Hewlett Packard Enterprise

NFV at scale—an architecture for vCPE

Deployment case study

Introduction

A leading European communications service provider (CSP) has deployed HPE OpenNFV technology to provide virtual customer premise equipment (vCPE) to its business customers. Previously, its network functions were deployed at an end customer's location, requiring dedicated on-site appliances and significant CAPEX.

Their new vCPE model allows them to manage their customer's network infrastructure from a centralized location, providing networking services on demand, leading to lower costs, faster service deployments, and higher service availability. Additionally, end users can manage their own services from a self-service portal, which leads to faster service changes, increased customer satisfaction, and OPEX savings for the CSP.

This paper examines the overall architecture of the solution, including how they leveraged their legacy architecture as well as some key learnings from the deployment.

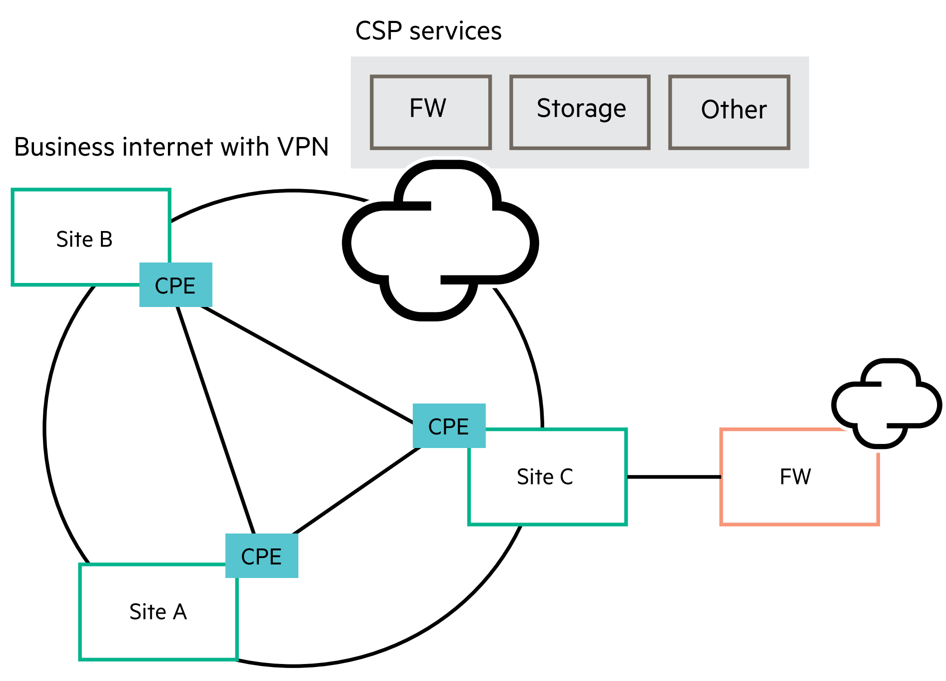

Figure 1. CSP services

Customer goals/criteria

Problem statement
This CSP, like many, had the need to respond to competitive pressures from over-the-top (OTT) providers who deliver their services over all-IP networks. They had begun the transformation to IP, but also had a time-division multiplexing (TDM)-based legacy network, which they left functioning for existing accounts. The goal of increased operational efficiencies and scalability afforded by fulfillment automation and integration of their cloud services was central to their decision criteria. To combat the OTT pressures they also wanted to improve speed-to-market of new services.

Business need
This CSP has a base of business customers that want their network infrastructure managed by the CSP and this was addressed through a traditional enterprise CPE model. However, like most legacy networks, the provisioning of services (i.e., adds and changes) was managed by the CSP. The goal of full self-care for customers was essential to satisfy both, the customer's desire for flexibility and speed of service, as well as the CSP's desire to streamline the operations required to support the customer for service management. Handing over the service provisioning to the customer would allow greater flexibility and agility to the customer as well as decreased customer care costs for the CSP.

As with most CSPs, time-to-market for new services was in the range of many months. Only by reducing service onboarding down to weeks would the CSP be able to react fast enough to new market demands. The new cloud-based elastic usage models affords the CSP cost efficiencies to be able to personalize services at scale.

To reduce OPEX and CAPEX, the CSP standardized the CPE device on a low-cost piece of hardware that is uniform across the deployment. They then used a base set of network functions (including dynamic host configuration protocol [DHCP], domain name system [DNS], centralized firewall, remote access service, and authentication) in the foundation of their network functions virtualization (NFV) capability to be the building blocks of their vCPE offer. Having a flexible NFV platform was essential not only to replicate the services currently offered, but to also be able to rapidly add new innovative services in the future.

Deployed architecture

Service requirements
The CSP needed an architecture not only capable of supporting several existing services, but also able to support new offerings as well. For vCPE the requirements are centered around the needs of business users, namely, site-to-site VPNs, internet access (NAT, public IP), firewall, DHCP/DNS, VoIP/TV, and remote access services. They also wanted an architecture that would support their customers to do their own self-care by means of a secure portal. This self-care can allow customers to quickly bring up new services or modify existing services, as their business needs change.

Design requirements
When deciding on an architecture to support their service requirements, the CSP centered their decisions on five key objectives that defined an open solution architecture for addressing future NFV use cases as follows:

- Faster development
- Cost-efficiency
- Customer-driven service design
- Coexisting services (legacy and virtualized)
- Extensible (numerous use cases)

Delivery requirements
Previous operations support system (OSS) solutions led to extensive vendor lock-in because only the vendors were able to configure and customize the software, driving costs up and slowing down delivery. Large software projects often follow a waterfall methodology resulting in long time-to-deployment and little flexibility in adjusting the solution to late requirements. Both the lock-in and the waterfall problems were to be resolved for the new solution.

Key aspects of the solution

The HPE OpenNFV foundation architecture from Hewlett Packard Enterprise supports these requirements and this deployed architecture closely aligns with these principles as well. The architecture follows the layered European Telecommunications Standards Institute (ETSI) NFV approach and leverages the existing infrastructure. For example, the access layer (be it 3G/4G or terrestrial, Ethernet, or synchronous digital hierarchy [SDH]) remains in place, while the new NFV core network uses this connectivity to provide vCPE services through CPE that can be either legacy- or x86-based.

vCPE architecture and its characteristics

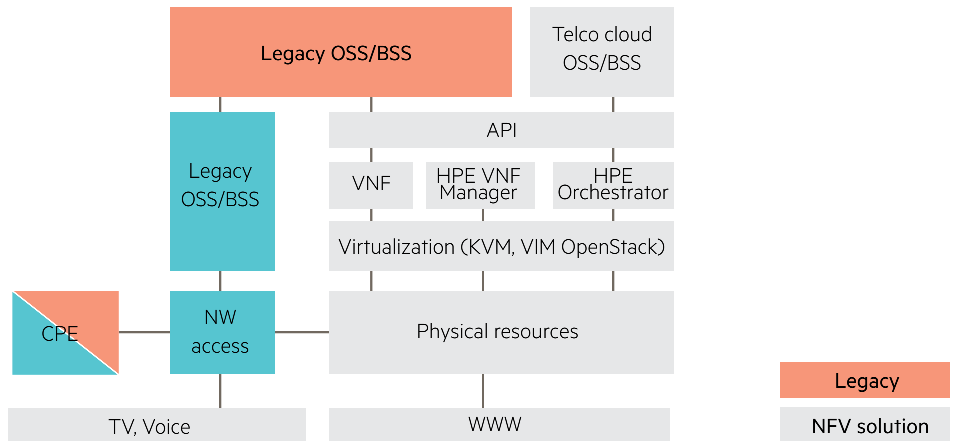

Figure 2. Deployed architecture

The solution utilizes OpenStack® as virtualization technology on standard x86 server hardware, HPE Service Director (HPE SD), a custom self-service portal, and existing OSS/BSS. The CPE device is a simple Linux®-based broadband modem, which includes a built-in four-port LAN switch and support for an optional Wi-Fi AP; it supports DSL and 3G/4G via USB port or dongle.

Customer services offered

End users are able to network among sites in a secure manner using centralized virtual services on a simple, low-cost CPE:

- Virtual premise equipment
  - HPE VXLAN tunnel termination between CPE and vCPE
  - L3 routing between customer sites and networks, as well as routing toward the internet and other customer sites outside of their domain
  - Zone-based firewalling between any of the customer networks as well as the internet
  - DHCP server functionality for customer end users
  - Network address translation (NAT)/port address translation (PAT) for access to the internet
  - Auxiliary functions such as alerting, statistics, and more
- IP address management system provides assignment of individual IP addresses per virtual network function (VNF) as well as for special customer networks, for example, DMZ

NFV infrastructure

The NFV infrastructure (NFVI) layer comprises some standard x86 server platforms as the most widely fielded hardware in CSP data centers today and will be able to scale with future business growth.

Virtual infrastructure manager

For NFV to succeed, automation must be implemented at all stages of the software and hardware deployment lifecycle—from setting up the NFV platform to adding services, to managing scale-in/out and application and hardware changes. The virtual infrastructure manager (VIM) for this architecture is OpenStack-based, providing the advantages of openness and automation when deploying a cloud OS.

Infrastructure overview

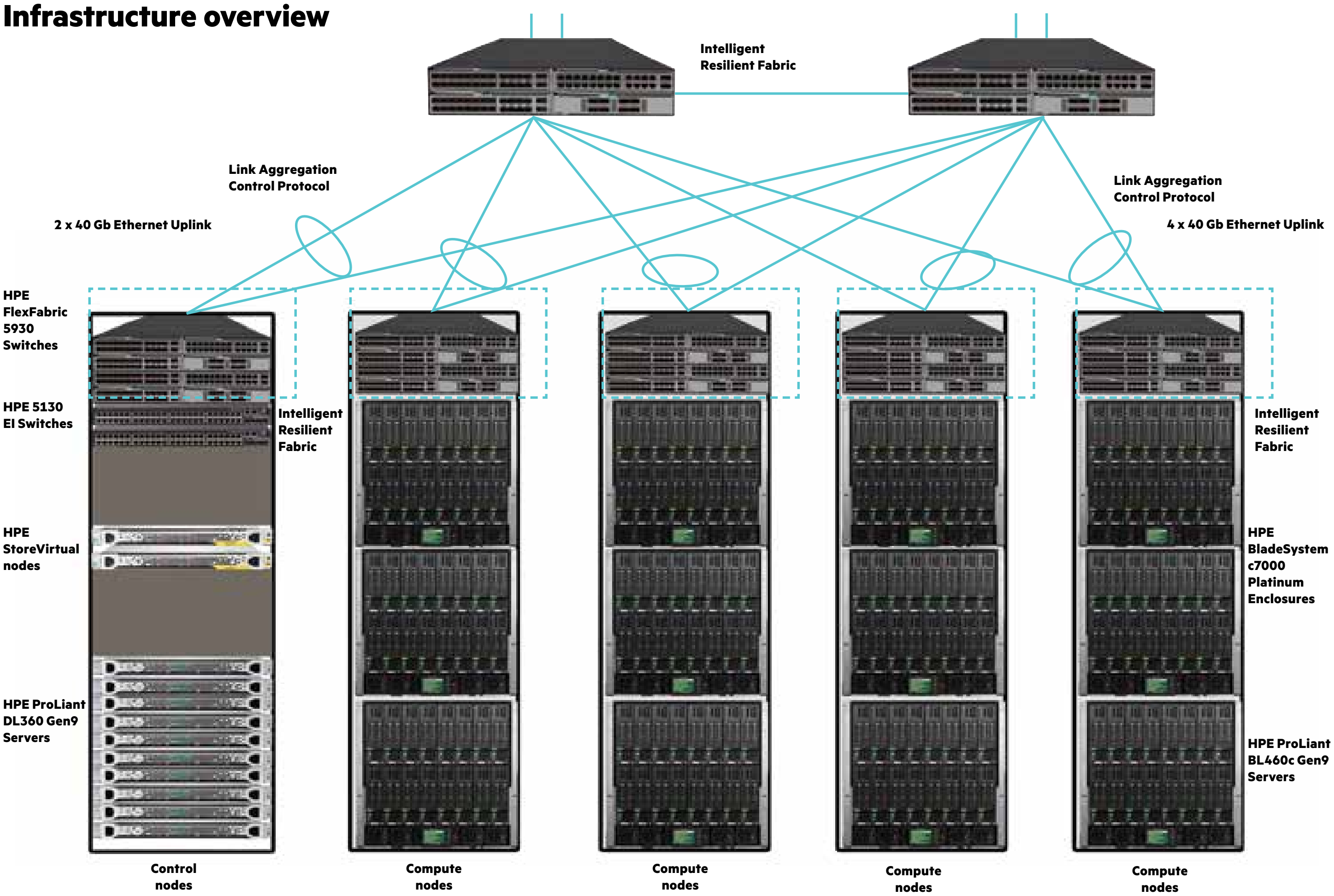

Figure 3. Data center infrastructure overview

Openness and choice in the VIM and virtualization layers future-proof an OpenStack-based NFV solution, while ensuring the broadest set of VNFs can be implemented today. This reduces project risk, as well as operations, maintenance, and integration costs, and increases the utility of the NFV solution, for faster return on investment. OpenStack offers choice in compute, virtual network, and operating system benefits for VNFs such as:

- Kernel-based Virtual Machine (KVM), VMware® ESXi™, and Baremetal approaches for compute
- Wide choice of guest OS including major variants of Linux and Windows®
- Choice of network virtualization
- Choice of deployment architectures to extend the NFV solution to support NFV data centers from very small without control nodes, to very large

The VNF layer features HPE Virtual Services Router (VSR), along with other third-party virtual routers, and is capable of supporting various new VNFs in the future. The CSP will be able to offer innovative new services with much faster time-to-market, since onboarding a new VNF onto this extensible infrastructure is proven to be much less effort than integrating point solutions into a legacy infrastructure.

Orchestration

From a technology perspective, NFV introduces a new layer—virtualization. It adds complexity to the existing OSS landscape, and requires additional orchestration to manage the new lifecycle of VNFs and network services (NS). Orchestration can be viewed as three layers: service orchestration (managed by HPE SD), resource orchestration (which were simple in this case and also managed by HPE SD), and virtualized infrastructure (managed by OpenStack).

Important factors to consider
For the near future, the network infrastructure is expected to remain in a hybrid state: a mix of traditional networks (physical) and virtualized (NFV-enabled) infrastructures. The same challenges exist for the operations domain, where orchestration and traditional OSS systems will coexist.

CSPs are moving away from mass rollouts to a **fast-fail** methodology, made popular by OTT players. This methodology consists of rapid prototyping of alpha services, which then are run in beta trials with selected customer bases. Depending on failures and first feedback, the services are changed and adapted on the fly. Finally, if considered stable and profitable enough, they are brought into mass production. This new way of service design will be prevalent for dynamic services in particular.

End-to-end service orchestration is provided by HPE SD across both VNF and physical network functions (PNF). HPE SD provides a model-driven modular approach to service design. Key aspects of HPE SD include service provisioning and closed loop automation between fulfillment and assurance. HPE SD is a single, extensible, and modular product that supports design principles including:

- A production system for dynamic services across PNFs and VNFs.
- Unified operations across fulfillment and assurance, enabling a closed loop (based on events).
- Functions are configured through a single-service catalog. Services in the catalog are described in a service model, which combines data, relationships, and policies, reducing the need for coding.
- A common inventory between fulfillment and assurance provides quality and accuracy.
- A single-pane-of-glass user interface improves productivity by giving multiple stakeholders access to information—from operations to sales.

HPE SD is configured through an easy-to-use, model-driven language, which is completely open. Changes can be made immediately and tested using the built-in simulation mode, thus enabling continuous integration/ continuous deployment of the software.

Results

In the past, the CSP employed a classical waterfall approach to service development. This approach was stable and established and focused around several releases a year. The process was dependable, but not rapid enough to keep up with competitive threats to the business. Now with the NFV architecture in place and the use of HPE SD, they are able to use a SCRUM process consisting of one Sprint per month and are able to achieve fully automated services and feature development within a single Sprint.

Agility has been made real with the new service models enabled by NFV. Time-to-market for new features has been reduced from nine months to four weeks. Flexibility improved dramatically with service instantiation reduced from 30 days to five minutes. And cost savings are implicit due to automation and the new deployment model.

The CSP has been able to develop most of the models and business logic itself, thereby reducing vendor lock-in significantly—the agile delivery approach allows for a **fast-fail** culture and has reduced the need for late change requests significantly.

Key learnings

vCPE, when done right, delivers on the goals of cost reduction and service agility. When carefully planned and architected, it can be a standardized platform capable of supporting a variety of new services in the future, and with VNFs and a self-service portal allow for a marketplace of on-demand services for end users.

Initial findings with HPE SD show a drastic reduction in the time required for foundational processes like VNF onboarding and network service graph creation—from months to hours. Improving time-to-market by even a few weeks has a net positive impact on revenues. In addition, faster time-to-market also results in higher market share (gaining subscribers from competitors by coming to market first with an innovative offer). Using the HPE Service Director, the ease and the faster pace at which new services can be composed and offered to the market enables a CSP to constantly churn out innovative services and outperform the competition, resulting in a positive cycle of subscriber and revenue growth.

Learn more at
hpe.com/dsp/infrastructure

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