SDN/NFV Whitepaper

Central Office Re-architected as Datacenter
Proof-of-concept demonstration at Open Networking Summit, June 2015

A Whitepaper by

In collaboration with:

Introduction

Many carriers in both the telecom and cable fields are espousing next generation architectures that borrow heavily from web scale data centers and cloud providers. With this they use SDN and NFV to transform their carrier functions into workloads that are hosted on this common infrastructure. We've coined the phrase *Central Office Re-architected as a Datacenter* (CORD) to refer to this approach of providing infrastructure as a service and networking services as tenant applications for that infrastructure. This paper focuses on applications that can support broadband access by virtualizing Optical Line Termination equipment (vOLT) as well as CPE (vCPE) and Broadband Network Gateway (vBNG). A companion paper focuses on managing the fabric underlying CORD.

Central Office Re-architected as Datacenter (CORD)

CORD re-architects the Telco Central Office as Datacenter to bring in cloud-style economies of scale and agility. It takes today's proprietary boxes, determines how their functions can be aggregated or disaggregated, and instantiates them on commodity infrastructure.
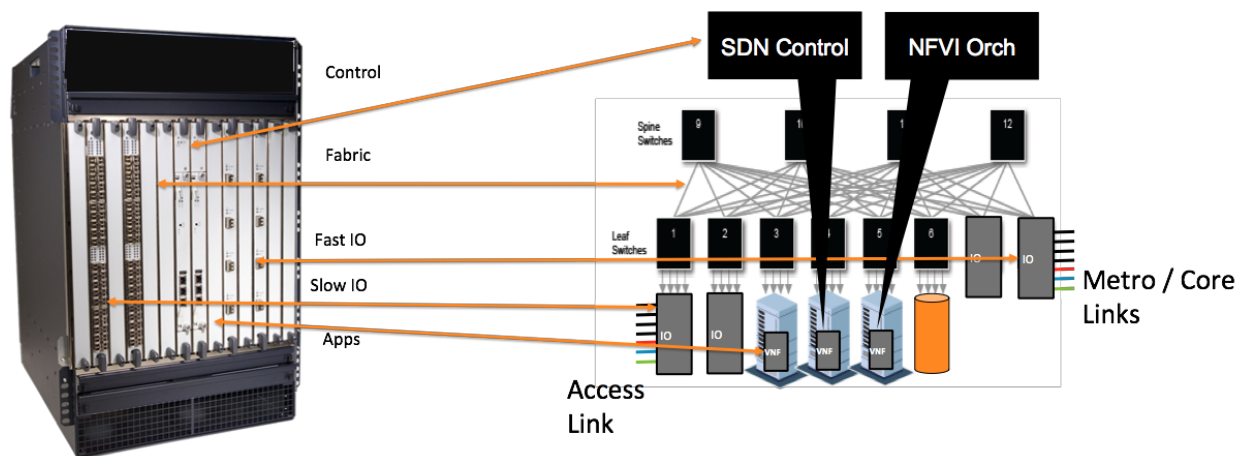

Figure 1. Mapping then to now

In addition to virtualized network functions such as firewall, parental control, and caching, the CORD demo also includes virtualization of three legacy network devices common to today's access network -- Optical Line Termination (OLT), Customer Premises Equipment (CPE), and Broadband Network Gateway (BNG) -- all refactored as software running on (and controlling) commodity servers, white-box switches and merchant silicon I/O blades. The resulting software is then organized as an interconnected set of elastic and scalable services, all managed by open source software -- specifically ONOS, OpenStack, and XOS[1] -- to unify SDN, NFV, and the Cloud under a common, intuitive, carrier-grade framework.

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[1] XOS is an extensible cloud operating system that supports services and service composition as a layer on top of OpenStack.
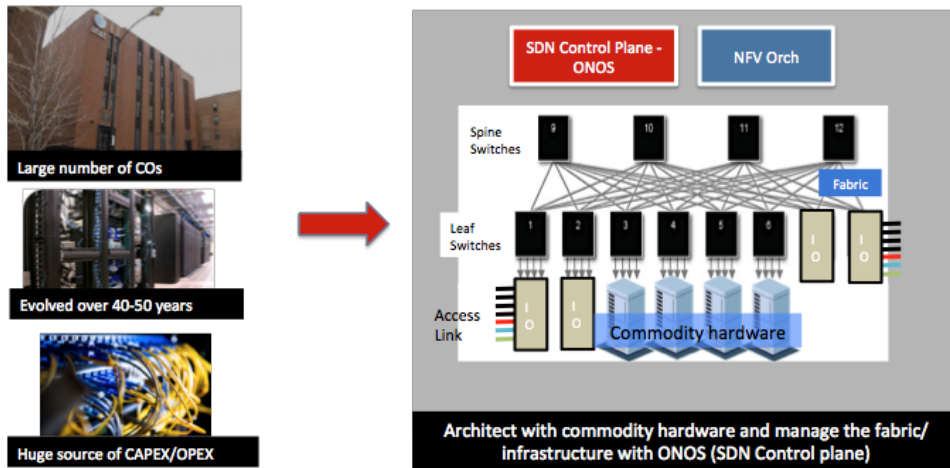

Figure 2. Central Office Re-architected as Datacenter

Figure 2. above shows the traditional Central Office which houses 300+ appliances, each requiring a physical install and specialized management, re-architected using common, commodity software and hardware building blocks to create a common underlying infrastructure to host a diversity of services and solutions.

AT&T, ON.Lab and ONOS project, in collaboration with PMC Sierra (for GPON) and Sckipio (for G.Fast), will demonstrate a CORD proof-of-concept at Open Networking Summit in June 2015. This whitepaper describes the details of the CORD demo at ONS.

CORD Demo at ONS

A CORD proof-of-concept demo is being provided by AT&T, ON.Lab and the ONOS Project. It's slated for June 15-18, 2015 at the Open Networking Summit, focuses on GPON (in collaboration with PMC Sierra), G.fast (in collaboration with Sckipio) and other access technologies.

The CORD demo is a proof of concept that showcases the following:
- a central office architected using commodity hardware
- an open, high-performance spine-leaf fabric controlled by ONOS
- virtualized customer premises equipment (CPE) where the existing complex CPE is replaced by a simple switch and many functions are hosted in the Central Office
- virtualized OLT which is comprised of standalone PON OLT MAC hardware with all other existing OLT functions moved into software
- an Openflow-enabled G.fast distribution point unit
- virtualized functions in the Central Office - firewall, URL filtering, parental control
- virtualized BNG (note- only a subset of BNG functions, specifically those related to Internet connectivity, are virtualized in this proof-of-concept)

● orchestration/management of the virtualized functions and infrastructure in the proof-of-concept Central Office with a SDN/NFV control plane comprised of ONOS, Openstack and XOS.

CORD Demo Building Blocks

Commodity Hardware

The hardware for the CORD demo consists of commodity servers and switches. An open ONOS-controlled leaf-spine fabric interconnects all components as shown below:
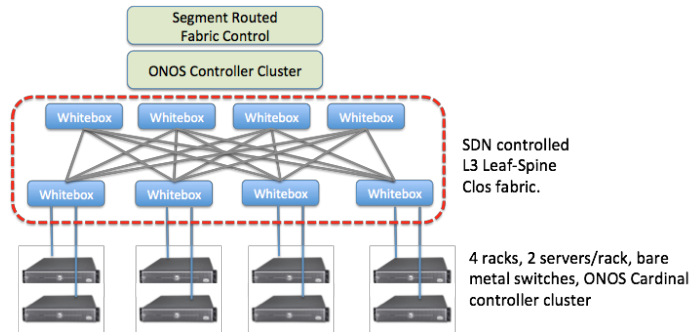

Figure 3. CORD Fabric

GPON OLT IO

An OLT terminates the GPON optical access link in the Central Office, with each physical termination point aggregating a set of subscriber connections. Given the number and cost of OLT devices in a Central Office, virtualizing the OLT has the potential to yield significant CAPEX and OPEX savings. All components of the traditional OLT, except the MAC, can be virtualized and moved to common NFV infrastructure. However NFVI does not typically include GPON physical ports, and so there is a need to develop an IO Blade to provide the GPON OLT MAC.
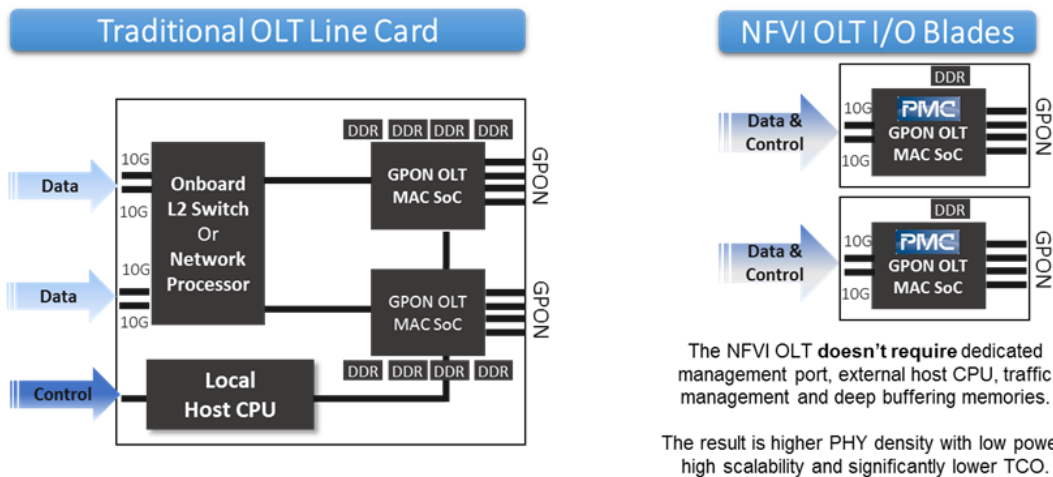

Figure 4. GPON OLT IO

The CORD demo highlights such a GPON OLT IO developed by PMC Sierra where the PON OLT MAC is disaggregated from the legacy OLT Line Card into a standalone module. The remaining functions of the traditional OLT are then virtualized and instantiated in software in this demo.

Software Building Blocks

CORD uses three open source software platforms as the control plane- ONOS, Openstack, XOS.
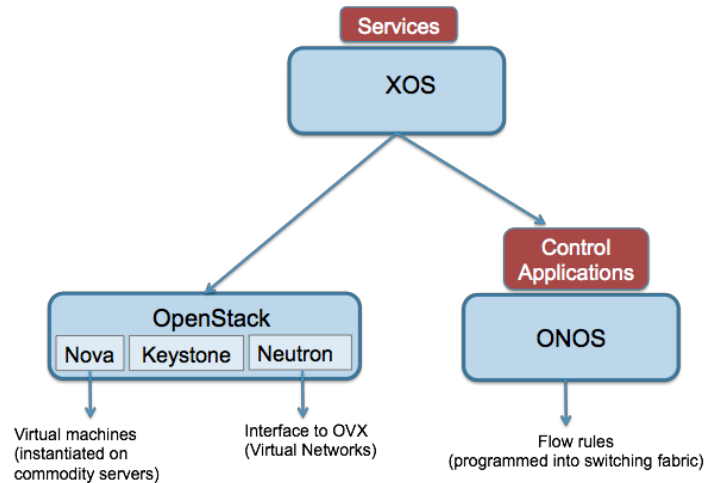

Figure 5. CORD Control Plane - ONOS, Openstack, XOS

- **ONOS** is the SDN network operating system (control plane) that manages the underlying white-box switching fabric. It also hosts a collection of control applications that implement many control plane features and functions previously found within typical OLTs, CPE, and BNGs.

- **OpenStack** provides the core IaaS capability, and is responsible for creating and provisioning virtual machines (VMs) and virtual networks (VNs).

- **XOS** is the overarching service orchestration layer that unifies infrastructure services (provided by OpenStack), control plane services (provided by ONOS), and any data plane or cloud services (running in OpenStack-provided virtual machines).

CORD demo set-up

The CORD demo puts together all the above software and hardware building blocks as shown below:
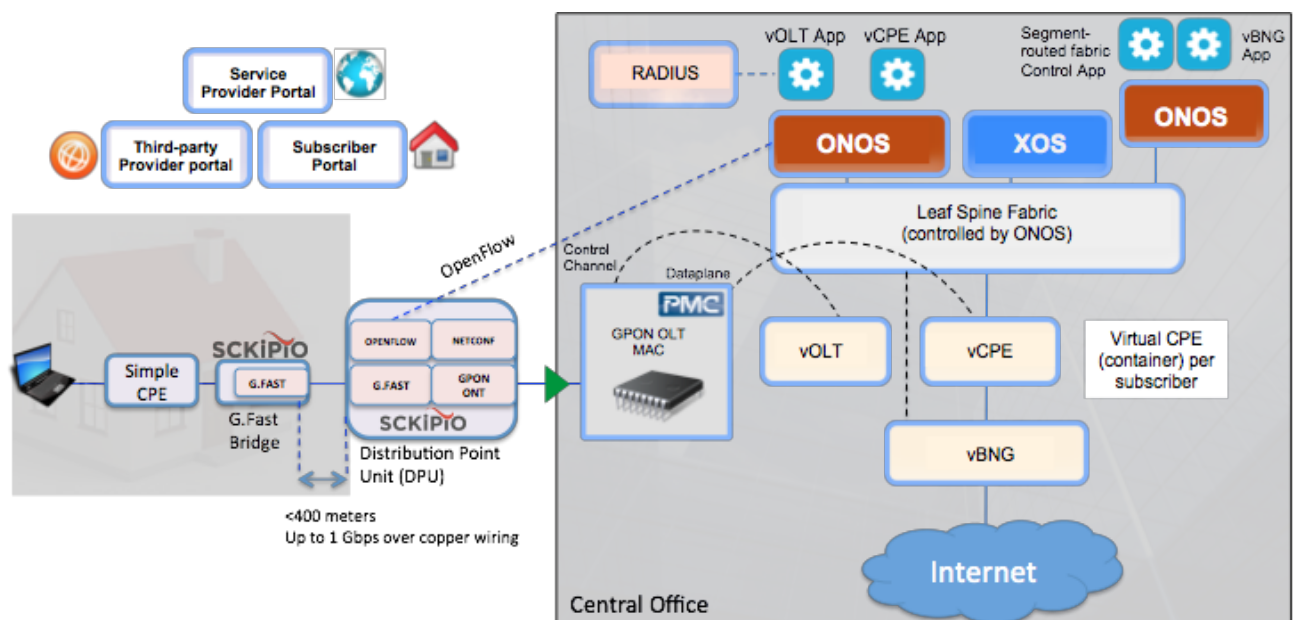
Figure 6. CORD Demo Set-up

The above set-up shows two ONOS clusters- one of the clusters controls the Leaf-Spine Fabric and the other cluster supports the control applications and provides related dataplane programming capabilities. These are split because one runs on behalf of the infrastructure provider, and the other on behalf of the tenant - where the fabric is common and directed by the IaaS layer, and the Broadband Access application(s) are a tenant of this NFVI.

The demo at ONS 2015 constructs the CORD Fabric with Dell switches. See the separate white paper on CORD Fabric for more details.

CORD Demo Highlights

CORD demo at ONS highlights the architecture and benefits of the Central Office Rearchitected as Datacenter from the Service Provider, Subscriber and Third-party provider perspectives.

Service Provider
The demo highlights the following features for the Service Provider:
- Service Provider portal for intuitive provisioning, management, monitoring
- Access-as-service
- Subscriber-as-a-service
- Internet-as-a-service
- Caching/Content delivery-as-a-service
- PON OLT MAC hardware enabling virtualization of the traditional OLT
- Virtualized functions including Firewall, URL Filtering, Parental Control, BNG
- An open high-performance leaf-spine fabric
- SDN Control, orchestration and management with ONOS, Openstack and XOS

Subscriber

The demo highlights the following features for the subscriber:

- Subscriber portal for signing up for and configuring services, managing account/services
- A simple CPE that replaces existing complex CPEs and can be managed from a portal hosted in the CO.
- Subscriber Services: Internet, Firewall, Parental Control

Third-Party Provider

The demo highlights the following features for the third-party provider:

- Third-party provider portal for signing up for and configuring services, managing account/services
- Third-party provider services: Content delivery (Caching) for its own content in the Service Provider network

CORD demo in action

Come by ONS SDN solutions showcase to see the CORD demo live at Open Networking Summit from June 15th-18th, 2015. Additional details [here](#).