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Virtualizing Managed Business Services for SoHo/SME Leveraging SDN/NFV and vCPE

A Technical Paper prepared for SCTE/ISBE by

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Introduction

The cloud managed services market has been flourishing in recent years due to the advancements in cloud computing, virtualization and mobility services. This market will grow from $35.54B in 2016 to $76.73B by 2021, at an estimated CAGR of 16.6% from 2016 to 2021. Managed services allow businesses to outsource most aspects of their IT infrastructure to a service provider. This can reduce the recurring in-house IT costs by 30-40% and bring about 50-60% increase in efficiency.

While many of the managed service offerings have been focused on medium to large enterprises, there is a major opportunity for Multiple Systems Operator's (MSO) to offer a solution for the SoHo/SME market. The MSO can offer compelling services to this segment, like a custom guest Wi-Fi splash page, social network sign on, promotions management, customer analytics, multi-site VPN, and more.

This document covers a virtual CPE (vCPE) architecture that provides enterprise-class, cloud based value added services for the SoHo/SME market. Using technologies common in data center networking such as virtualization, SDN and overlay tunneling this real-world MSO deployment was able to leverage their existing business infrastructure and premise equipment on top of their DOCSIS network. This Virtual Service Edge (VSE) solution greatly amplifies the types of business service offerings for the operator. The platform is designed to be owned, controlled and maintained by the service providers, while reducing their time to roll out and manage these new enhanced service offerings. This architecture seamlessly integrates into a service provider's OSS, BSS, customer care processes and other back end systems and the offering can be combined with other existing services like residential homespot and outdoor Wi-Fi.

Managed Business Services

Figure 1 below shows current service provider architecture for SoHo/SME market where network intelligence and control functions are hosted by customer premise gateway. This architecture provides little to no visibility to the service provider of actual devices/users on the premise or their use and demand of network resources such as bandwidth; so, any value added services are delivered at a whole premise basis, i.e., parental control is usually implemented using DNS and everyone is subjected to the same level of restriction. Lack of intelligence about customer's usage of the network bandwidth prevents MSO's customized marketing efforts to achieve higher level of acceptance of value added services.

Furthermore, with this architecture, the service providers need to think long and hard about introducing new products and services, as they need to consider capabilities of CPE vendors and types of CPEs in the deployed base before they can determine if a new product or feature can be supported. This dependency has both cost in money and time implications to new product introductions, with typical new time taken being anywhere from 9 to 18 months.

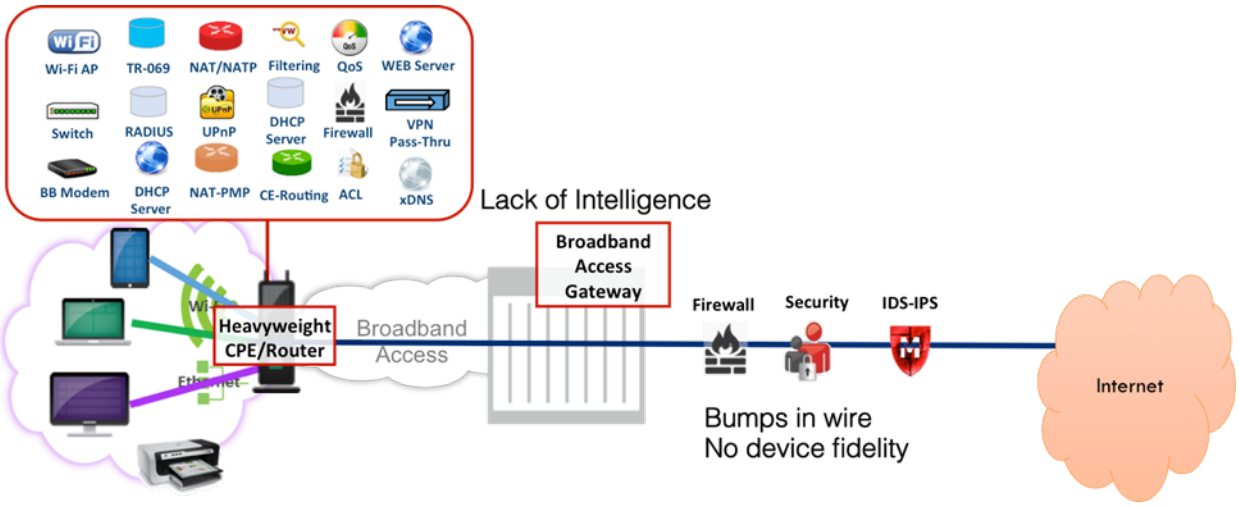

Figure 1 - Legacy Architecture

Virtual CPE solutions moves complex network functions from the physical CPE into a Virtual Network Function (VNF) running at provider edge. Benu VSE's vCPE architectural framework provides visibility into the devices and networks at the SoHo/SME premise, and allows greater agility and flexibility to roll out highly programmable, fully virtualized service. The VSE unlocks the IP router logic previously embedded in vendor-specific CPE, and consequently out of reach of service providers' control, and makes it open, available, and part of the service provider's native service offering. Conventional customer gateways are repurposed as lightweight, agile NTUs (network termination units).

The lightweight premise-based equipment requires minimal configuration, or other change; the services are fully instantiated in the service provider network. This simple but fundamental architectural transformation has a profound impact on the pace of innovation and the economics of new services.

This vCPE solution enables service providers to accelerate service velocity by reducing dependencies on CPE and helps providers improve the bottom line and accelerate time-to-market by avoiding expensive and time-consuming CPE evaluation, certification, and integration and support lifecycles. The solution also streamlines customer support by moving business logic from the customer premise into the service provider edge/cloud. This fundamental shift enables the service provider with full visibility all the way to the subscriber device.

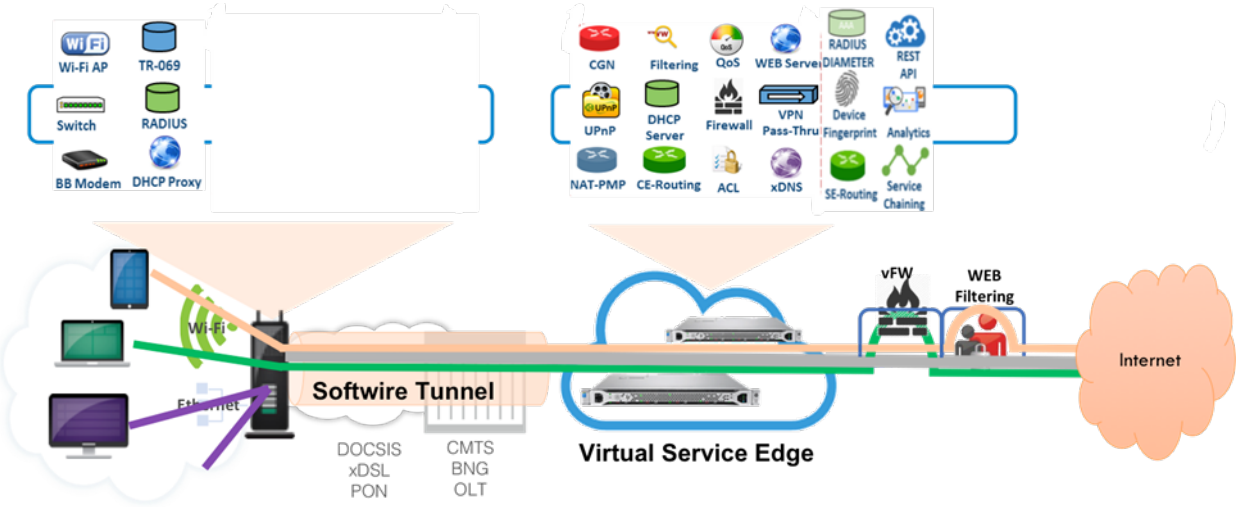

Figure 2 - vCPE Architecture

1. Network Architecture

Like any other network transformation, this architecture requires changes in the existing network elements, but not a lot. The network architecture consists of Smart bridge CPE deployed at customer premise and VSE solution deployed in the cloud or service provider edge network. The two elements transfer layer 2 frames via Soft GRE tunnel.

1.1. CPE

The CPE is enabled into a “smart bridge” mode. In this mode, CPE is acting like a switch on the LAN/wireless side, and simply puts any WAN or broadcast traffic into an overlay tunnel (ie; softGRE) toward the vMEG (Virtualized Multi-service Edge Gateway). Conversely it takes the incoming traffic from the overlay tunnel and forwards the traffic on the LAN/wireless side. The operations and lifecycle management on the CPE does not change at all. Simply a firmware upgrade to allow smart bridge functionality is required. By doing so, all the other CPE network functions are disabled. All broadcast traffic including DHCP packets are forwarded to the vMEG nodes running at the customer edge. The smart bridge CPE tags the layer 2 frames with different VLAN IDs, each ID corresponding to a specific segment or slice of the customer premise network. For example, all traffic to and from business or customer private devices is tagged with one VLAN ID whereas the traffic from visitors is tagged with another VLAN ID.

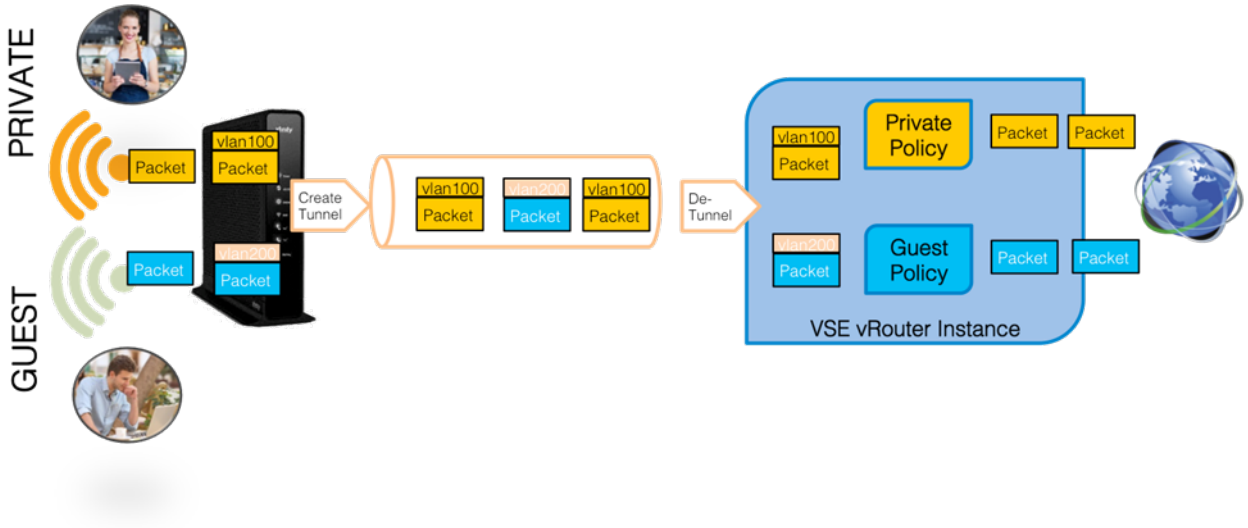

Figure 3 - SmartBridge and Soft GRE tunnel

1.2. User Portal

User portal provides customer ability to view and change existing services and subscribe to new ones. It is deployed in a typical web services model and front ended with an external firewall. When customers access the default home gateway using a browser, they are redirected to this portal, login to their accounts and manage their subscription, and perform all administrative functions for their business service. Bringing intelligence and analytics to the customers enables them to differentiate the value added services that works well from the ones that don't and tethers them to the superior service offerings and leads to greater overall satisfaction.

1.3. Service Provider Admin portal

Service provider has ability to view each business customer's network and capture packets. The service provider gets holistic view of the entire network like number of businesses connected, average bandwidth per business, total number of devices on the network and many more metrics. Using this portal, the service provider can implement policies or behaviors desired based on device type such as IOT and set up default business account settings for customers.

The portals are a natural place to view analytics by business customer at the customer premise level and by the operator at the customer premise level and also at operator network level.

1.4. Virtual Service Edge

Virtual Service Edge is a collection of Virtual Machines running together to provide a high scale multi-tenant vCPE solution in the NFV environment. It consists of mainly two VNFs/components: SSC and vMEG.

1.5. Subscriber Session Controller (SSC)

SSC is a database centric application running on Linux based VMs and acts as aggregate subscriber policy database and control functions for the service provider. SSC maintains subscriber accounts and their policies configured via REST API or portals. It also stores network and device usage analytics reported by vMEGs. It interacts with user and service provider portals and north bound service orchestrators. And it provides customer and device specific policy information to the policy enforcement engines (vMEG).

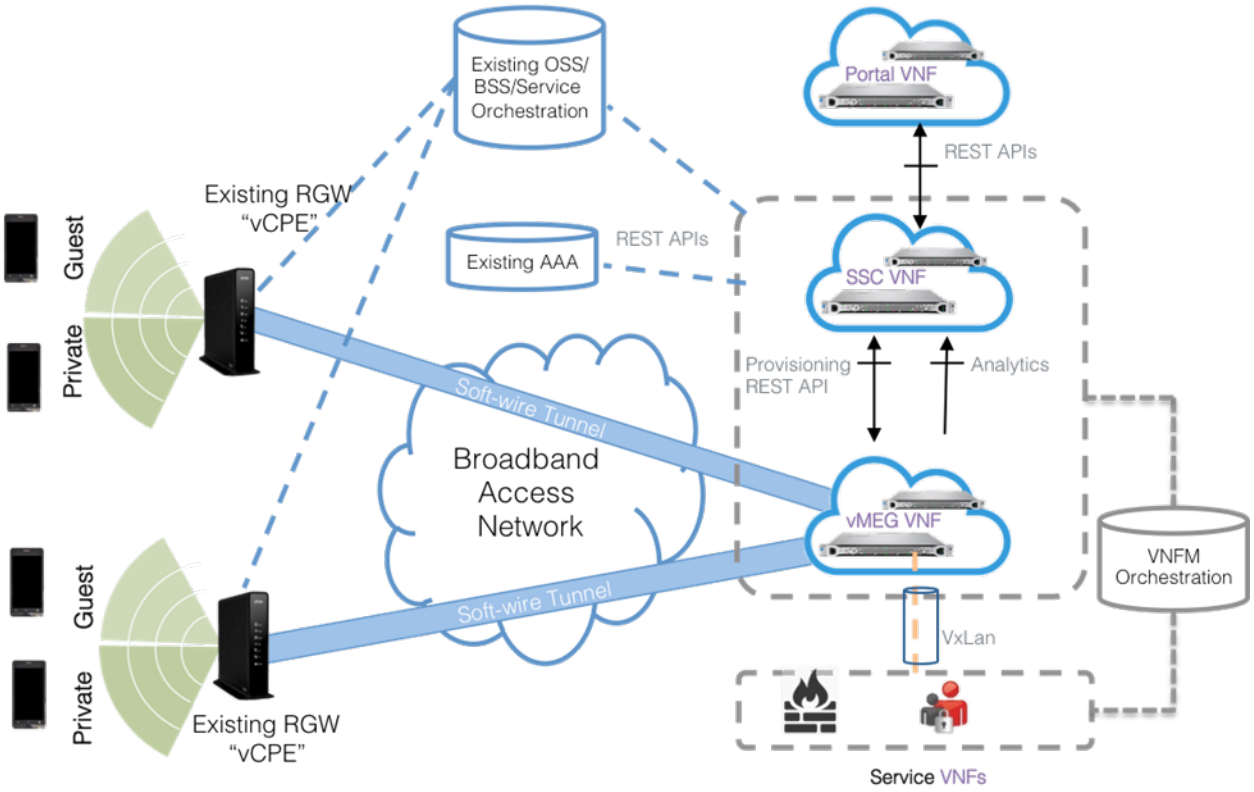

Figure 4 - VSE Solution

1.5.1. Virtual Multi-Service Edge Gateway (vMEG)

vMEG is the high performance and throughput packet processing and policy enforcement virtual machine simultaneously performing tens of millions of packets per second from and to multiple businesses. This high throughput data plane virtual machine is based on Intel DPDK framework, and especially designed to handle real time traffic such like gaming and voice/video at low latency and jitter.

Each vMEG instance can handle multiple tens of thousands virtual router functions in a single VM. Many of these vMEG virtual machines are clustered together as one VNF to create a very high capacity Managed Business Service solution in an NFV framework that can support millions of devices across multiple businesses.

1.6. Service VNFs

One of the key tenents of vCPE architecture is its ability to add and remove service/network functions to a device, VLAN or business on need basis. With this architecture new services are added and stitched using Service Function Chain(SFC) framework over VxLAN and NSH tunnel.

2. NFV Architecture

The following figure shows VNFs for the Managed Business Services in an NFV framework diagram. Each of the elements scale up and down independently to provide flexibility and agility in the service provider network.

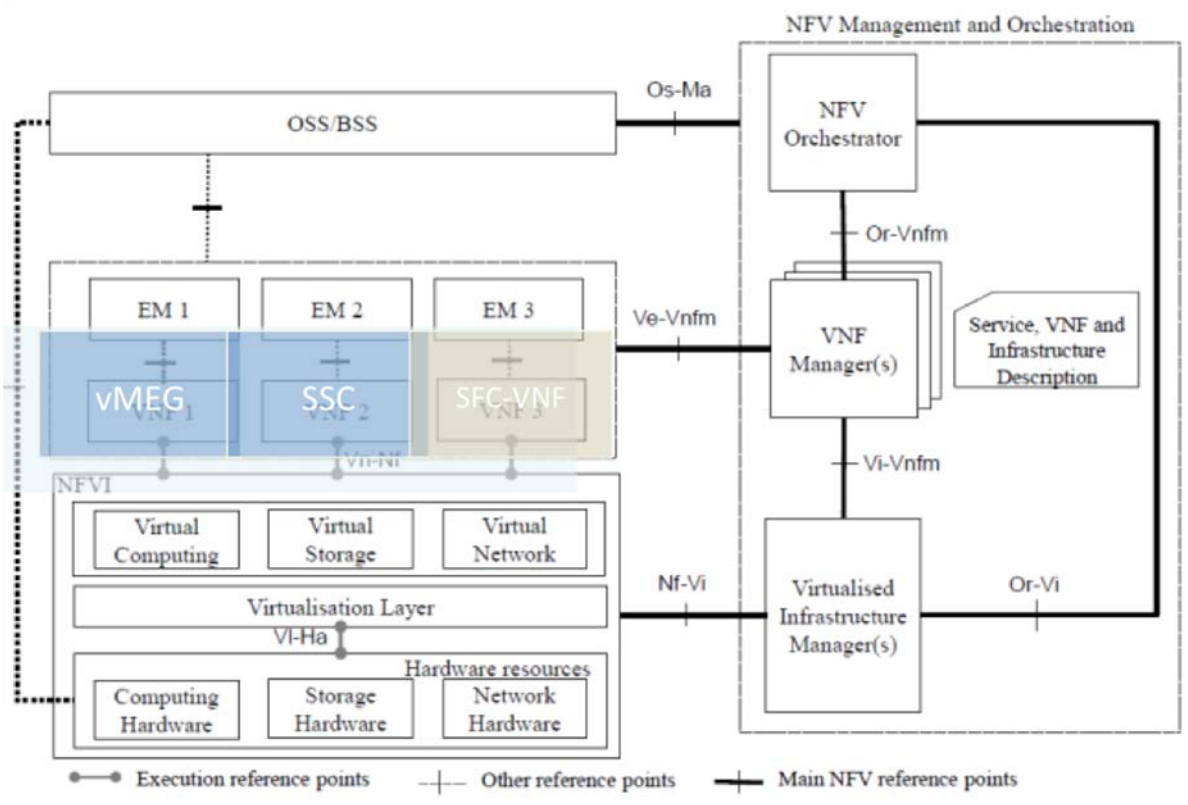

Figure 5 - NFV framework

Conclusion

Highly scalable vCPE solutions have moved from the labs to the real world deployment. Along the way, several complex issues have been worked out to make this a reality, with numerous improvements in

performance and scale in a virtualized dataplane environment with close collaboration with Intel and VMWare, and integration of the MSO's back-end OSS/BSS functions. All these innovations would amount to nothing if the customer experience has not been improved. Using this solution, small business owners can easily opt in for new value added services from the service provider, like guest network services, social media integration, parental control, enterprise grade security, promotions and vouchers, etc, and are armed with intelligence of their network like top site usage, repeat guests and their behaviors.

Service provider retains control over several key aspects of the network functions and their customer network intelligence, without requiring big changes in their existing underlay network.

Abbreviations

AP	Access Point
bps	bits per second
DPDK	Data Plane Development Kit
FEC	Forward Error Correction
HFC	Hybrid Fiber-Coax
HD	High Definition
Hz	Hertz
IOT	Internet Of Things
ISBE	International Society of Broadband Experts
MBN	Managed Business Networking
MSO	Multiple Systems Operator
NFV	Network Function Virtualization
NSH	Network Service Header
SCTE	Society of Cable Telecommunications Engineers
SDN	Software Defined Networking
SME	Small Medium Enterprise
SSC	Subscriber Session Controller
vCPE	Virtual Customer Premise Equipment
VM	Virtual Machine
vMEG	Virtualized Multi-Service Edge Gateway
VNF	Virtual Network Function
VSE	Virtualized Service Edge