NFV and What it Means to You

From ETSI to MANO to YANG – Making Sense of it All

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The Road to NFV

For the last few decades networking was mainly a physical thing. The most basic building blocks like switches and routers were physical devices with their own configuration and management system.

More complex network functions were provided as blades and racks where the vendor controlled both the hardware and the software, largely built in a black-box approach, that albeit provided the safety of control, at the dire expense of complete lack of scalability paired with a long time to market, and very specialized staff to run and manage these systems.

With the need for agility and scale these days, this has started to hit a wall. However, the problem with scaling up of network functions is that in order to do so, you have to change boxes as demand fluctuates, and when you reach peak time you need to be elastic on the fly - and this is nearly impossible with manual configurations.

As NFV (network function virtualization) becomes a real pain point more network vendors are working on a solution of how to take their existing investment in network products and make them NFV-enabled. The decision to move to NFV is based on the growing need for standardized architecture built on commodity hardware, elasticity and scale based on software-driven networking, which would then enable flexibility that would reduce vendor lock-in, all enabling faster time to market, and representing a growth engine for this highly-competitive industry.

The target is that eventually everything (OSS and BSS combined) will run as virtual software components on commoditized hardware - migrating from core systems based on dedicated hardware & software into standardized software-driven virtualized network functions.

With open source cloud being software driven infrastructure that exposes the networking APIs to the users, it is now possible to build customizable Software Defined Networks (SDN) to fill this gap where we can automate this as part of our application deployment. That said, working with SDN requires knowing a bit more about how information moves around between your cloud resources, and ensuring they are application-oriented and are able to communicate with the layers above and below.

However, the crux of the matter is that typically network components require substantial code changes to turn an existing NF into a VNF (virtualized network function). This, in turn, becomes an NFV service running on virtualized hardware & software, which then ultimately runs on the cloud. This becomes an even more daunting challenge when we want to do this in a standardized way and without losing control.

Each of these components was typically built to run in a legacy environment, while not taking into account virtualization and cloud requirements.

ETSI, MANO and Modeling Languages

To this end, many Telcos and Enterprises these days are searching for modeling languages to help achieve the goal of application and network orchestration, and they are betting on OpenStack and the nature of standards-driven open source cloud to help deliver this in the real world.

"One enterprise IT vendor (GigaSpaces) has been included in this report because its open source technology is the basis for a number of telco vendors NFV MANO implementations."

Caroline Chappell, Principal Analyst, NFV & Cloud | Heavy Reading

ETSI, the European Telecommunications Standards Institute, has defined a standard reference architecture to achieve NFV, which includes the stages of rewriting the previous OSS black boxes to become VNFs, which is then built upon a VNFI (virtualized network functions infrastructure - AKA the IaaS, in many cases OpenStack).

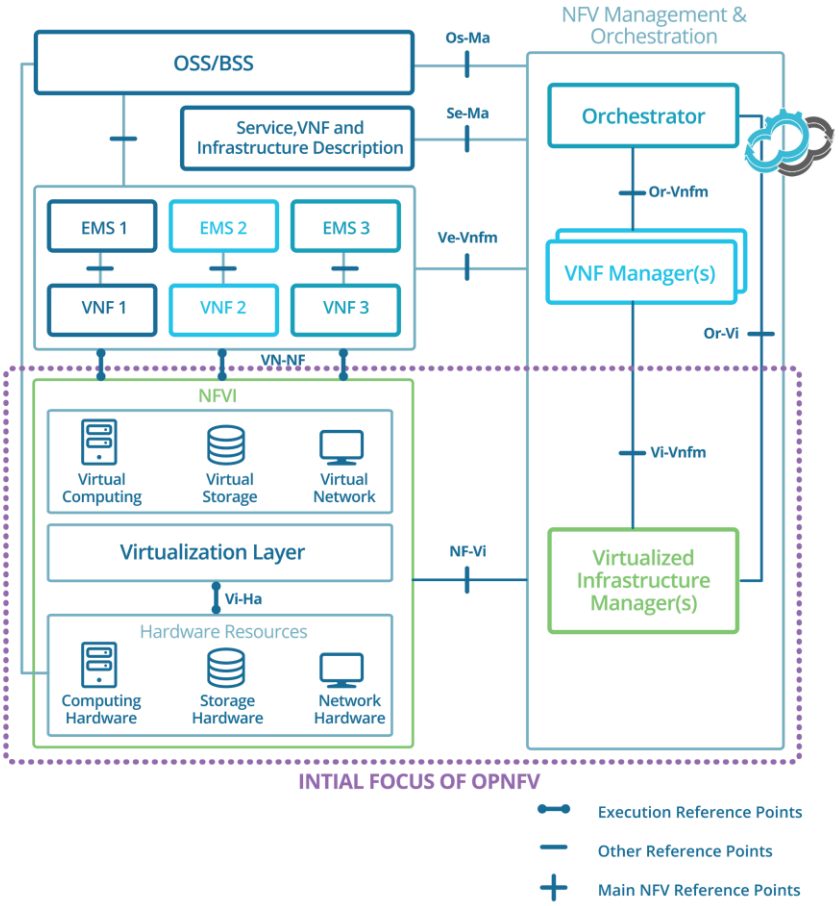


Figure 1: ETSI Architecture with Cloudify Orchestration

ETSI also discusses the MANO specification, which is the management and orchestration specification that currently is just basically theoretical and has no actual existing implementation aside from companies that have written proprietary specifications to materialize MANO in the real world.

MANO is the layer defined by ETSI that manages and orchestrates the cloud infrastructure and resources, and it is comprised of the following elements:

- The VIM (Virtual Infrastructure Manager), essentially controls the interaction of the VNF with the compute, networking, and storage resources of the chosen NFVI (i.e. cloud or virtualization layer).
- The VNFM (Virtual Network Function Manager), is responsible for the VNF lifecycle management - e.g. it takes action on instantiation, termination, failover, scaling in and out, and more.
- The NFV Orchestrator (which is where Cloudify comes in), as its name implies, basically serves the purposes of orchestrating and managing the software and infrastructure resources of the VIM, and realizing the NFVI's network services.

ETSI's MANO is intended to provide the full end-to-end lifecycle of NFV orchestration and management – from installation and deployment through post-deployment, or in the telco industry terminology - Day 0 through Day 2 support.

This brings us to TOSCA (Topology Orchestration Specification for Cloud Applications). TOSCA is a specification by the Oasis standards foundation (the same people that brought us XML), that provides a standard templating language that has been gaining adoption. TOSCA is the direct result of the need to create an alternative and agnostic syntax that is freely available that enables you to describe more advanced functionality scenarios specifically around complex topologies and applications, in a standardized manner.

MANO Based on TOSCA with Cloudify

As MANO is currently just a guideline all implementations of MANO are proprietary, aside from the TOSCA-based agnostic implementation that also enables the plugging in of additional standards like YANG/Netconf for service chaining.

Cloudify essentially plays the role of the ETSI orchestrator, where it not only is able to leverage VNF managers, having an open and pluggable architecture - Cloudify is able to interface with the VIM in the same manner, and even the NFVIs virtualization layer, enabling better orchestration of the lower level SDNs.

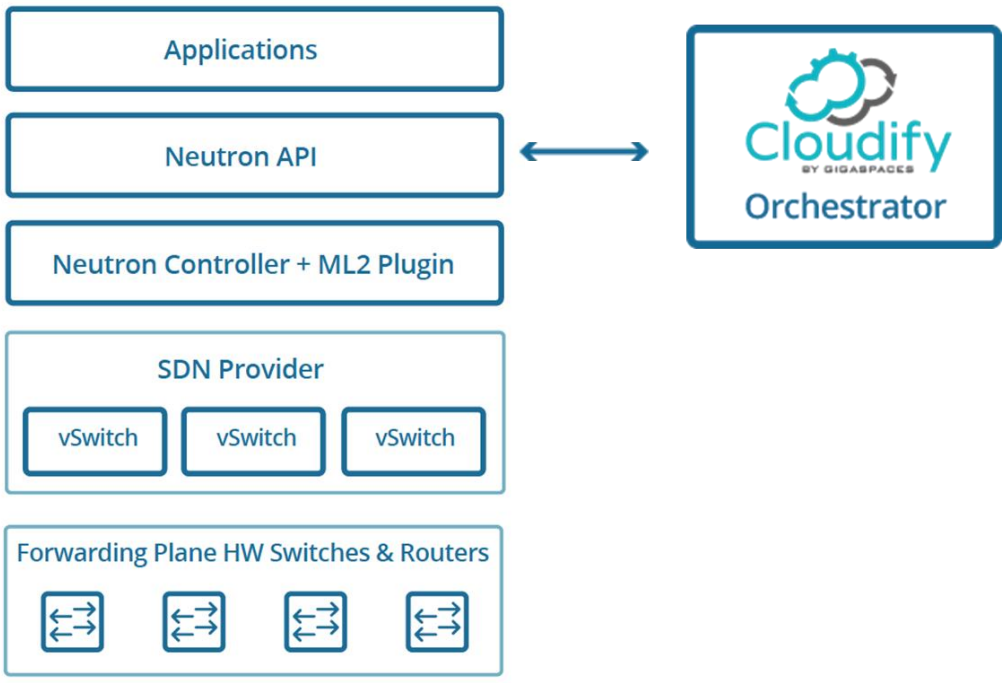


Figure 2: Cloudify & SDN in OpenStack

Key Solution Benefits

Cloudify is the only pure-play orchestration framework uniquely positioned to fit into heterogeneous enterprise and Telco environments, and also includes:

- TOSCA-based, pure-play standard-driven orchestration
- Topology-driven and application-centric management and monitoring of the entire NFV lifecycle
- Integration with any tool chain
- Support for any application stack, with native OpenStack, bare metal, and virtual appliance support (enabling portability to any cloud and hybrid cloud models)
- Support for containerized and non-containerized workloads
- Designed for federated deployment
- Support legacy network functions
- Built in auto-healing and auto-scaling policies for deployed applications
- Embeddable (OEM)

Since Telcos are a very standard driven industry, we're seeing the importance and adoption of a standard like TOSCA becoming an important criterion in the choice of orchestration. As a result, the formerly disparate IT worlds of NFV and enterprises are beginning to converge, and TOSCA has been playing a leading role in becoming the standard for NFV orchestration for both these industries. On top of TOSCA & MANO, many carriers & Telcos use YANG/Netconf for the purpose of service-chaining on the VNF level. With TOSCA as the engine, it is very easy for Cloudify to plugin to other standards, such as YANG to be able to minimize the learning curve, and leverage existing know-how.

Cloudify provides the full end-to-end lifecycle of NFV (VNFs) orchestration – from installation and deployment through monitoring of KPIs, with automatic action taking such as auto-healing and auto-scaling based on these metrics -- i.e. Day 0 through Day 2 support -- all through a simple TOSCA-based YAML blueprint. This significantly simplifies the complexities involved with exposing networking elements to the user by abstracting the networking piece of the deployment into an application blueprint. In addition, the fact that you can setup your network configuration as part of your application deployment allows you to harden security to match the application topology exactly.

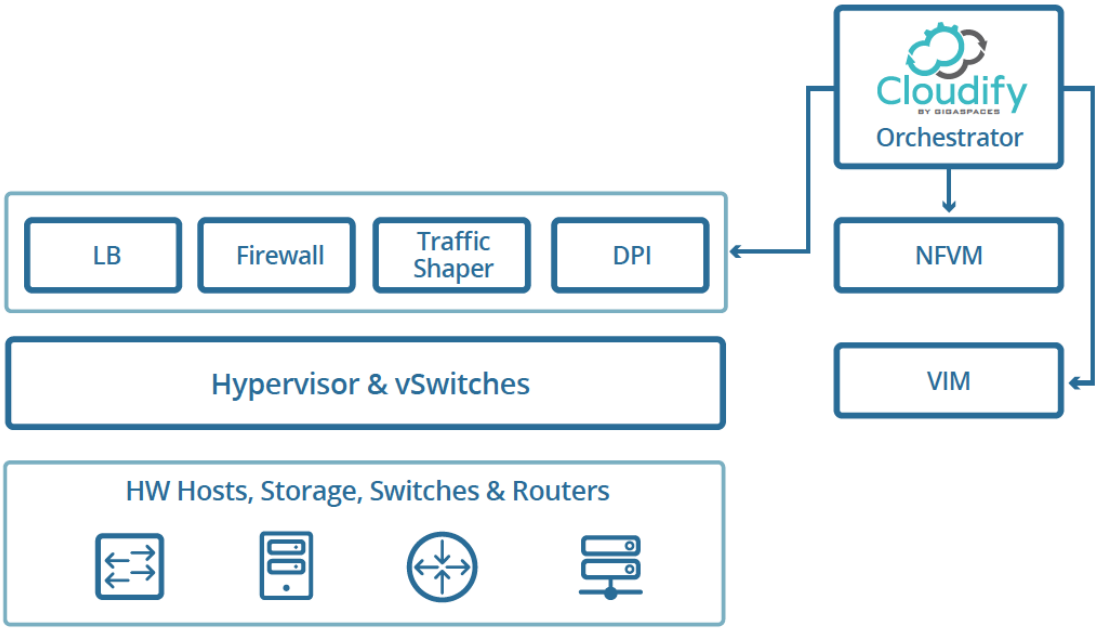


Figure 3: Cloudify in NFV Architecture

Many big Telcos have chosen and are evaluating Cloudify in large part due to it being open source, as well as modular in nature, enabling pluggability with existing and new toolsets and environments. On top of this, Cloudify provides many plugins to interface with peripheral network databases, such as DNS and LDAP, and has already demonstrated its capabilities to orchestrate large subsystems like IMS, internet activation and provisioning per tenant out of the box. With the ability to have one manager that supports multiple clouds (from VMware to OpenStack) as well as multiple data centers and availability zones, Cloudify, is very attractive to mid to large Telcos, ISPs, and enterprises with a hybrid cloud model.

VMware is just one such company that has selected Cloudify as their orchestration platform of choice to launch applications and VNFs on vCloud Air. To watch the recent webinar on this, as well as a live demo visit: [Cloudify for VMware](#).

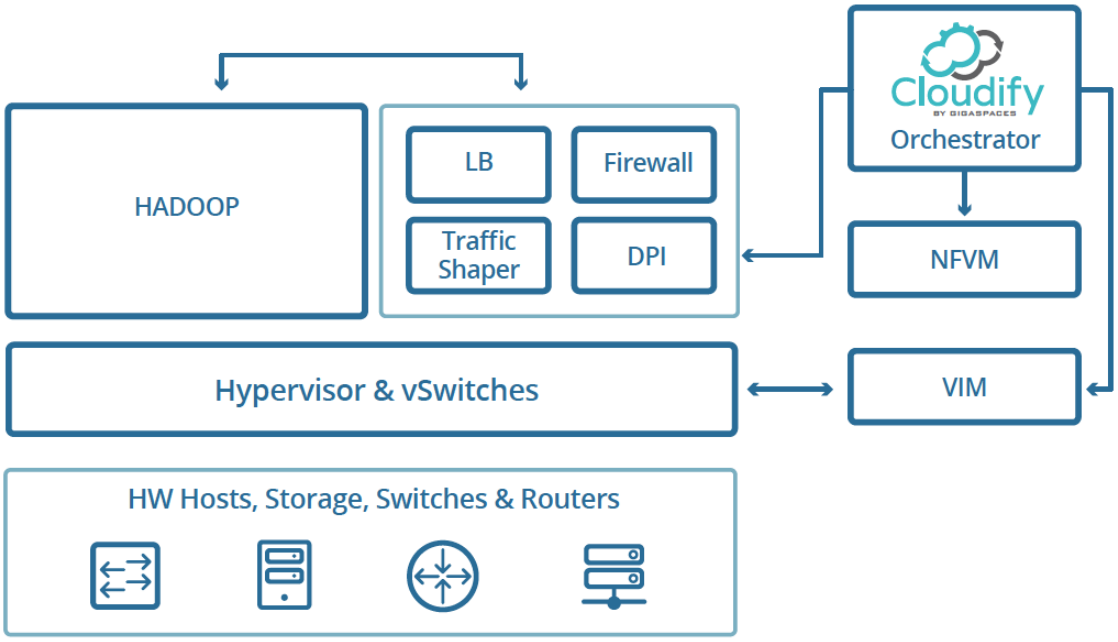


Figure 4: Putting it all Together

Use Case: NFV in a Week with Open Source Tooling

A major Telco was looking to expand its offering to provide on-demand internet connectivity for small to medium-sized offices. This would include a web portal that provides a simple experience to choose an internet provider, as well as infrastructure considerations -- speed, security, and VPN - and any other additional services required, instantaneously, and get connected. Much like on-demand cloud resources.

To be able to truly be able to offer such an added value service, this entire process would need to be automated, be able to support the connection to many devices that are software driven, with consistent management and orchestration.

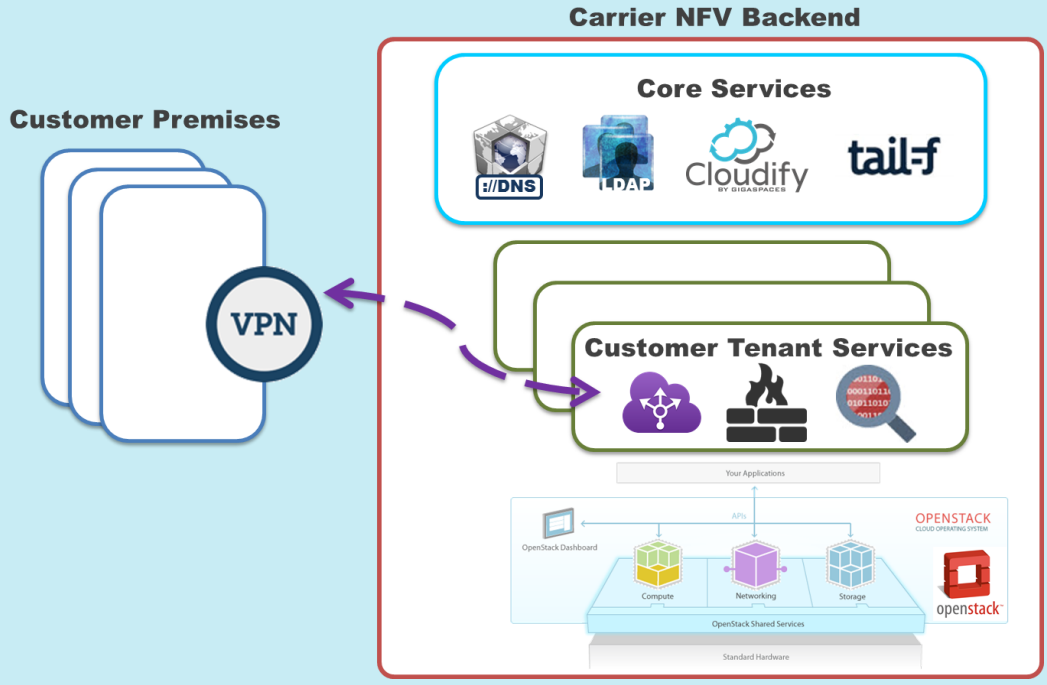
To do so, they realized they would need an NFV architecture, coupled with a standard-driven orchestration engine to provide the backbone for this virtualized networking environment.

Through the Cloudify orchestrator the Telco was able to define a TOSCA blueprint that brings up all of the pieces in the architecture, and places them in the right service chain.

This was how the overall architecture looks, it is comprised of two main parts:

- Shared services which are part of the carrier backend.
- A set of services that are created per tenant/customer as part of the internet activation process – that includes services like vfirewalls, vDPI, vRouter and VPN connectivity.

In some cases Tail-F was also used to configure the network devices after they have been established.



Use Case - Figure 1: Reference Architecture

The Architecture

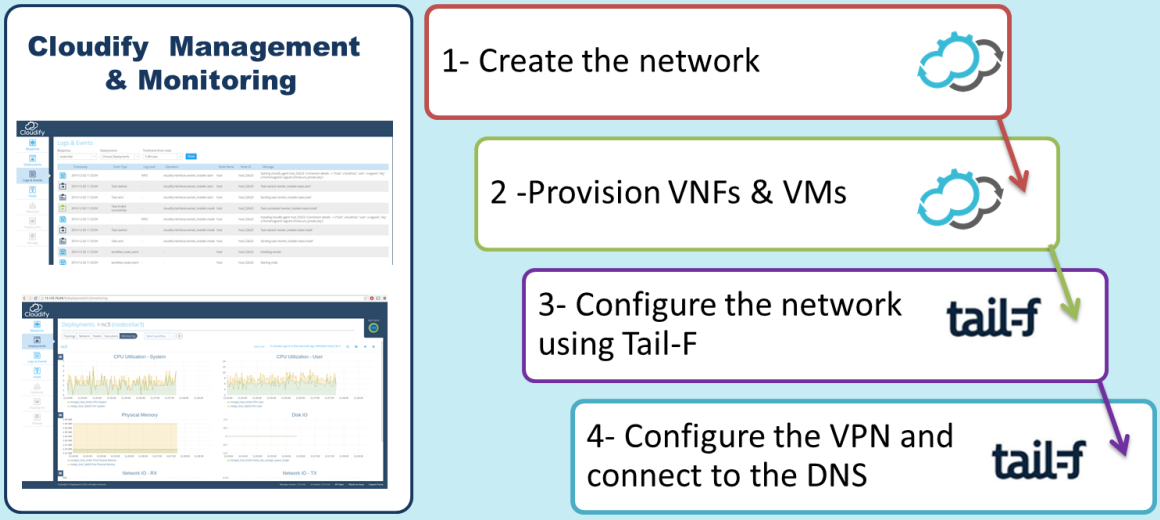
The system architecture that they chose to rely on was an IP aggregator, called an IPAG, which was also the given piece of the architecture to build the orchestration around, which is almost like a switch for internet connectivity in LAN or WAN fashion, just for multiple clients.

Based around the IPAG, the next pieces of the architecture required were first the vCE device (virtual consumer edge), which basically serves as the client-side router piece (a virtual router piece). The vCE has a one-to-one relationship with each customer, meaning every customer that signs up receives a dedicated vCE configured for them. This vCE then connects to the vPE device (virtual provider edge), which is a set of routers provisioned by the Telco that connects to the outside networks, (i.e. the actual internet providers that ultimately provide the internet access to the end user). In between the vCE & vPE, additional NFV devices can optionally be included in the architecture, including virtual firewall, proxy and any other components.

Through the Cloudify orchestrator the Telco was able to define a TOSCA blueprint that brings up all of the pieces in the architecture, and places them in the right service chain.

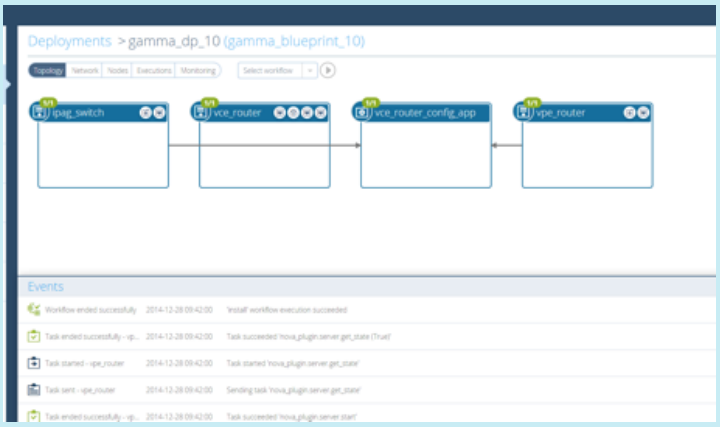
- This starts with the IPAG, which is provisioned first.
- Next the vCE is provisioned on demand along with all of its configurations - routing tables, network interfaces that need to be configured to connect to the chosen internet providers.
- The vPE allows the Telco to connect the customer to multiple internet providers - this ability to connect to multiple ISPs provides an added layer of resiliency for the Telco and client, so that if that one connection hiccups the customer is not affected, as well as more competitive pricing.
- The firewalls, proxy and additional networking components are brought up between the vCE and vPE steps in the blueprint.

This was achieved through the following workflow:

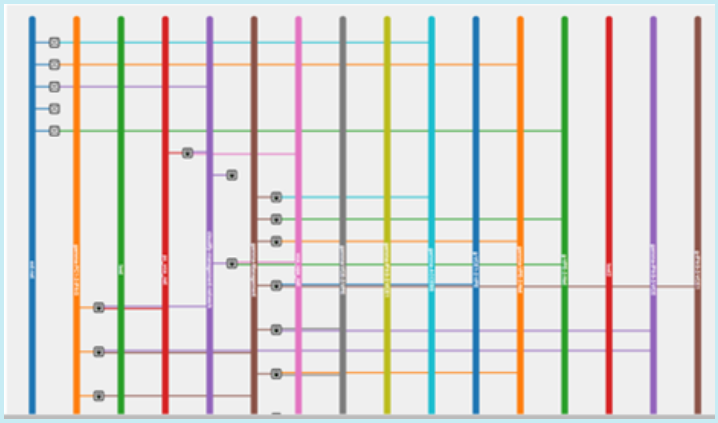


Use Case - Figure 2: NFV Workflow

The resulting blueprint and topology are as seen below:



Use Case - Figure 3: Blueprint



Use Case - Figure 4: Topology

Achieving NFV Automagically

Where previously these routers had to be manually configured, and there would be actual physical router boxes that played the role of the vCE and vPE, this NFV model on top of adding a level of flexibility and time to market formerly impossible with dedicated hardware and software - eliminating the need for time-consuming procurement processes of hardware, and the unscalable and costly model of dedicated staff to configure it.

What's more Cloudify's TOSCA-based pluggable architecture is completely infrastructure agnostic, enabling the Telco to easily move between different data centers or locations by just assigning the NFVs to the different location, providing much-needed deployment flexibility and agility, as well. Cloudify also provides much-needed auto-scaling of NFV resources based on metric and environment changes, out of the box, which was implemented in phase two of the network function virtualization.

This Telco was able to offer customers this new service in less than two weeks, including the entire auto-configuration and post-deployment capabilities.

Conclusion

If in the past with dedicated hardware and software, networking functions were complex and had innate scale limitations, the cloud has now made it possible to expose these aspects to the user, and has enabled dynamic customization as never before. NFV enables the breaking up of the network into the sum of its components, leaving just the software aspects. This coupled with standard-based management and orchestration now makes it possible to maintain the flexibility and simplicity needed in a cloud-based world, coupled with maximum control – a previously complex undertaking.

This added layer of auto-scaling, dynamic resource allocation, high availability, remediation, and the orchestration of complex workflows and processes is the backbone to enabling the simplified management of the diverse VNFs in their service chains, providing the true agility and production readiness required in the competitive Telco and enterprise worlds.

"Network functions virtualization (NFV) is at the heart of some major transformations for telecom operators, but it's only going to work if it remains as open as possible…vendors' enthusiasm for NFV is leading to "a zoo of orchestrators," where each vendor proposes its own variety of NFV management. What's needed is a unified approach, one where all services are managed end-to-end."

Axel Clauberg, Vice president of IP architecture and design at Deutsche Telekom

That said, the complexity this area has seen with the "zoo of offerings" from diverse vendors, has made this area quite confusing to navigate. This where the need for pure-play orchestration, that is backed by a leading standard, becomes important in addressing these challenges. By providing network vendors a TOSCA-based, open source framework (such as Cloudify), that can easily be embedded as part of each solution stack built on standardized orchestration, enables the gluing all of the pieces of these complex systems and solutions together, all with a common management layer.

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