R-CORD GPON Aggregation Switch

1. Introduction

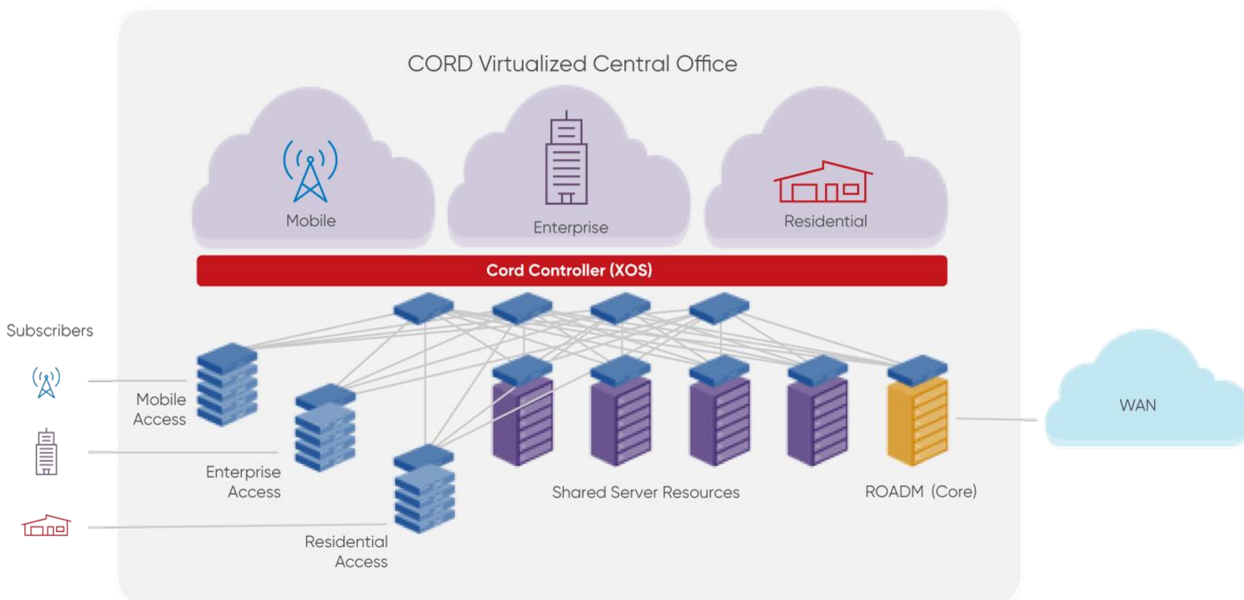
This document describes the project undertaken by PalC Networks for building GPON Aggregation switch in a CORD deployment.

1.1 CORD Introduction

The CORD (Central Office Re-architected as a Datacenter) platform leverages SDN, NFV and Cloud technologies to build agile datacenters for the network edge. Integrating multiple open source projects, CORD delivers a cloud-native, open, programmable, agile platform for network operators to create innovative services.

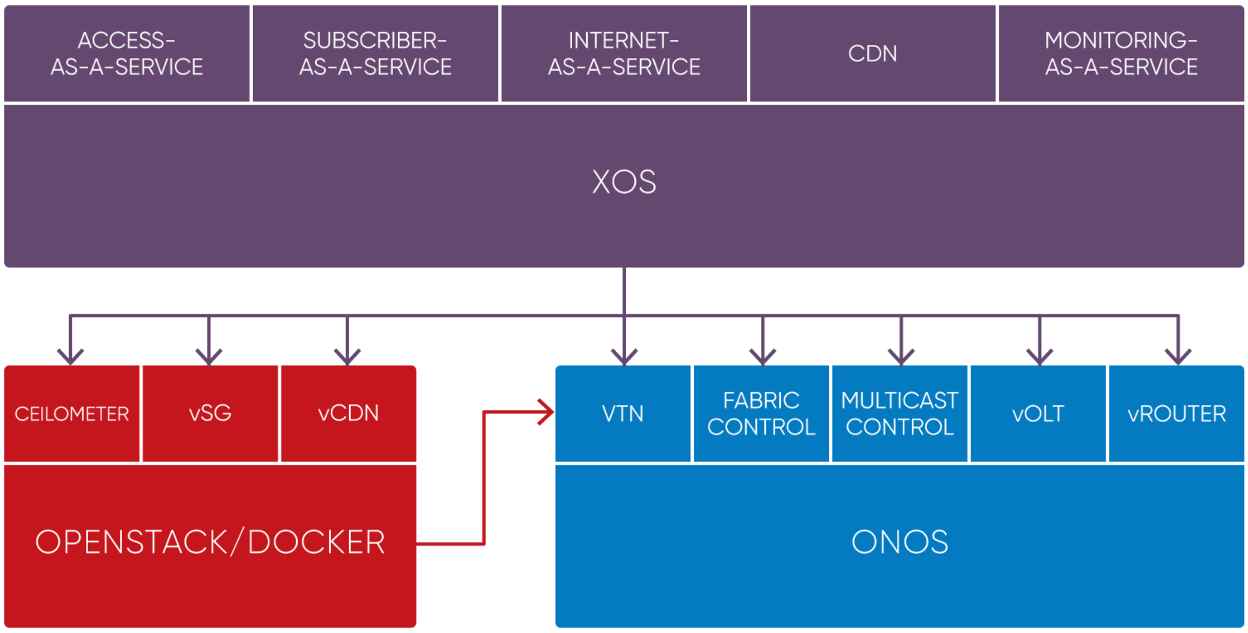
CORD provides a complete integrated platform, integrating everything needed to create a complete operational edge datacenter with built-in service capabilities, all built on commodity hardware using the latest in cloud-native design principles.

The below diagram represent the hardware architecture of the CORD.



- Commodity Servers Interconnected by a Fabric of White-box Switches
- Switching Fabric in a Spine-Leaf Topology for Optimized East-to-West Traffic
- Specialized access hardware for connecting subscribers (residential, mobile and/or enterprise)

The below diagram represents the software architecture of the CORD deployment



Built with commodity hardware, the CORD platform leverages dozens of upstream open source projects including

OpenStack - Provides IaaS capability for creating and provisioning virtual machines (VMs) and virtual networks

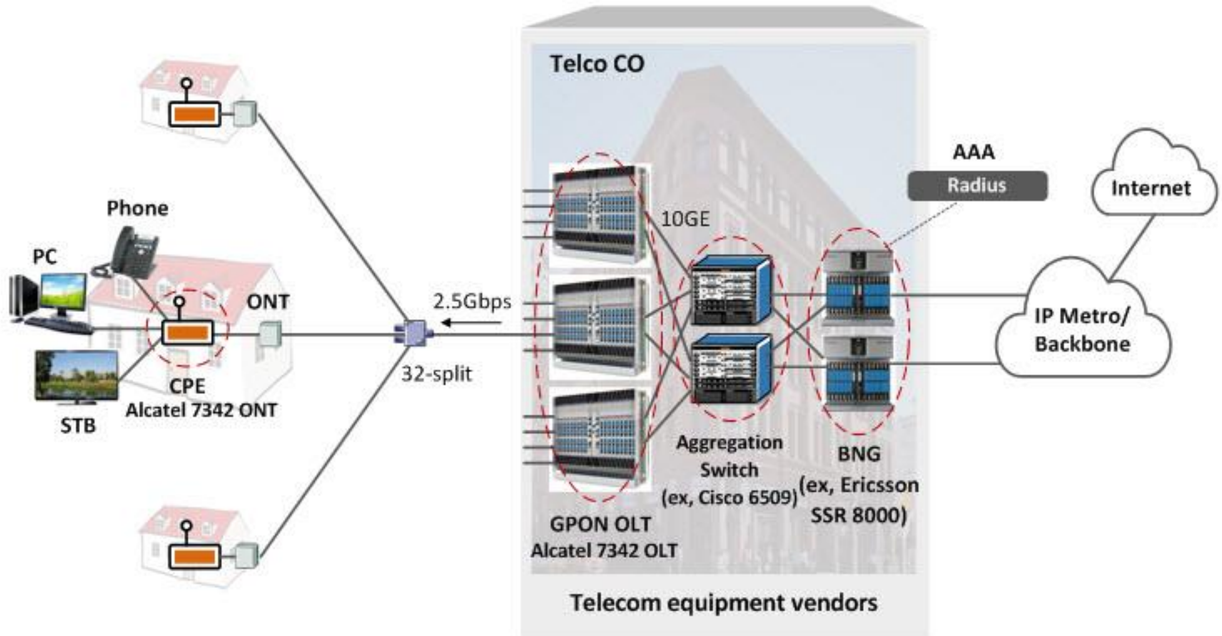
Docker - Provides a container-based means to instantiate service elements

ONOS - Network operating system that controls the underlying whitebox switching fabric and overlay networks, enabling delivery of end-user service from the fabric where possible (minimizing the need for all services to be hosted as VNFs on more expensive servers)

XOS - Framework for assembling and composing services

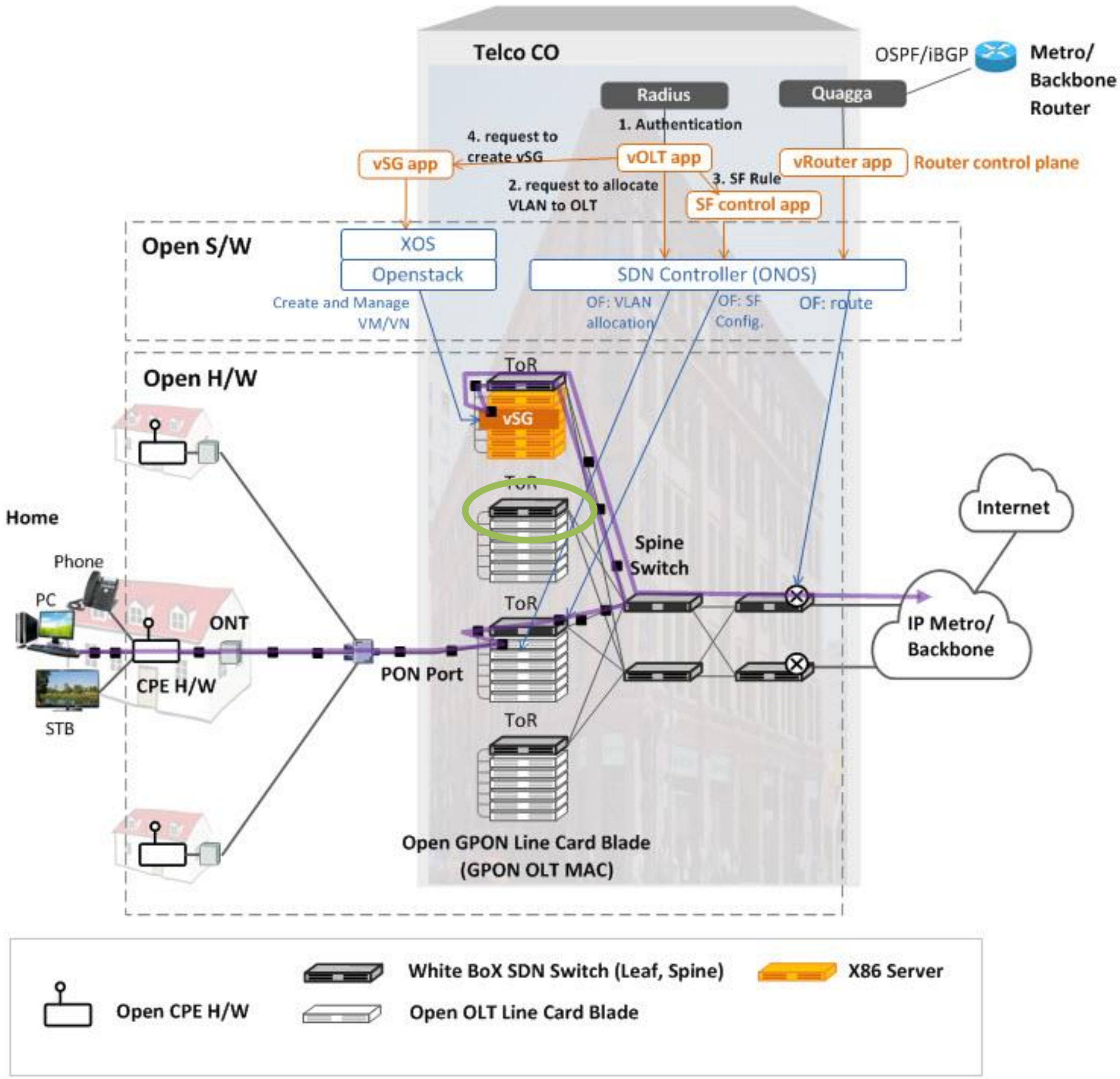
1.2 Residential CORD Introduction

The below diagram represents non CORD deployment of Telco's central office.



The prime focus of R-CORD is to dis-aggregate the various services running in the specialised hardware to a virtualised appliances running in the server. Residential CORD (R-CORD) includes services that leverage wireline access technologies like GPON, G.Fast, 10GPON, and DOCSIS. R-CORD includes a virtual OLT (vOLT), virtual Subscriber Gateway (vSG) and leverages a core networking service - virtual Router (vRouter); the former is implemented by a container that is bound to each subscriber and the latter is an ONOS control application.

The below diagram shows the R-CORD deployment with various services deployed in X86 server which are being orchestrated by ONOS controller. The OLT blades are connected to a WhiteBox Aggregation switch (mentioned in the green circle) which terminates the subscriber and provides the services mentioned in the TR.101 Broadband Spec.



1.3 Requirement

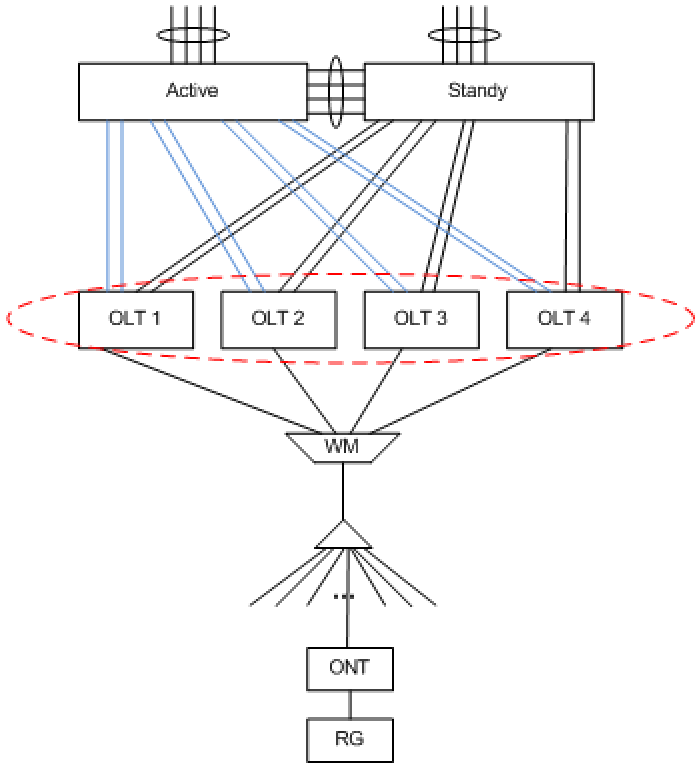
The requirement is to develop most of the features mentioned in TR.101 Spec from the aggregation switch side on top of one of the commercial whitebox NOS vendor. Refer to the section 5 for more information about the list of features developed as part of this project.

2. NOS Platform Architecture

The below diagram represents the high-level overview of the NOS architecture.

3. Network Architecture

This section talks about the deployment models and network architectures.



The above diagram describes the network architecture of the GPON network to provide data, voice and video services for subscribers. The aggregation switches which is shown as Active and Standby or Active and Active based on user configuration in the above diagram provides Layer2 termination based on subscriber and service VLAN. After terminating the Layer2, it provides routing service. These devices run MC-LAG in between them to provide active-standby or active-active redundancy paths for group of OLT devices. The OLT devices are connected to ToR device via LAG interface which is operating in active-standby or active-active mode. This is to provide redundancy in layer2 level to avoid any packet loss when the active node goes away. In L3 side, VRRP will be running across these two aggregation nodes (towards the south-bound interface) which brings redundancy in L3 level.

4. Supported Features

Below is the list of features, which we had supported for the GPON network deployment.

4.1 MC-LAG
4.2 Subscriber Interface
4.3 Guest VM
4.4 NAT for Private Backplane VLAN
4.5 TACACS+
4.6 Traffic Management

5. Approach

We understood the customer requirement and discuss with the customer about the list of features to be developed for the use case. Once the use case was understood we have the developed the following items.

1. MC-LAG with active standby and active-active support and it should support Switchover with minimal link Switchover with minimal bandwidth with Basic ACL.
2. Syncing ARP and MAC entries across MC-LAG nodes
3. BGP ECMP with route advertised from i-BGP an e-BGP neighbors

4. VRRP on named VRF
5. Tracking of upstream link state to degrade VRRP priority and BGP state to degrade VRRP priority
6. MC-LAG support was provided with DHCP Relay and Port Mirroring
7. Creating a logical L3 interface (SVI interface) based on two VLAN tags or a single tag
8. Support for unnumbered interface with host routes
9. Making double tagged logical SVI interface to be part of VRF
10. proxy-arp on subscriber interfaces.
11. Ability to create static ARP entry on a subscriber interface.
12. The guest VM or vBNG must be able to transmit and receive packets with an aggregate rate of 6000 packets per second
13. The host environment must be able to allow the vBNG virtual machine to share any of the L3 interfaces that are set up with an IP address
14. The host environment should source NAT packets from the virtual machine
15. The user must be able to configure TCP and UDP port forwarding for incoming traffic to server applications running in the vBNG
16. The host environment (ie. OcNOS) must provide a mechanism to protect the vBNG virtual machine fromDDoS attacks.
17. The host OS supports multiple addresses on an IP interface, therefore it must be possible to specify a preference for the address to use when performing source NAT (or however a shared IP is accomplished) on packets originating from the guest virtual machine
18. The user must be able to create a virtual machine by specifying an existing hard drive image file
19. The user must be able to specify up to 2 virtual hard drive images files, the amount of RAM allocated to the guest VM, the number of virtual CPUs allocated to the guest VM, which host cores the VM is allowed to run upon, the type of OS running in the virtual machine, the OS variant running in the virtual machine.
20. The user must be able to give the virtual machine a unique name, start and stop a VM, able to get status of a VM, able to change an existing VM parameters.
21. The SWITCH should fully support TACACS+ for AAA (Authentication, Authorization and Accounting).
22. QoS support for the subscriber interface.

6. GLOSSARY

Acronyms	Abbreviations
SOW	Statement of Work
OS	Operating System
NPU	Network Processing Unit
SoC	System on Chip
SDK	Software development kit
CPU	Central Processing Unit
PDB	Project Data base
GPON	Gigabit Passive Optical Networks
VRRP	Virtual Router Redundancy Protocol
MC-LAG	Multi-Chassis Link Aggregation Group

Acronyms	Abbreviations
LAG	Link Aggregation Group
LACP	Link Aggregation Control Protocol
BGP	Border Gateway Protocol
DHCP	Dynamic Host Configuration Protocol
VLAN	Virtual Local Area Network
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
NAT	Network address translation
TACACS	Terminal Access Controller Access Control System
QoS	Quality of Service
WRED	Weighted random early detection
WDRR	Weighted Deficit Round Robin