2018

"For moving to SDN and NFV, the cloud IT technology way is to rely more on open source for de facto standards. Collaboration in the open source community gives us many opportunities to practice the integration of open source components. When working toward deployments, integration and testing become critical, and this VCO approach gives us experience and toolsets to solve technical deployment challenges."

– Fu Qiao, Project Manager, China Mobile

KEY OPEN SOURCE PROJECTS:

OpenAirInterface

OpenDaylight

Open Compute Project

OpenStack

OPNFV

DEMOS CREATED:

Public internet data connectivity

Corporate network connectivity

COLLABORATIVE DEVELOPMENT OF DEMO:

30+ volunteers

10+ organizations

5 open source projects

SHOWN AT MULTIPLE FORUMS:

ONS Europe 2018

OCP Regional Summit 2018

THE TRANSFORMATION OF THE CENTRAL OFFICE

Communication service providers (CSPs) 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 at the edge of the network, and are therefore prevalent, with more than ten thousand COs in the United States alone. Thus, COs provide connectivity between access networks and the backbone, and increasingly, rich edge services enabling AR/VR, drones, autonomous vehicles, and other new applications

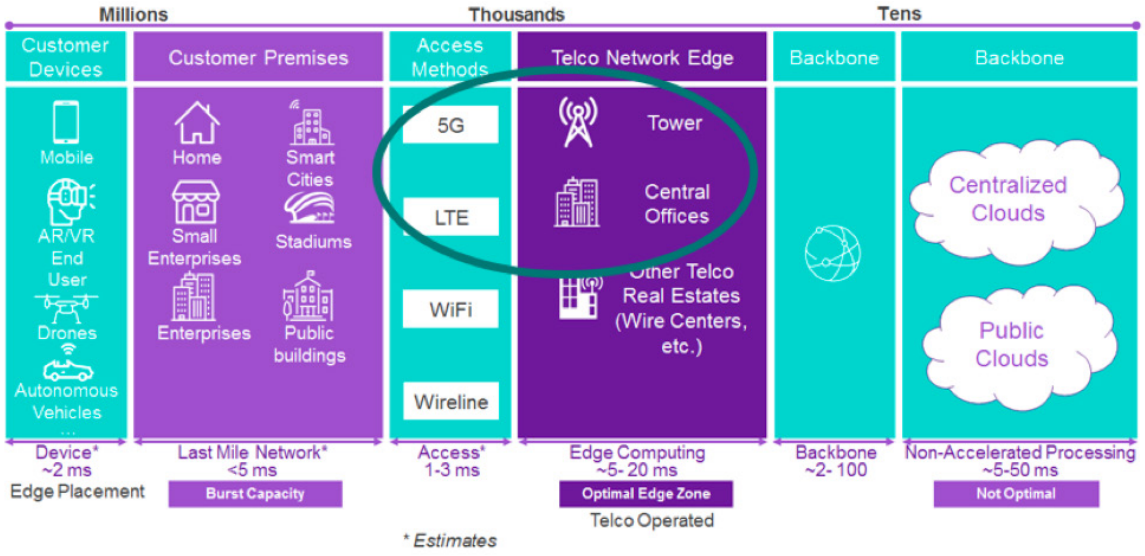


Figure 1: Role of VCO (Diagram Courtesy **Akraino** Project)

Traditional COs built using purpose-built proprietary hardware are transforming into virtual COs (VCOs) that use cloud technologies such as NFV and SDN. VCOs are evolving toward fully cloud-native architectures resulting in automation, agility, improved customer experience, and dramatic cost reductions. For a full discussion of this evolution, see the VCO 1.0 solution brief.

VIRTUAL CENTRAL OFFICE REQUIREMENTS

Since a VCO is essentially a cloud-native approach to deploying NFV closer to the user, a VCO needs to meet SDN, NFV, and edge computing requirements. Some of these requirements are:

- Support for a massive scale of COs (i.e. distributed at scale)
- Common deployment model for edge <=> core locations
- Support for bare metal, VM and container compute types
- Flexibility and agility
- Ability to run NFV and edge computing workloads
- Centralized management and troubleshooting
- Service assurance covering metrics and events
- End-to-end orchestration

Getting into some specifics, for example, China Mobile, expects the number of COs or access level edge data center sites to be in the 100,000 range. Assuming an average 10 servers/CO means roughly 1M servers just for China Mobile. The CO, in the case of China Mobile, will connect to other edge locations — the base station on one side and metro/region level data centers on the other side. Each CO will be expected to support mobile, enterprise, residential services along with edge computing and RAN software applications.

THE OPNFV COMMUNITY
VCO 2.0 DEMO

In 2017, the OPNFV community with other open source projects first demonstrated the concept of a VCO with residential and enterprise services. Given the success of the 1.0 effort, the community decided to work together on mobile services for the VCO 2.0 demo. The VCO 2.0 demo shared a common architecture and philosophy with VCO 1.0 in terms of using 100% open source software for NFVI, VIM and SDN controller layers while accommodating proprietary products for VNFs and service assurance where applicable.

The software architecture of the VCO 2.0 stack is as follows. The NFVI, VIM, and SDN controller layers are consistent with those used for VC0 1.0. This commonality allows residential, enterprise and mobile versions of VCO to reuse a common software infrastructure layer while limiting the differences to the VNF layer.

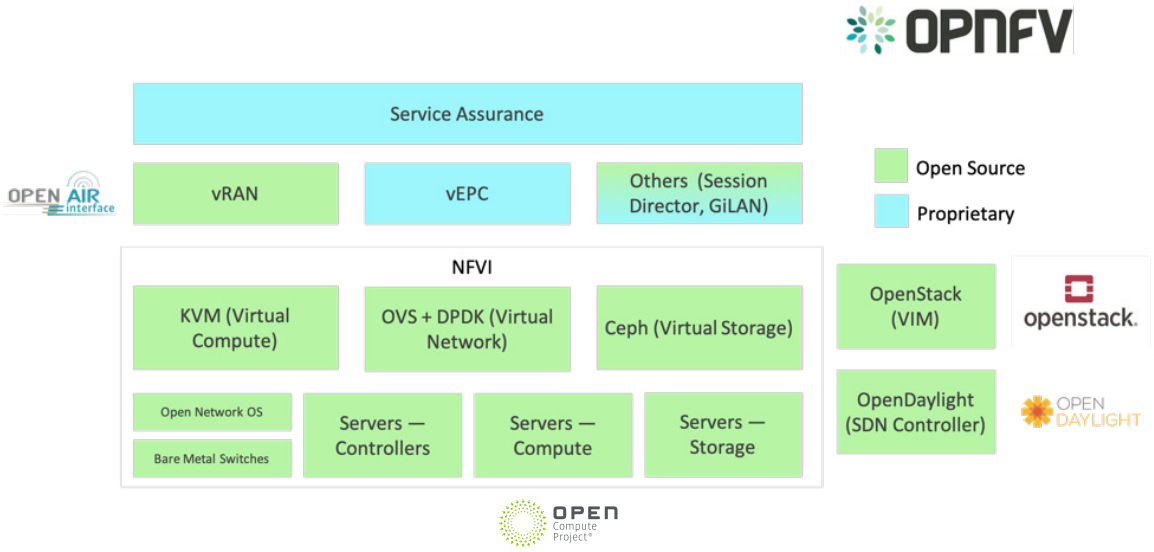


Figure 2: VCO 2.0 Reference Software Stack

The VCO 2.0 reference software stack consisted of the following elements:

NFV infrastructure (NFVI)

- The NFVI hardware consisted of servers where some rack and Open Compute Project (OCP) server equipment came from CircleB and Mitac respectively. The networking hardware included bare metal and Mellanox switches.

- The NFVI software consisted of Red Hat® Enterprise Linux®, Red Hat OpenStack® Platform, Red Hat Ceph® Storage, and Cumulus Linux open network operating system.

Management and Orchestration (MANO)

- Red Hat OpenStack Platform provided VIM capabilities. OpenStack Platform is an open source software project that controls large pools of computing, storage, and networking resources throughout a data center. OpenStack Platform was used to manage both virtual and bare metal machines.
- The SDN controller used was OpenDaylight (ODL); ODL configured the underlying network including WAN links, overlay network (OVS), and VNFs. OpenDaylight is a leading SDN controller open source project and a modular open platform for customizing and automating networks.
- A full-blown NFV Orchestrator (NFVO) layer was not used. Instead, Red Hat Ansible® Automation was utilized for onboarding VNFs.

Virtual Network Functions (VNFs)

- Open source vRAN software was used from the OpenAirInterface (OAI) project.
- The demo included vEPC software provided by Quortus.
- Additional VNFs such as Session Director (SD) and Gi-LAN were based on F5, the open source Vyatta router and FreePBX amongst other technologies.

Service Assurance & Other Software

- The service assurance software from NetScout identifies systemic end-to-end problems before they impact service.
- VCO 2.0 also includes probes from EXFO that can be used for active monitoring.
- Additionally, a software defined radio (SDR) from Ettus Research was used in the demo.

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DEMO **RESULTS**

The above components were used to create a network service that successfully showed end-to-end mobile services. The demo also included a virtualized core to show two end-to-end capabilities.

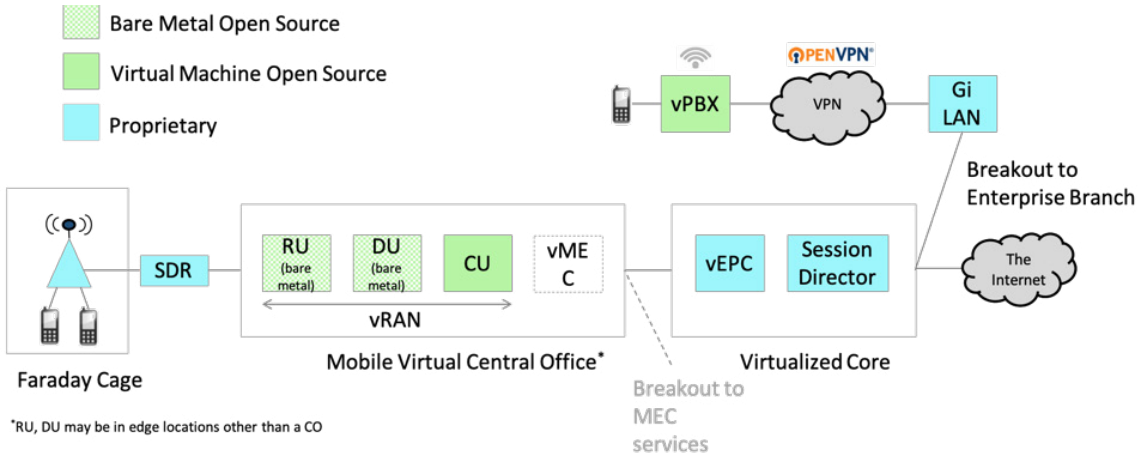

Figure 3: VCO 2.0 Demo

Specifically, the two parts of the demo were:

1. The first part showed an Android phone connecting to the internet via SDR, vRAN, and vEPC. The phone was able to access data services such as Twitter and music sites.

2. The second part showed another Android phone connecting to a branch office via SDR, vRAN, EPC, GiLAN, VPN, vPBX and finally through WiFi to successfully make a SIP call.

The VCO and virtualized packet core were hosted in Cumulus' lab in California, while the branch office software was shown on-stage in Amsterdam. Once the connectivity was demonstrated, the demo exhibited service assurance capabilities where a number of KPIs such as call details, faults, performance,

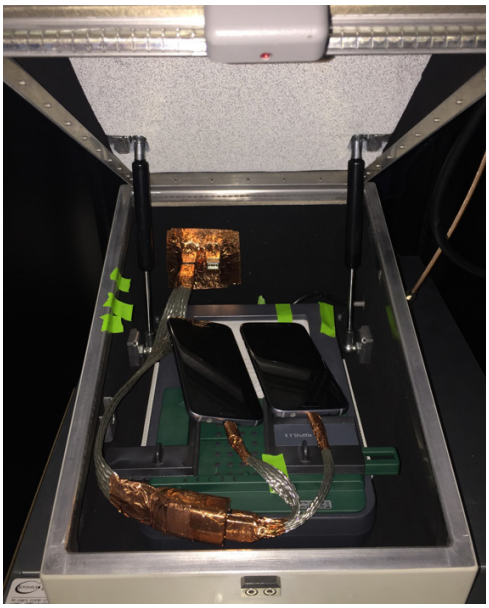

Figure 4: Faraday Cage with 2 Android Phones and Radio

and latency were displayed. This capability can be used to solve complex fault and performance management problems.

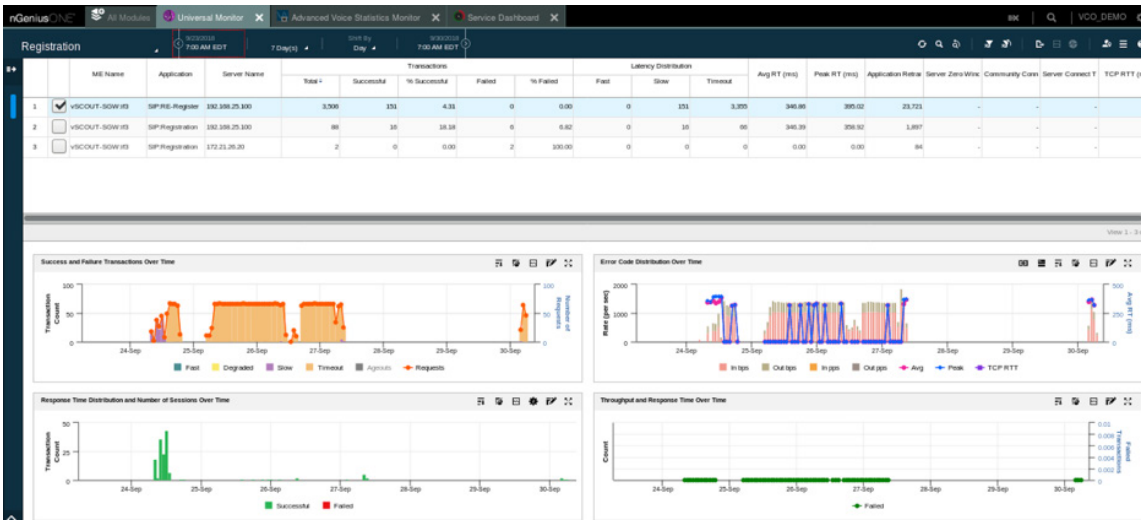

Figure 5: Service Assurance Metrics and KPI Display

The demo is general in nature and can be adapted to specific service provider needs. For example, virtual edge computing services could be inserted. Figure 3 shows where these services might be inserted in the future.

A notable aspect of the demo was that the RU and DU software stacks were running on bare metal servers managed by OpenStack. This shows how a heterogeneous mix of computing types can be used together — bare metal and VMs in this case. In the future, a mix of containerized network functions could be shown as well. Second, the branch hardware was hyperconverged OCP infrastructure, achieving maximum resource efficiency in a constrained environment.

Once the infrastructure was set up and the OAI software was available, it took the community a matter of weeks to complete the demo. This is remarkable given that this specific OAI software for the split of RU, DU, and CU was tried out for the first time. Additionally, OpenStack was upgraded from Red Hat OpenStack Platform 10 to Red Hat OpenStack Platform 13 just a couple weeks before finalizing the demo. This shows the agility of working in an open source community, where experts from a wide variety of skill sets are available from across teams, and also shows how open source is supplementing standards as a way to ensure interoperability and eliminate vendor lock-in.

The concept of VCO certainly doesn't stop with this demo. Future enhancements being explored include the move to containerized network functions, use of hardware acceleration, additional 5G capabilities such as network slicing, and edge applications.

SUMMARY

CSPs are looking to modernize their central offices, apply NFV and SDN principles, gain agility in terms of creating and deploying services and cut both OPEX and CAPEX. The VCO 1.0 and 2.0 demos and associated reference architectures achieve this through delivering services as close as possible to the customer by leveraging computing capabilities at the edge. These demos establish the feasibility of the VCO concept for the residential, enterprise, and mobile use cases through open community collaboration across the networking stack. Network providers working to transform their networks with programmable, software-defined infrastructure, and use of open source will find redesigned COs an area of competitive advantage.

COMMUNITY PARTICIPATION

The VCO 2.0 demo was made possible by active community participation by the following organizations and open source communities:

RESOURCES

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

VCO 1.0 Solution Brief: opnfv.org/wp-content/uploads/sites/12/2017/10/OPNFV_VCO_SolutionsBrief_Oct17.pdf

VCO Mailing List: opnfv-vco@lists.opnfv.org

Links to VCO presentations and videos: opnfv.org/resources/virtual-central-office