SERVICE PROVIDER SOLUTIONS – WHITE PAPER

UNLOCKING THE FULL POTENTIAL OF NFV

Helping Communications Service Providers (CoSP) achieve the most out of NFV through a microservices architecture

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MICROSERVICES OVERVIEW

As noted in the [“Five Things You Need to Know About Microservices”] blog, microservices is not new. Here are a few key points that can apply to any software function:

- Microservices were on the hype curve since 2015 when the world started to discover how organizations such as Apple, Google, Facebook, and Netflix managed to iterate and innovate with speed and agility.
- The foundational principle of microservices is disaggregation. Rather than referring to the disaggregation of hardware and software (NFV), or the disaggregation of control and data plane (Software-Defined Networking), this disaggregation specifically targets the software stacks themselves.
- The goal to unlock value in a large application, like a network function, is to disaggregate it into a set of composable services. Those services can expose a set of APIs to applications or other services.
- Disaggregating software stacks has an innate impact on operations. Companies that have embraced and leverage microservices architectures require changes to operational processes and technical skill sets – most notably an increased ability to develop (or script) applications to take advantage of these new APIs. DevOps, and Continuous Integration/Continuous Development (CI/CD) principles are intrinsically linked to microservices conversations and processes ensuring stable development test and delivery.
- The net result of this effort is accelerated innovation, improved manageability, increased resiliency, and higher scalability.

Crossroads for Communications Service Providers

The industry “crossroads” for Communication Service Providers (CoSP) is well-known and well-understood – Technology, operational, and business drivers are fueling dramatic industry transformation. At the core is an adoption of virtualization technologies designed to introduce greater capability and agility in service delivery environments. In order to facilitate the technology, operational, and business drivers facing CoSPs, a single, underlying virtualized platform is a must. This single virtualized platform, delivered via new technology and operational tools and leveraging a combination of vendor and open source technologies, is the foundation for driving new business models and operational benefits.

The CoSP industry needs to move from physical (legacy) to virtual network functions marked by multiple applications residing on shared underlying infrastructure and virtual functions residing in hypervisors (NFV 1.0). However, the industry is still stuck at single application on dedicated x86 infrastructure and virtual functions leveraging the hypervisor only as an abstraction, not as a virtualization technology. The current state of NFV is not delivering on its full potential.

The industry needs to go even further with virtual functions residing in containers (NFV 2.0). There also needs to be an associated evolution of orchestration functions increasingly being leveraged for automation and scheduling of resources across hypervisor-based applications, container-based applications, and bare-metal applications. This is not an evolution of orchestration, but increasing automation for more closed-loop tasks that do not require the complexity in logic and policy that are required for closed-loop orchestration. All of this will, in turn, essentially drive the industry towards a more operationally-friendly architecture and DevOps-based operating model and Ci/CD processes applied to network operations, which will trigger increased disaggregation of software functions towards microservices architectures, as a means to facilitate these new operational models.

A History of Network Virtualization in Telco Environments (2012-Present)

Before examining the concept of a microservices architecture, it’s important to look back at the history of network virtualization and its adoption by CoSPs. Network virtualization has gone through four phases as shown in the next diagram:

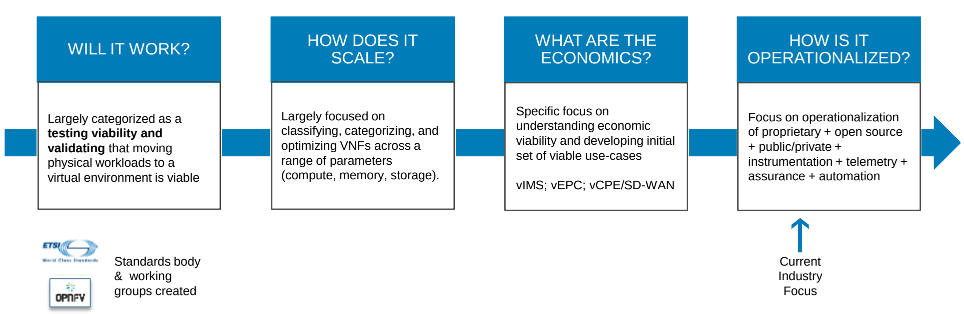

Figure 1. Virtualization adoption path for CoSPs

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Let's examine each phase in further detail:

1. **Will it work?** This phase led to the creation of ETSI NFV Working Group and various open source spin-offs, such as OPNFV. The output, of course, is a set of standards documents that number in the hundreds of pages in totality.
2. **How does it scale?** This phase was marked by investments into evaluating how network functions in a virtual environment scaled, and eventually yielded open source projects, such as DPDK, that drastically accelerated packet process on x86.
3. **What are the economics?** It turns out that it is difficult to evaluate the economics of an architecture, especially one as complex as NFV. As a result, the economic viability analysis has been focused on an initial set of use-cases, including Virtual CPE (and associated SD-WAN), Voice-over-LTE, and Virtual EPC (M2M and MVNO use-cases). The net result – lots of proof of concepts, field trials, and small scale deployments of use-case driven NFV.
4. **How is it operationalized (at scale)?** Upon understanding the first three phases, the industry is now focused on bringing together vendor technology, open source technology, public and private cloud technology, and integrating them together with the same level of telemetry and service assurance capabilities as their physical counterparts, with increased automation.

The NFV phases predicament

The phased approach to NFV, and the tepid investments into operationalization, has put the industry in somewhat of a quagmire. Why? The initial focus on driving use cases before abstracting a common operational model across these use cases has resulted in a hybrid Virtual Network Function (VNF) appliance architecture. See Figure 2, below.

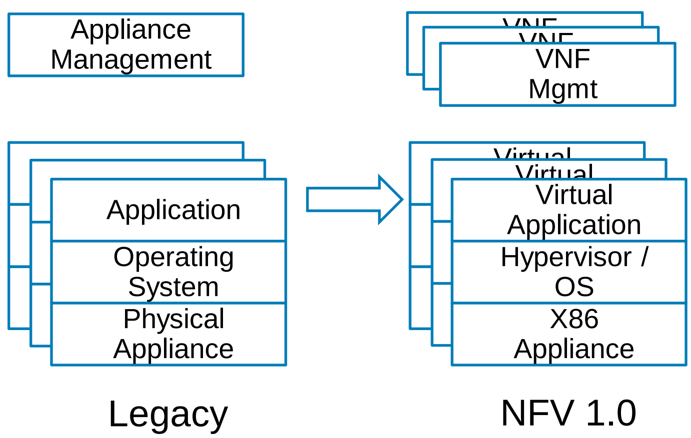

Figure 2. NFV 1.0: From legacy physical functions to virtualized functions

Moving from the legacy phase to the NFV 1.0 phase has introduced in many cases a siloed VNF appliance effect. Many deployments are simply virtual instantiations of former physical network functions, relying on dedicated underlying infrastructure like its predecessor, but with the exception of that underlying infrastructure being x86-based vs. a proprietary system architecture.

The original path to a fully disaggregated, microservices-based architecture should have been linear – one that first went through a hypervisor-driven approach as a means to learn a new networking paradigm that includes compute, virtualization, control- and user-plane separation, orchestration, automation, and eventually DevOps/NetOps principles all in a sandboxed environment. The role of the hypervisor was as much to enable secure environments where engineering and operations organization could learn these skills with relatively lower risk of causing a network

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outage as much as it was a platform for shared resource utilization. But by verticalizing network functions into VNF appliances, another step is introduced in the journey towards operationalization.

As the industry seeks to incorporate increasing amounts of open source technology, the rate of technical innovation is accelerating. The Innovation Adoption Lifecycle is no longer a normal distribution, but instead is skewed to the left – more innovators and early adopters than ever before. Adding a step into the network virtualization journey serves to introduce an increased amount of confusion into the process, resulting in an uncertain mix of technologies (Containers, Docker Swarm, Kubernetes, Ansible, Mesos, etc.) that are close enough to production-ready but have not been at the forefront of the learning curve battling for mindshare against a set of technologies (Hypervisors, OpenStack, MANO, etc.) that are now much better understood but starting to lose their “new and innovative” luster. These are exactly the issues that must be addressed with NFV 2.0.

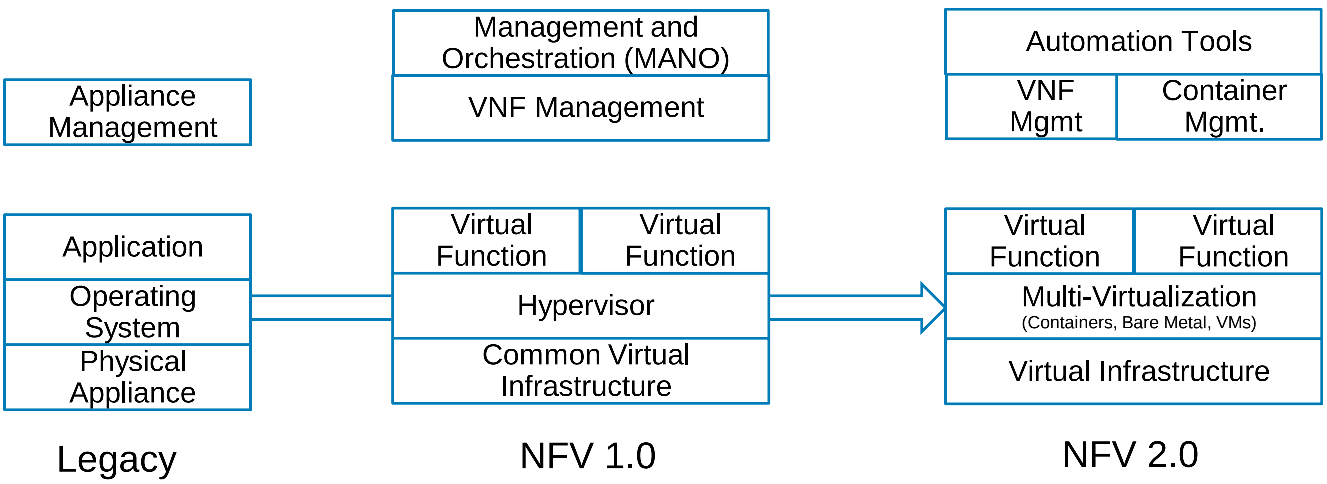

Figure 3. The path to NFV 2.0

The next step – NFV 2.0

The goals of NFV 2.0 have to be more than technical – more than just building a common technology platform unified across disparate use cases with an iterative, release-based delivery model that incorporates increasing amounts of open source componentry and “DevOps-style” tooling. It has to do more than account for the multiple technology directions the industry might take going forward.

The infrastructure stack itself also has to adapt to changes in operational and business models, as well – and account for nuances in current and future procurement processes, operational models, software stacks, and buying paradigms (i.e., the shift to consumption-based). To do this, vendors who target the network virtualization arena need to do so with more than just shiny technology, but also adapt their business practices to redefine the entire engagement model with telecommunications service provider.

Examining the microservices architecture

CoSPs want to be able to simplify and isolate network functions, and reduce/reuse/centralize the valuable flow and state information contained within each network function. Deploying a microservices architecture can help communications

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service providers to achieve this simplicity. As shown in the Microservices Overview sidebar on page 2, microservices is not a new concept and it has been around for quite some time.

Applying microservices to network functions

Applying the same design logic of microservices for enterprise applications to network functions requires first defining some of those microservices. Today, a VNF is tightly integrated software application consisting of a data plane for bit processing, a control plane that programs the data plane based on events/information received, control logic, a database for storing state information, and a message bus for communicating between services. Those APIs are either closed (vendor-proprietary), or non-existent (boundary between software function is not exposed externally between services). This architecture has allowed networking vendors to continue to differentiate their product offerings across a number of parameters:

1. Performance
2. Scale
3. Latency
4. Feature differentiation
5. Ease of operations

And further differentiate their companies across another two:

1. Velocity of feature development
2. Services and support

This model has persisted for the entire history of networking, both in the enterprise Local Area Network (LAN) and in the Wide Area Network (WAN), and has stretched across fixed and mobile networks from DSL and cable to 3G, 4G, and even the pending 5G architectures.

Going forward, with a microservices approach, many of the core functions of a VNF may get disaggregated, with the potential that many of these disaggregation functions are commoditized in open source, turning what were once differentiators in a composed network architecture into infrastructure services in a composable network architecture model.

What microservices can be expected to become infrastructure services in the long run?

- Integrated Databases give way to Database as a Service
- Integrated Data planes become shared Data Planes
- Message Bus as a Service (MBaaS)

Not only does this microservices framework allow for disaggregation, it also allows for re-aggregation in new and exciting ways. Much like service function chaining allows network functions to be arbitrarily arranged in series, such Superservices allow services to functionally be chained together in parallel. As such, a packet can be taken off the wire one time, replicated across a set of services (firewall, IPS, DPI, etc.), and analyzed against their individual rules (or control logic). If the packet does not meet one or more of the rules associated with the individual service, a packet handling decision (I.e., Drop) can be made.

This architectural model is not necessarily imminent or ubiquitous. In fact, there is still considerable maturing of container networking that needs to happen. Further, not all network functions will fit neatly into the prescribed architecture, and we will find that network functions that leverage pieces of this infrastructure services framework while keeping other, more differentiated componentry, integrated.

The implication to the network function vendor community are as important to those facing the CoSPs themselves (discussed in the next section). As a means of competing in an increasingly-disaggregated market, the levers of differentiation get smaller:

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- Performance differentiation goes away (since software functions leverage a shared data plane)
- Scale goes away (since the infrastructure offers database services)
- Latency may go away (MBaaS)

The net result is that product and corporate differentiation in network functions are largely limited to:

1. Differentiated feature sets in the control plane
2. Feature velocity
3. Ease of operationalization

Historically, features get commoditized as the industry adopts them, so this is not sustainable. Maybe the only sustainability is feature velocity, meaning that pace of innovation, and ability to operationalize that innovation, is the only differentiator left.

Conclusion and next steps

In the constantly changing world of network communications, one thing that can be learned is that foundational paradigm shifts such as the one above seldom happen in real-time. Instead, they go through iterations all objectively targeting the ideal end architectural state. The answer is to begin this journey with an eye on the end goa

There are three things the industry, and especially the CoSP, can do now to prepare:

1. Truly understand this changing world - even if CoSPs don't do the integration themselves, they need to really understand it so that they get the architecture right.

2. Be able to swap in new, highly-pluggable blocks to the solution easily, even if they get a software integrator to help pull in a new part to the solution their operational processes need to be able to quickly take this new block and put it into production.

3. Start adapting operational processes towards DevOps, most specifically incorporating a Continuous Integration / Continuous Development (CI/CD) process for network operations, with an end-goal of eliminating the periodic, lengthy maintenance windows in favor of an ongoing rollout of new functionality.

By taking these steps, CoSPs will be well-equipped to take advantage of microservices and get the most out of their NFV deployments.

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