Boosting
White Box
Performance

Introduction

Operators are looking to deploy agile services on demand, based on generic white box platforms and a rich assortment of powerful virtual network functions (VNFs) that can be dynamically added, removed and chained to deliver differentiated service offerings without the risk of vendor lock-in. The beauty of white boxes is that they are general purpose, low-cost and easy to commoditize. However, the problem is that they lack many of the specialized functions and interface options that cannot be virtualized. Pluggable physical network functions (P-PNFs) with the required physical interfaces, programmable hardware capabilities, and specialized components can help close these gaps on an "as needed" basis and in a consistent manner, across multiple vendor white box platforms.

RAD

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vCPE Market Landscape

According to a recent market report, virtualized customer premises equipment (vCPE) is "...high on the agenda at many CSPs, but... many operators are still seeking the right combination of hardware, VNFs and management software to take their vCPE strategies forward..."[1]

For carriers, NFV, and in particular the vCPE use case, promises new ways of delivering services – including services they have never been able to offer before – in a more agile, flexible way, while allowing greater end-customer control of their cloud-based resources. However, the pace of vCPE implementation has been slow, as service providers are still figuring out the right plan for migrating from their current networks and service mix – one that would not strain their operations and, consequently, their bottom line.

One key issue that service providers are struggling with is the proper virtualization network design to fit specific business needs, such as target markets and service offering, access rates, available compute processing resources, and more. Another issue is orchestration and integration with business and operations support systems (OSS/BSS).

White Box Is Network Virtualization's New Staple Ingredient

The transition to network virtualization brought about various vCPE architectural approaches:

- Physical CPE (pCPE): where functions are virtualized and moved to data centers while only the minimal functionality remains at the customer premises
- Universal CPE (uCPE): where functionalities are virtualized and hosted on a customer-located device with NFV infrastructure and optional SW/HW networking capabilities

Paint it white (box): In parallel, as software-defined networking (SDN) technology began seeping through the enterprise IT domain to carrier WANs, there appeared the white box servers. These are typically off-the-shelf computation platforms, most frequently x86-based, hosting VNFs on virtual machines (VMs) or containers. White boxes, with the help of an appropriate operating system, can be deployed as pCPE with required networking functions or uCPE when customer premises appliances are virtualized and hosted as VNFs. The allure of white box servers is quite clear: since CPE devices are deployed in volume, they represent a major pain point for service providers still using discrete appliances for each networking functionality.

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[1] vCPE Market Outlook Report, Light Reading, December 2016

Current service turn-up and maintenance operations are slow, complex and costly. As a result, time to market for new offerings/upgrades is lengthy and not competitive. White boxes, in contrast, are agile and nimble. They allow automated and on-demand remote rollouts of VNF-based services, thereby helping SPs realize business opportunities faster and improve customer experience.
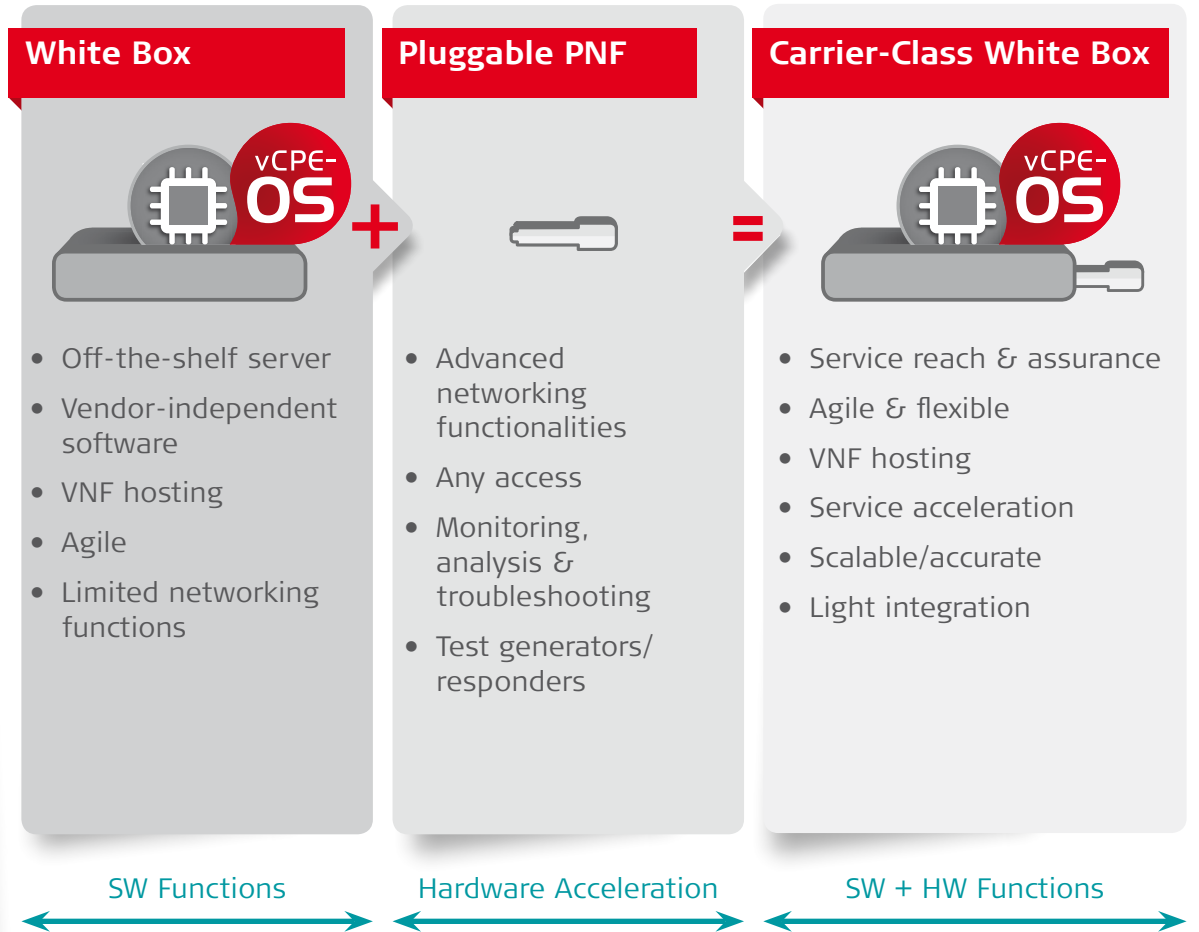
Or are they?

Tinted white: As attractive as white box servers are, however, current challenges hinder their widespread adoption, specifically networking capabilities and mandatory operational functionalities. They lack, for example, accurate performance monitoring, network interface options to fit any available access, and advanced troubleshooting tools to ensure viable service reach, optimal performance and QoE for business customers. Current software-based PM and troubleshooting tools are characterized by low accuracy and low scalability that lead to high CPU consumption, especially for functions such as service activation testing (SAT). As white boxes lack such OAM capabilities, service providers risk higher rates of truck rolls and longer time to resolve reported customer issues. These limitations also require service providers to implement workarounds, such as external boxes to provide broadband access where fiber is not available.

Making Your White Box Sparkle

Service providers are gradually learning that there's no need to settle for poor performance due to deficient functionalities or undertake huge upfront investments to compensate for them. Instead of network build-ups/forklifts and deployments of additional appliances, missing networking capabilities that cannot be properly implemented in software, can nevertheless be deployed – on an as needed basis – with smart SFPs that serve as pluggable physical network functions (P-PNFs).

Recent innovations in smart SFPs offer some interesting – and unique – capabilities that are added with minimal effort:

• Network interfaces, such as xDSL (VDSL, SHDSL, etc.) and GPON

• L2/L3 demarcation and PM probe

• Ethernet over TDM and IP over PPP/MLPPP over TDM

• TDM circuit emulation

White Box	Pluggable PNF	Carrier-Class White Box
• Off-the-shelf server • Vendor-independent software • VNF hosting • Agile • Limited networking functions	• Advanced networking functionalities • Any access • Monitoring, analysis & troubleshooting • Test generators/ responders	• Service reach & assurance • Agile & flexible • VNF hosting • Service acceleration • Scalable/accurate • Light integration
SW Functions	Hardware Acceleration	SW + HW Functions

Boosting white box performance with pluggable PNFs

Such pluggable PNFs do not require separate power, cabling, rack space, or other OpEx-intensive resources, yet they ensure function consistency across multiple hosting devices. "Buy-as-you-need" networking functionalities with management integration ensure a successful vCPE deployment and help carriers rapidly deploy new applications, services and infrastructure to quickly meet their changing requirements.

The following are some examples of the value that pluggable PNFs offer for fast, high performance rollout of vCPE-based services:

P-PNF Example 1: Any Access

While the industry is busy ushering in the next era of services, the reality is that current infrastructure is a heterogenic mix of network technologies with a variety of access types. Fiber is king, but TDM access is very common, especially when a service path traverses leased connections to make up for the carrier's lack of footprint in some target markets. Many service providers who are looking into rolling out vCPE services are challenged by their current installed base.
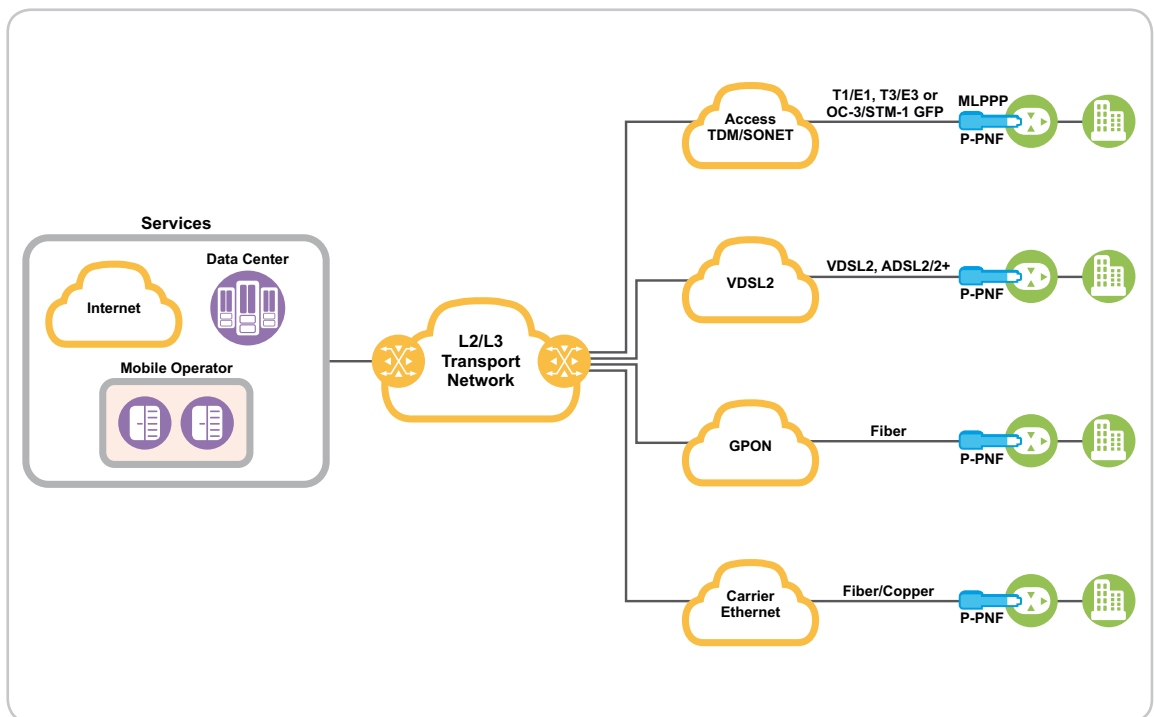

Flexible access P-PNFs

With a flexible access P-PNF, a service provider launching a universal CPE (uCPE) for fiber access can reliably introduce VNF services over T1/E1, T3/E3, SONET/SDH, VDSL2, GPON, and Carrier Ethernet. In the case of legacy TDM networks, the smart SFP should also feature PPP/MLPPP support to allow bonding over multiple E1/T1s without requiring an external router, while allowing interoperability with core routers.

P-PNF Example 2: Service Demarcation and Performance Assurance

Service providers can employ a service demarcation and performance assurance P-PNF to deliver premium, SLA-based L2 and L3 services. By augmenting white box servers with P-PNF, service providers can benefit from:

- Full CE 2.0 NID functionality without consuming CPU cores or memory

- High-level accuracy and scalability for performance monitoring, service activation testing (SAT) and traffic management

- Deep network visibility with remote packet capture, granular analysis of bandwidth usage and micro-bursts

- Simplified operations with advanced diagnostics, threshold crossing and dying gasp notifications

- Active NFVI/VNF monitoring to identify connectivity and VNF "freezing" issues, as well as excessive processing delay/PDV (PM)
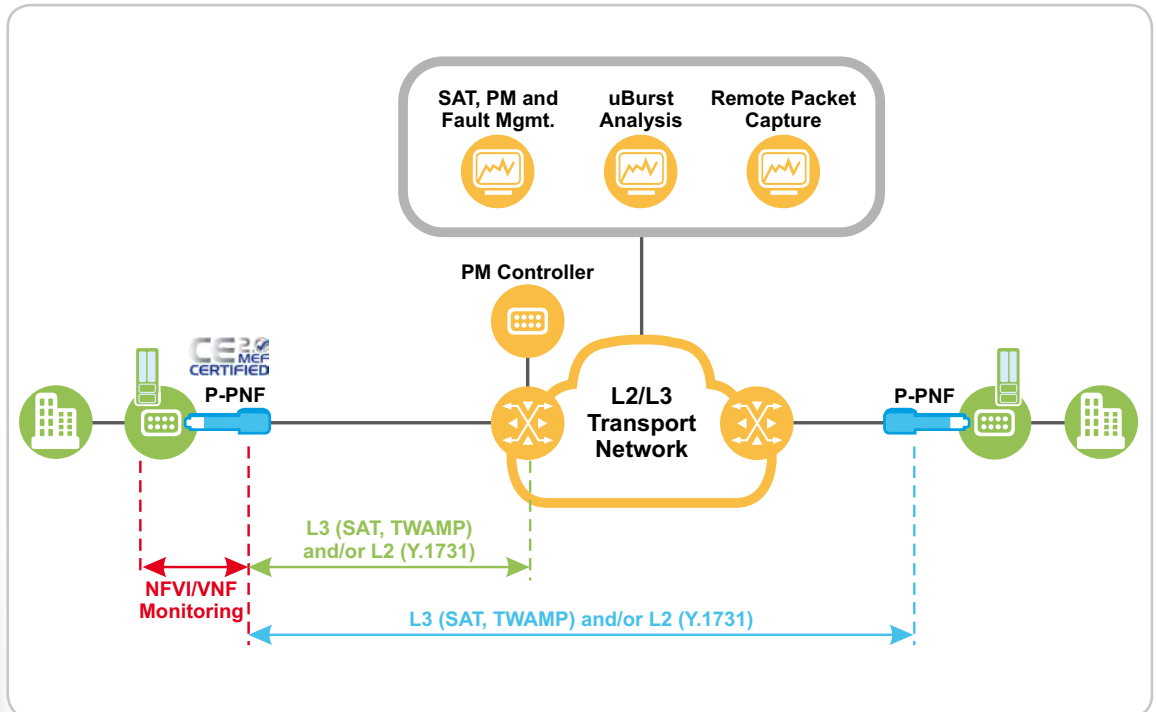
Service demarcation and performance assurance P-PNF

P-PNF Example 3: TDM Circuit Emulation over Packet

As networks migrate to packet/SDN/NFV, service providers will want to decommission "End-of-Life" PDH/SDH networks. However, some of their enterprise, utility, government, and transportation customers may not yet be ready to do to the same to their own networks, requiring TDM leased line services to be maintained. An ideal solution is a smart SFP capable of emulating TDM over Ethernet or IP and employing various tools to ensure service quality and minimize delay when the service traverses a packet network.
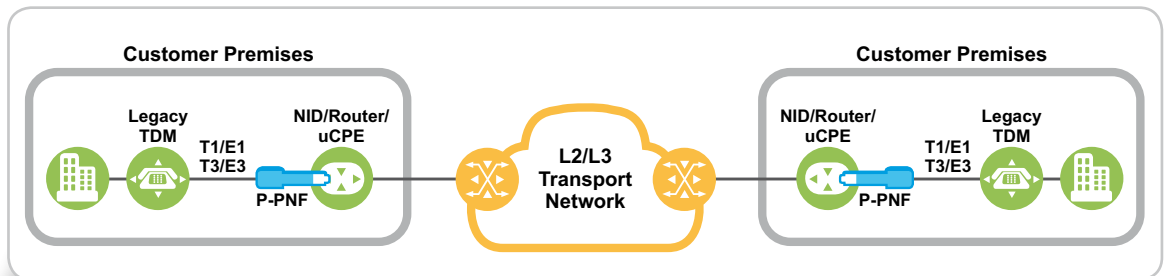
TDM circuit emulation over packet P-PNF

Management integration

P-PNF management can be performed in a number of ways. These include in-band management where each P-PNF has its own separate IP address (or, in some cases, shares the host's), via out-of-band I^{2}C channel where the host manages the smart SFP via a common CLI/API for seamless "look and feel," or using a white box operating system that automatically recognizes and manages the P-PNF. Each option offers various considerations, so that service providers can choose the alternative that best suits their needs.

Don't neglect your OS

The selection of a proper operating system for uCPEs and white boxes should be considered with care. There is a clear market demand for separating hardware appliances and the software that runs (on) them. While there is much to be said about the natural compatibility of an operating system running the white box for which it was created, there are some strong arguments for a standalone OS in certain cases. One such argument, for example, is for a powerful OS that combines virtualization and VNF hosting functionalities with strong networking capabilities, which are typically lacking from common white box operating systems.

Another important aspect is interoperability with open source management platforms, and easy integration (using standardized protocols, such as NETCONF/YANG) with orchestrators and operations/business support systems (OSS/BSS).

RAD's vCPE Toolbox

RAD, the industry pioneer of network edge virtualization, provides flexible vCPE platforms for the customer edge and a complete solution to fit diverse performance, cost and security needs:

- Universal CPEs (uCPEs) – L2/L3 NIDs with pluggable x86 server modules

- Enhanced white box platforms

- Pluggable physical network function (P-PNF) devices to accelerate server performance

- Powerful, carrier-class vCPE-OS operating system for virtualized services

- Management and orchestration for the network edge

- D-NFV Alliance: pre-tested VNFs and apps

As THE access market leader and hardware miniaturization leader, RAD offers a rich portfolio of pluggable PNFs to enhance white box performance:

MiNID
L2/L3 Demarcation and PM Probe

MiRICi, SFP-GPON, MiDSL
PDH/SDH/SONET Uplink; IP over PPP/MLPPP over TDM; Ethernet over Copper; ONT

MiTOP
TDM User Interface (Circuit Emulation)

RAD's pluggables provide an easy and cost-effective performance boost for any white box, including service assurance, interface conversion, troubleshooting, and more. The flexible access P-PNFs are also interoperable with leading MSANs and OLTs (VDSL and GPON, respectively). They can be managed independently, using I^2C, or via RAD's management system for network edge virtualization. When combined with RAD's vCPE-OS, the pluggable PNFs become a native part of the operating system, resulting in seamless, effort-free integration – even on third-party white boxes running vCPE-OS.

Click here for more information on RAD's P-PNFs and complete portfolio for network edge virtualization.

Conclusion

As the industry is making steady progress towards network functions virtualization and software defined networking, service providers are cautiously setting up their migration plans to address the reality of their network assets. And while the IT-centric white box servers are transitioning to the carrier domain, there are several performance and functionality issues that need to be resolved before they can deliver on their agility and automation promise. Smart SFPs that serve as pluggable PNFs can help resolve gaps such as service demarcation and performance assurance.

In addition, pluggable interface options can help bring universal access to universal CPE (uCPE). This is critical for the delivery of virtualizing business services that must reach a level of scale, economy and ease-of-deployment to reach deep into the business market with an increased service provider footprint to cover customer sites in a consistent way. Backed by strong management and OS tools, pluggable PNFs enable service providers to rapidly deploy white boxes at customer sites, with modular P-PNFs for every service need, ensuring smooth migration to NFV-based business services.

For more information visit **www.rad.com**

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