Demonstration of Real Time VNF Implementation of OLT with Virtual DBA for Sliceable Multi-Tenant PONs

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Abstract: We demonstrate the VNF implementation of a sliceable PON architecture enabling true multi-tenancy, giving Virtual Network Operators full control over capacity scheduling. We analyze resource sharing efficiency and latency performance for different NFV co-location scenarios.

OCIS codes: (060.4250) Networks, (060.4256) Networks, network optimization

1. Overview

The ability of optical access networks to support multiple heterogeneous services while being shared across multiple virtual operators is crucial to the economic viability of upcoming 5th generation networks. In this demonstration, we present a real time implementation of a sliceable PON to enable multi-tenancy, based on the principle of virtual DBA (vDBA) initially introduced in [1]. We demonstrate the feasibility of virtualising the DBA function, moving it from its typical hardware placement to a Virtual Network Function (VNF) software implementation. Our methodology analyzes the real-time latency, jitter, and throughput of each Virtual Network Operator (VNO) for each T-CONT in different traffic loading scenarios, demonstrating the slice isolation performance offered by our solution. We also analyze the effect of communication overhead between the different virtualized PON components on the overall performance, reproducing scenarios where the software and hardware PON components might be either co-located or else reside in different locations.

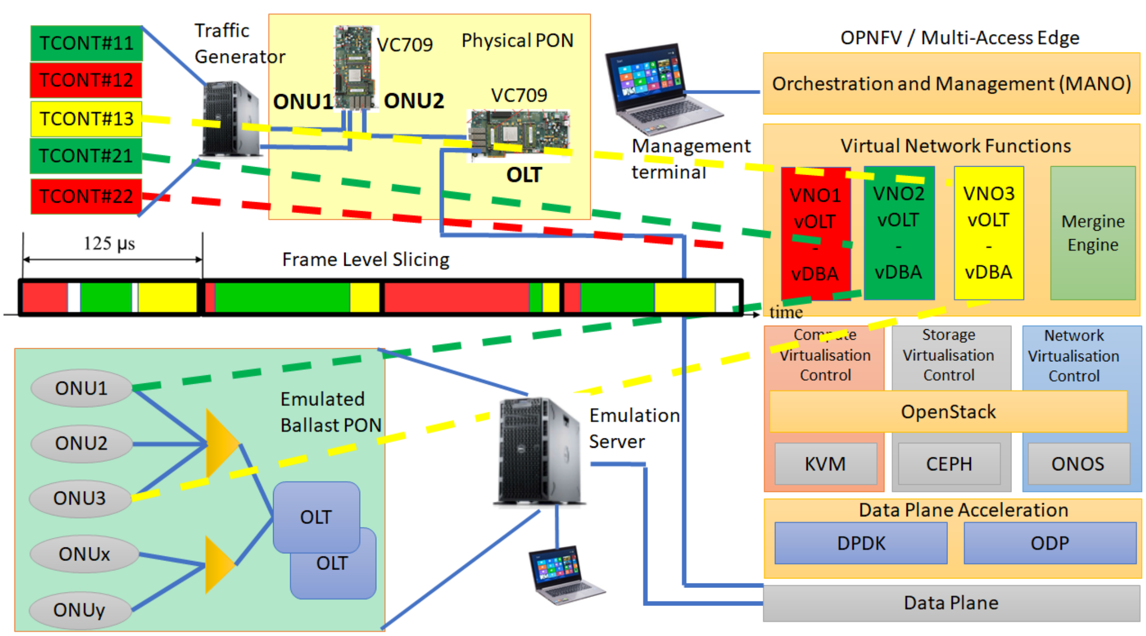

Fig. 1: Demonstration of Real Time Virtualized True Multi-Tenant PON

Our demonstrator (see figure 1), implements a shared PON scenario with 3 VNOs, 24 ONUs (both hardware and software), each with 3 T-CONTs. The main components making up the testbed are: a physical PON, a set of emulated ONUs, a traffic generator and a multi-access edge computing node. The physical PON is based on one OLT and two ONUs (with the ONUs multiplexed into the same physical board), implemented on Xilinx FPGA development boards VC709 [2] and offer 10Gb/s symmetric capacity. The emulated ONUs, running in software, are used to increase the number of users, and generate typical self-similar traffic. The traffic generator generates real-time sensitive and best effort traffic flows (such as file transfer and video streaming) through the physical PON. Traffic flows are VLAN-tagged which are then mapped to specific TCONT's at the ONUs. The Multi-access Edge Computing (MEC) node runs the NFV implementation of the PON, running the virtual DBA and the merging engine (i.e., the element that blends together all virtual bandwidth maps from the different VNOs generating one physical bandwidth Map allocation) and the SDN control plane. The MEC node is logically composed of the Virtual Network Functions, an Openstack virtualization platform, a Data Plane Acceleration toolset and an Orchestration and Management (MANO) layer. We have implemented the Merging Engine (ME) and the vDBA functions for 3 Virtual Network Operators (VNOs), as Virtual Network Functions within the OPNFV architecture. OPNFV, which is consistent with the OpenCORD standard use cases [3], and has a strong regime of continuous integration/deployment (CI/CD) and testing. Openstack is responsible for allocating the virtual Compute, Storage and Network resources through Kernel-based Virtual Machine (KVM), CEPH (a software storage platform) and the SDN ONOS controller. MANO is used for Orchestration and Management of the OPNFV environment, and life-cycle management of constituent vDBA and merging engine VNFs. Due to the real-time critical nature of receiving and transmitting status report messages from the ONUs (called DBRUs) and Bandwidth Map data, we make use of the Data Plane Development Kit (DPDK) toolkit to optimize the packet transfer through the physical host to and from the Virtual Network Functions.

2. Novelty

Traditionally, access network sharing is implemented at the higher layers of the telecommunication stack, typically at the network management level, giving VNOs loose control over the quality of service provided to their customers. Our proposal, which is built upon most recent guidelines of the Fixed Access Network Sharing [4] and Cloud Central Office [5] frameworks, **extends them with our novel concept of virtual DBA [1]**. vDBA gives VNOs in-depth control, at the individual physical frame level, of the upstream capacity allocation in PONs, allowing the enforcement of strict QoS parameters.

To the best of our knowledge, our demo is the first to implement the virtualization of the PON scheduling mechanism in the OLT (see figure 1). Our vDBA implementation gives each VNO full control over capacity assignment algorithms, which is crucial to guarantee the quality of service level required by future 5G services.

3. OFC Relevance

This demonstration is highly relevant to the OFC SDN & NFV event as it shows for the first time an SDN/NFV implementation of a **fully sliceable PON**. This topic is very timely and highly relevant to industry, which is currently standardising the framework for Fixed Access Network Sharing (FANS) [4] and cloud Central Office (cloud-CO) [5], following on from the OpenCORD architecture. The demonstration we propose is of high relevance to stakeholders (vendors, operators and service providers) interested in developing the next generation of access network infrastructure in support of 5G.

Acknowledgements

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