

## **TITLE: Business Cases for Virtual Customer Premises Equipment (vCPE) for end users**

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### **Keywords**

FTTH, Customer Premises Equipment (CPE), End User Gateway (EUGW), Virtual Software Execution Environment (VSEE), IaaS, OpenNaaS, Operational Expenditure, Capital Expenditure.

### **Extended Abstract**

Nowadays, the subscription of a new service is usually associated to the deployment of new devices within the customer premises. Such is the case of the ordinary deployment of a End User Gateway for Internet access, but it continues increasing with the installation of set top boxes for IPTV or an ONT for fiber-to-the-home (FTTH) deployments.

This practice leads to high deployment costs for service provider's business models, and it also implies increasing operational expenses in service maintenance, as newer and more advanced services require more complex devices prone either to failures, or to incidents related to firmware upgrade, lack of memory, etc.

In order to simplify customer infrastructure, service providers are looking for different solutions that could shrink capital and operational expenditures, preserving the capability for deploying current services, and even open the door to new services and opportunities.

Virtual CPE and layer-2 access network concept suppress the barrier of the EUGW aiming at a single device deployment for fiber Internet access that would decrease capital expenditure. In addition they would allow service providers to enhance the visibility over the customer LAN easing the deployment of remote management platforms, which would translate into fewer troubleshooting visits to the customer home for installation and maintenance purposes, resulting in a significant reduction of operational expenditure.

Virtual CPE solution relies on router partitioning to cover the service demand for high-bandwidth subscriptions (whether individual or institutional) As this technology is in an early stage of deployment, this solution supposes also an opportunity for a redefinition of the access network and the way services are deployed and delivered to the end user.

Shifting EUGW layer 3 functionalities to the edge node of the access network not only enhances CapEx and OpEx for fiber deployments but also enables reaching the end-user environment with layer 2 protocols. This new layer 2 visibility of the access network allows the operator to introduce new services without installing additional hardware at the customer site but installing special purpose hardware and software at their premises.

The possibility of installing this special-purpose hardware and software at the operator premises makes it work as if it were inside the end-user site. In fact, this is the main driver for the development of a Virtual Software Execution Environment (VSEE); a platform where each subscriber owns a virtual instance capable of executing end-user software applications.

With these virtualization techniques the operator will be able to partition the VSEE and allocate virtual instances to customer premises with different performance specifications (CPU processing and RAM capabilities), tailoring the network provider resources to the subscriber needs. Thus, the offer of high demanding services is not anymore constrained by the hardware and software capacities of the customer equipment but to network provider's IT and network infrastructure.

This new VSEE at disposal to the user will host all software applications covering not only operator's residential service portfolio (i.e. those campus network offer to campus residences) but also third party services. By combining the enrichment of the overall commercial offer and the provision of IaaS to third parties, operators can open new business opportunities with the same base infrastructure.

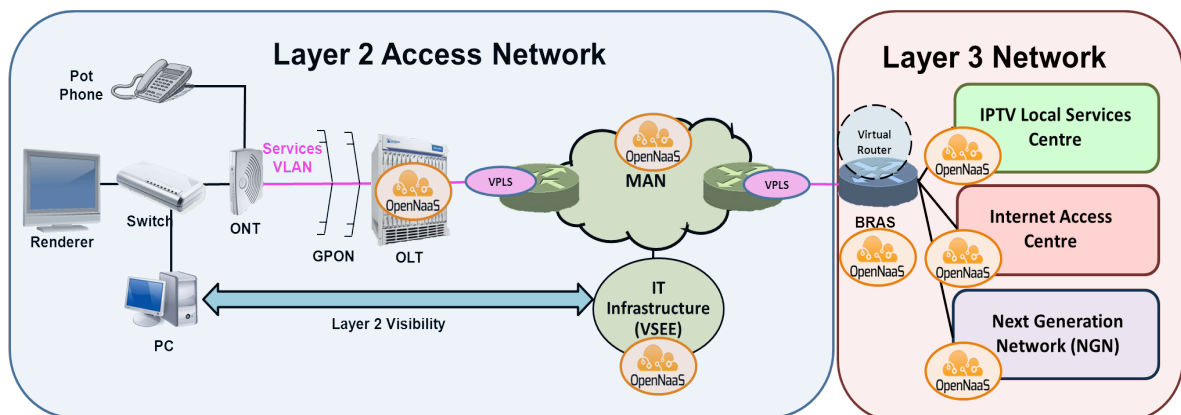
The VSEE solution adoption also facilitates the operator to have a better understanding on the services running within the home LAN leading to a better service management: incremental updates of the VSEE environment, a smoother transition to IPv6, and the application of QoS techniques for service coexistence are a few examples. Yet it also represents a challenge when managing thousands of instances.

Although vendors currently behold virtualization solutions within their product portfolio, these solutions have traditionally been concerned with packet forwarding and switching, being the software execution capabilities outside of their roadmap. Little by little manufacturers are including new software capabilities in their network products and SDKs, relying in a virtualized pool of resources that enable service providers to customize their nodes running applications such as load balancing and security services.

However, a further step must be taken because delivering a complete virtual CPE to residential customers is not already addressed by manufacturers. Execution capabilities have a very different nature with regard to the routing packet processing capabilities, requiring much more computational resources and management procedures. Hence, the addition of enough computational resources to carrier-grade network products to provide software based services to thousands of users is still a challenge while outsourcing this functionality to external blades or datacenters seems to be nowadays a feasible alternative.

The vCPE solution is a disruptive business model that aims to simplify the access to services and facilitate the roll out of new ones. Hence, in order to maximize its potential, it has to be accompanied by a reinterpretation of service delivery, and its provision and activation system.

OpenNaaS plays an important role on the redefinition of current service activation systems as it offers the opportunity to deploy a common provisioning engine for all services merging the operation of all independent provision and configuration systems into a single instance.



**Figure 1: OpenNaaS Applicability in vCPE Architecture**

In conclusion, the vCPE use case aims to propose a different paradigm for the integration of core-metro and access networks while enhancing the service offering at a lower cost. This new paradigm aims to leverage on: resource efficiency taking advantage of the rise of virtualization solutions that manufacturers provide in their network nodes, value added services (VAS) currently provided by the EUGW that can be clearly enhanced thanks to the layer 2 visibility and the set-up of a VSEE in operator premises, and end user environment simplification aiming to remove all dispensable devices from their premises shifting the software execution to the access network without lacking any functionality or service.

### Biographies

Diego R. López is responsible for technology exploration in network infrastructures within Telefónica I+D, and formerly in charge of middleware services in RedIRIS. He is currently working on matters related to SDN, virtualisation, network intelligence, and network APIs.

Borja Iribarne joined Telefónica I+D in 2009 devoted to the digital home initiative. He is currently working for the network intelligence initiative on matters mainly related to virtualisation and QoS.