Cloudify Executive Summary for NFV

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NFV (network functions virtualization) is the evolution of telco and enterprise networks from using proprietary, physical network boxes to specialized software to deploy, manage and scale network functions and services on generic, off-the-shelf hardware.

According to a recent survey titled NFV Strategies Service Provider Survey - 2017, operators indicated their top drivers for service provider NFV investments and deployments are:

- Using commercial servers rather than special-purpose network equipment: capex reduction
- Service and revenue agility: new revenue
- Delivering improved customer experience, such as on-demand or self-managed services
- Operational efficiencies: opex reduction

Key challenges for carriers according to the IHS Survey

Many carriers in 2017 are moving from their NFV proof of concept (PoC) tests, lab investigations, and evaluations to commercial deployments by working with vendors that are developing and productizing the software. The carrier mindset toward NFV has changed quickly. In 2014, there was only one significant barrier to NFV: the OSS/BSS. In 2015, 2016, and 2017, the top barriers show that carriers are very serious about NFV deployment.

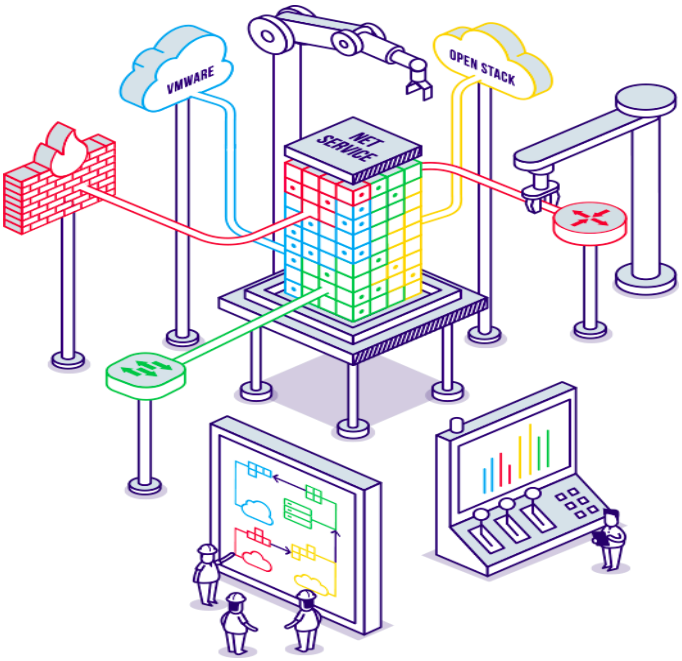
The top two barriers today are:

- Products not mature or carrier grade (76%)
- Integrating NFV into existing networks (52%)

Orchestration-first, model-driven NFV cloud management

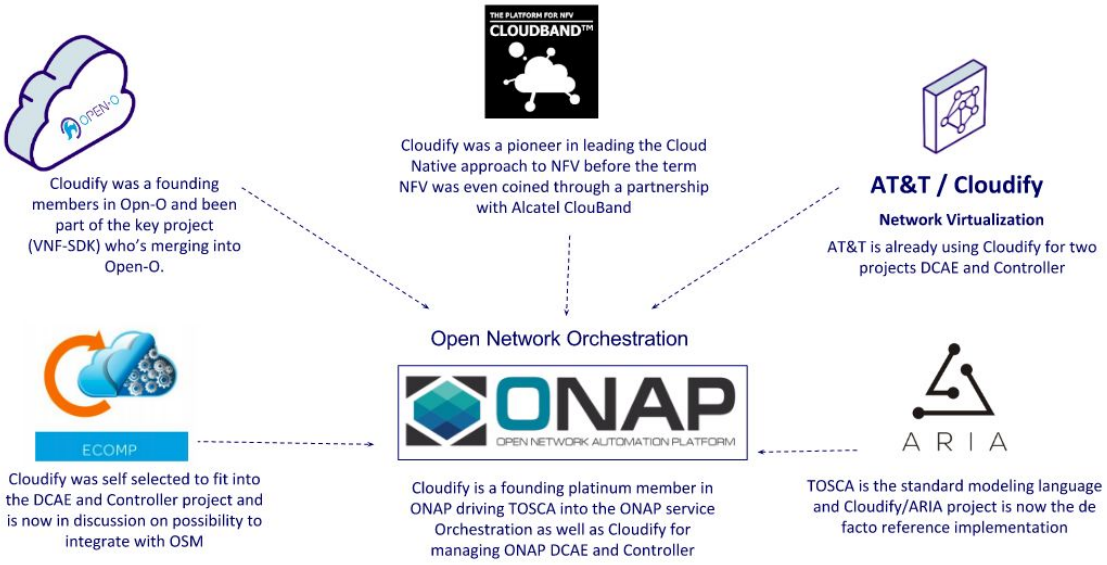
Cloudify is an orchestration-first, model-driven cloud management platform native to NFV, that is open source and based on the TOSCA standard. Cloudify also leads the open governance Apache ARIA project as the core of its NFV-RO and NFV-SO offerings.

Cloudify orchestration introduces a whole new paradigm for telecom providers virtualizing and automating their infrastructure via a process that is short and efficient, enabling integration with their existing network and infrastructure while simultaneously allowing for the gradual introduction of new virtual and network services. This approach facilitates a significantly faster time to market and lowers costs for delivering NFV solutions.

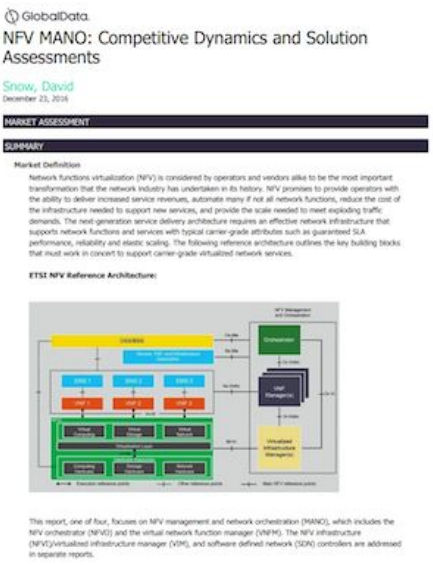


Cloudify is leading the open, cloud-native NFV orchestration movement

Cloudify is an industry pioneer leading the cloud-native approach for Telcos, beginning with an Alcatel Cloud Band partnership, before the term NFV was even coined. It was a founding member in Open-O and included as part of ECOMP. Cloudify is now a founding platinum member in ONAP and leading the TOSCA integration into the core of the ONAP service orchestration through the contribution of ARIA into ONAP. Cloudify is also integrated into the ONAP DCAE and Controller sub projects.



The continued investment in open orchestration has solidified Cloudify's position as the leading open source NFV orchestrator in the market. The industry research firm Current Analysis, now GlobalData, rated Cloudify as "Very Strong and above" with 10-20 live deployments, among the highest number, including NFVO and OSS integration, among the 13 vendors evaluated in its formal market assessment on network functions virtualization (NFV) management and orchestration (MANO).


GlobalData.

NFV MANO: Competitive Dynamics and Solution Assessments

Snow, David

December 23, 2016

MARKET ASSESSMENT

SUMMARY

Market Definition

Network functions virtualization (NFV) is considered by operators and vendors alike to be the most important transformation that the network industry has undertaken in its history. NFV promises to provide operators with the ability to deliver increased service revenues, automate many if not all network functions, reduce the cost of the infrastructure needed to support new services, and provide the scale needed to meet exploding traffic demands. The next-generation service delivery architecture requires an effective network infrastructure that supports network functions and services with typical carrier-grade attributes such as guaranteed SLA performance, reliability and elastic scaling. The following reference architecture outlines the key building blocks that must work in concert to support carrier-grade virtualized network services.

ETSI NFV Reference Architecture:

This report, one of four, focuses on NFV management and network orchestration (MANO), which includes the NFV orchestrator (NFVO) and the virtual network function manager (VNFM). The NFV infrastructure (NFVI)/virtualized infrastructure manager (VIM), and software defined network (SDN) controllers are addressed in separate reports.

"Cloudify, a pure play orchestration solution based on the ARIA TOSCA project, has seen strong uptake and is considered a "very strong" contender in this product category… .information available puts Cloudify at generally the same level of deployment as vendors rated Very Strong and above in this comparison."

The recent momentum around Cloudify and ARIA has positioned it as a reference implementation backed by the recent Light Reading report and OPNFV eBook covering a vCPE and vIMS (Clearwater) use case powered by Cloudify orchestration.

How Cloudify Addresses the Key NFV Challenges

Cloudify addresses the two key challenges, according to the IHS Survey, in the following ways:

Challenge 1: Products not mature or carrier grade (76%)

Cloudify is "battle proven". As previously noted, GlobalData reported Cloudify has among the largest number of NFV deployments used by both the largest carriers as well as small to medium carriers. It is also used today by a growing number of VNF vendors to deliver their own VNFM which ensures consistency between the VNF architecture and the carrier infrastructure. Cloudify also works with the leading carriers in the industry on delivering and defining a standard for open orchestration.

Cloudify also partners with key infrastructure providers including VMware and Intel (both are also investors in Cloudify), and has also been an active and well regarded member in the

OpenStack community since its inception. Other NFV vendors, such as Huawei, provide support for Cloudify as part of their product offerings.

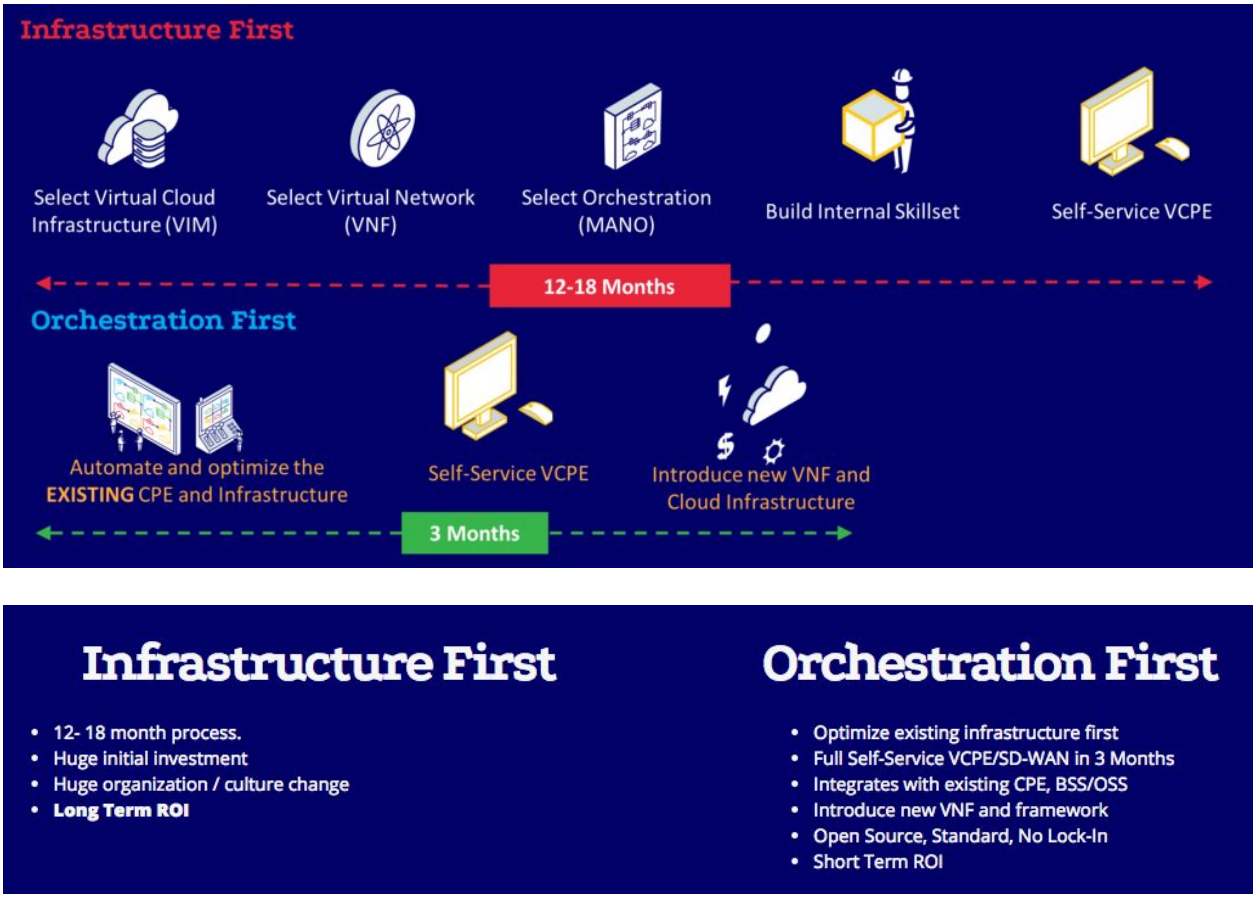
Challenge 2: Integrating NFV into existing networks (52%)

Many of the alternative NFV orchestrators take an infrastructure-first approach which requires customers to first replace their entire infrastructure and network services with a cloud-based, virtual infrastructure with new virtual network instances in order to experience the benefits of NFV.

This process is often complex, lengthy, and very expensive.

Our experience with many Carriers and VNF providers led to a unique solution that will allows for optimizing and automating existing network devices without imposing changes to the infrastructure and only then allowing gradual upgrades on those elements.

We refer to this as the **Orchestration-First approach,** as outlined in the diagram below which compares the infrastructure-first vs orchestration-first approaches.

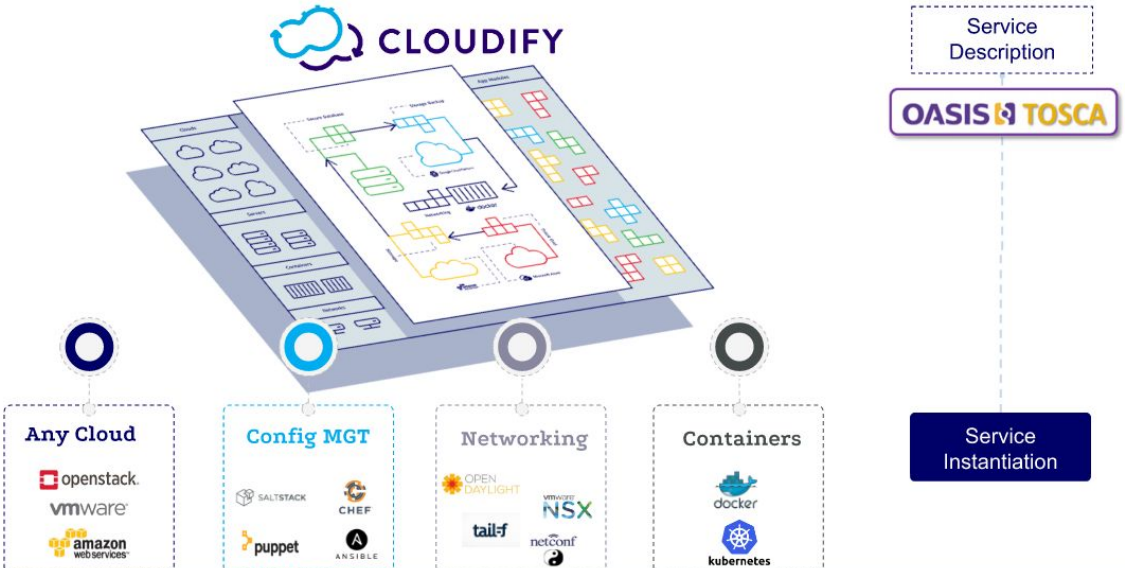


Infrastructure- vs Orchestration-first approaches

To allow this level of integration we recently introduced a set of plugins that enable integration with existing CPEs through the support of Netconf and YANG as well as telnet and SNMP protocols.

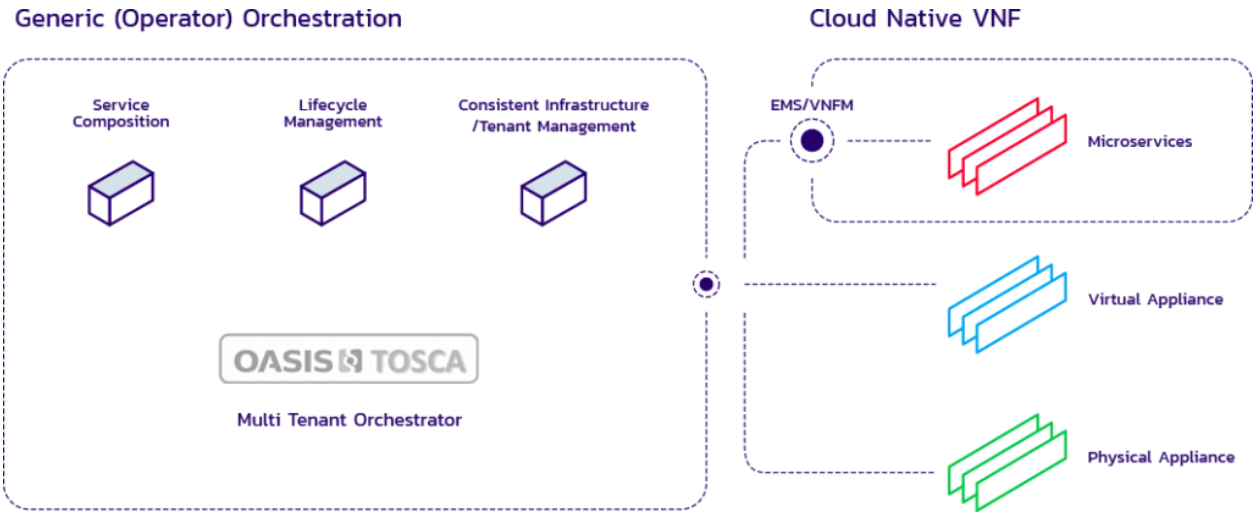
Cloudify Product Overview

Cloudify, based on TOSCA (Topology and Orchestration Specification for Cloud Applications), is built to automate the entire application lifecycle. Developers model their topology once, using a standards-based service modeling language (in YAML format), describing the desired state of the service. The Cloudify orchestrator is responsible for mapping the desired state into a set of execution workflows to interact with the underlying services and infrastructure, which include instantiation of the network, machines, and software installation on those machines once they have been instantiated in the order defined in the service model.



Cloudify Model-Driven Orchestration

Cloudify can be leveraged as both the NFVO and G-VNFM, in the context of the ETSI MANO architecture, and is able to interact with multiple VIMs, containers, as well as external and non-virtualized infrastructure and devices, and OSS and BSS in a brownfield environment, all through a single pane of glass. VNF providers, telcos, and operators alike can realize the benefits of the cloud with Cloudify's assistance in the transition from non-virtualized appliances to virtualized cloud-native network functions, with full lifecycle management and orchestration from the deployment phases, through intelligent placement awareness, service function chaining during runtime, and all the way through Day 2 operations of management, monitoring, self-healing, scaling, and tear down.



Cloudify can be used as full-blown Orchestrator (MANO) as well as embedded orchestrator (G-VNFM) and VNF manager

Cloudify can communicate with any northbound or southbound API, along with any modeling language or protocol - NetConf, RestConf, YANG, Tail-f - enabling service providers, operators, and VNF vendors to plug into Cloudify and revolutionize the way NFV can be delivered today. Cloudify has a Netconf plugin as well as Netconf blueprint that you can find in our examples catalog.

Key features

Cloud-Native Service Chaining

With a model-driven microservices approach it's now possible to model network services and their dependencies into a service chain. Network services can be modeled and provisioned independently from one another, and deployed as an overlay service that stitches together the input and output from each service.

Custom Multi-Tenant Portal

Designed to allow customization of the specific VNF configuration screens, maps, logos, and more.

Generic VNF Configuration toolkit (Netconf, YANG, more)

The configuration toolkit allows to "templatize" the configuration files that are passed into the device with input from the orchestrator engine. This model provides a flexible integration point to manage a large variety of devices without the need for specific integration with each one of them.

Simple VNF Onboarding toolkit

The VNF onboarding toolkit provides a simple wizard for automating the provisioning of new VNFs, auto-generating a TOSCA template. With the wizard users don't need to have advanced TOSCA backgrounds to automate the onboarding of VNF, and shortens the learning curve substantially.

Custom Monitoring

Cloudify comes with built in open metrics database as well as monitoring agents. The data from the agents is sent into the metrics database and can be presented in various formats through the web user interface.

Proven Delivery in Production

Our custom-built vCPE and SD-WAN solution enables the integration of existing CPE and brownfield network devices while providing maximum flexibility to plug-in new VNFs and cloud Infrastructure.

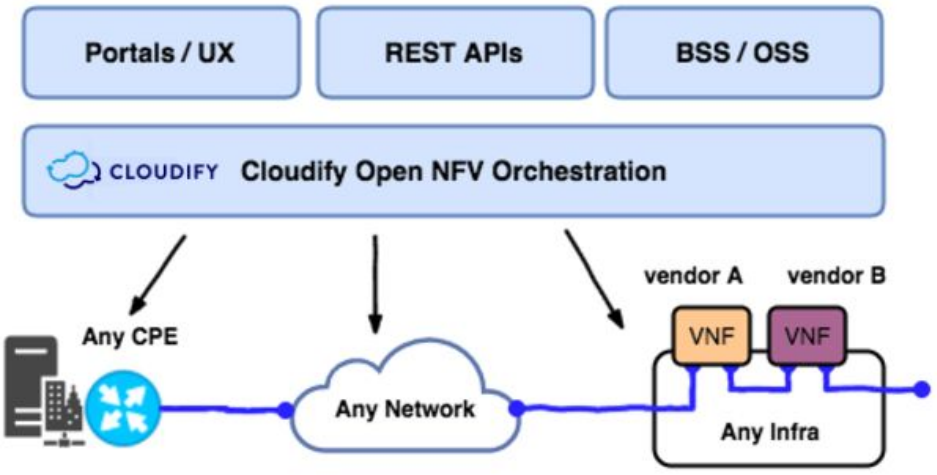
Advanced Patterns

A detailed overview of how Model-Driven Orchestration can be used to deliver specific patterns such as Service Chaining and Microservices are provided in the Open vCPE Design Patterns with TOSCA and Cloudify whitepaper.

Use Cases

Cloudify Open vCPE & SD-WAN Network Orchestration

vCPE (virtual customer premises equipment) is rapidly becoming one of the top priority use case for carriers. Cloudify provides a self-service experience for installing, configuring, and managing network services - firewalls, routers, load balancers, and more - on the customer premises through a central management portal. Cloudify's Open vCPE solution is targeted at carriers and vendors looking for a framework to build their own custom vCPE solution. Combining network configuration framework, simple VNF on-boarding, and a multi-tenant service portal, allows carriers to configure and deploy VNFs, build network service chains and on-board new VNFs in days, where previously weeks or months were required.



Cloudify's Open vCPE Architecture allows integration with physical and virtual CPEs

Fully Automated

Complete end-to-end service lifecycle automation enables reduction of labor costs often associated with each service interaction activation.

Fast Deployment of New Services

The new infrastructure provides a single point of access to the entire networking infrastructure through a single API. This would significantly reduce the ability to launch new services on top of the new platform as many of complexities usually involved in such projects are now carved out completely.

Reduce License Costs

There is a reduction in license costs by avoiding vendor lock-in, using open-source models, and allowing better bargaining position with infrastructure and VNF vendors. There is also flexibility to introduce new VNFs and infrastructure providers without breaking the existing system.

Leverage Existing Skill Sets

The use of existing PNFs and VNFs, along with the infrastructure-first approach, enables us to leverage existing skill sets and significantly reduce the time to deployment of the new service.

Real Life Deployment

The Open vCPE approach has been put to the test recently by a medium-sized carrier, Partner Communications, and Cloudify was the key enabler for reaching a record-speed launch of their new network service offering. It has also opened the door for a new class of services such as security services as well as IT management services.

Custom SD-WAN portal built on top of Cloudify Open vCPE

More details on this specific use case can be found in this post: [How Cloudify Enabled a Telco to Create a Fully Automated, Managed CPE Service - A Use Case]

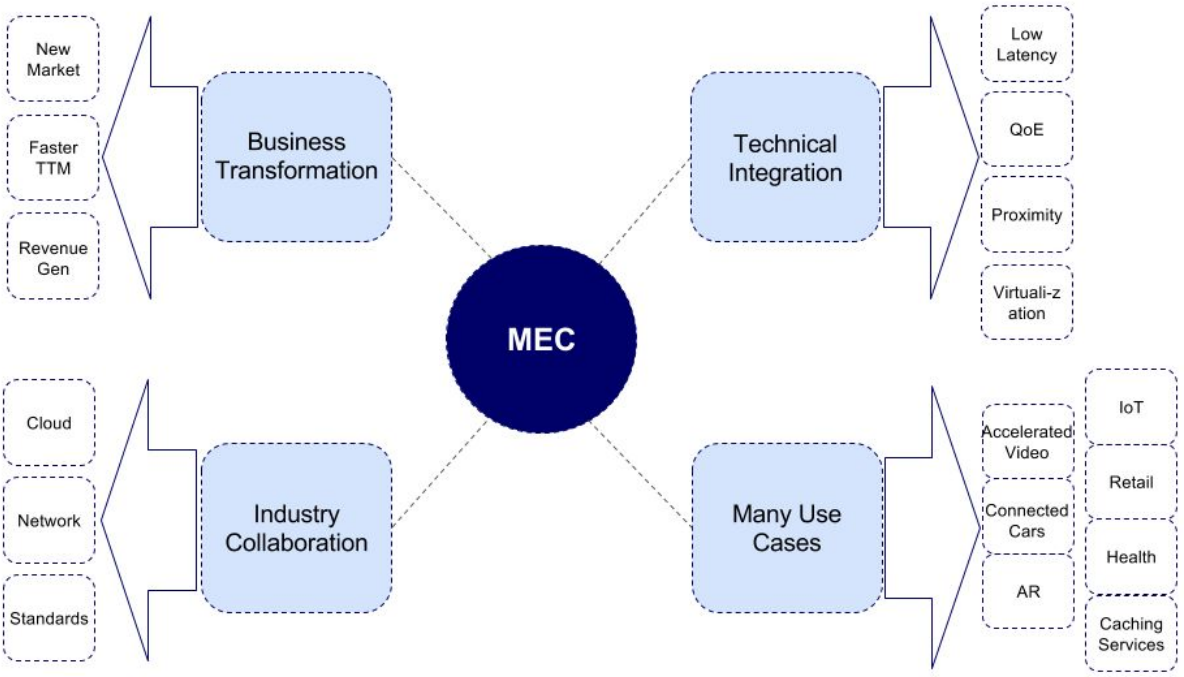
vCPE and SBC VNF Orchestration on VMware

Cloudify provides not only the power of TOSCA and open standards, but also comes with built-in, multi-VIM support which is tightly integrated with the entire VMWare NFV stack. This use case highlights the Brocade Vyatta router as the basis for the vCPE VNF used to connect multiple branch offices and allowing for chaining additional services on the cloud. Metaswitch SBC was chosen to allow the customer to utilize existing on-premise PBX assets while enabling connectivity across branches and to external PBXs managed by a cloud-based Session Border Controller.

You can read more about this use case in this post: [Orchestrating Brocade vCPE and Metaswitch SBC VNFs on VMware Using Cloudify]

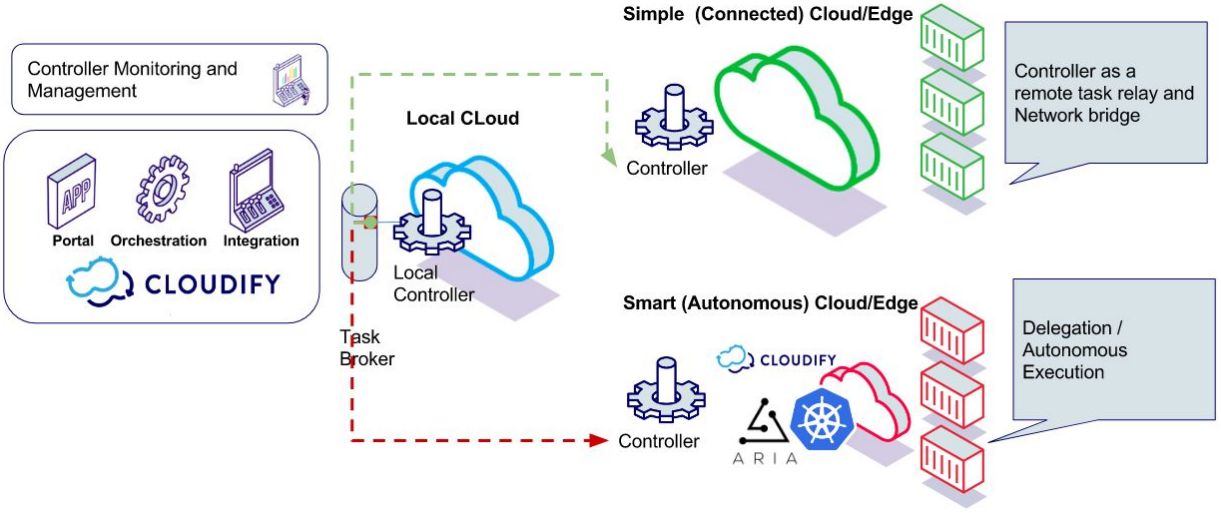
Mobile Edge Computing

Mobile Edge Computing (**MEC**) is a network architecture concept that enables cloud computing capabilities and an IT service environment at the edge of the network. MEC can be seen as a broader extension of the vCPE use case in which the edge can run just about anything, not only network services. This opens the door for many new use cases such as IoT, connected cars, fast image processing, and more.



The key drivers and use cases for edge computing

Cloudify provides a distributed cloud management architecture that allows for a hierarchy of central and local management resources all connected through the same network.



Cloudify's flexible architecture for managing autonomous and simple edge

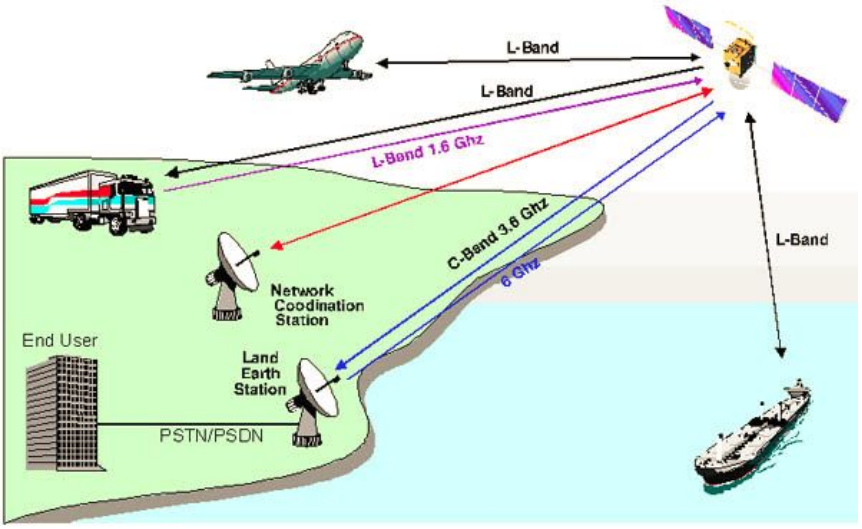
Cloudify's lightweight and highly modular management stack provide a great degree of flexibility for managing extremely lightweight edge devices, using zero footprint network management as well as the ability to run more intelligent orchestration at the edge, and allow autonomous devices, such as cars or ships, to run independent of the central management.

With ARIA built into Cloudify as a single library for lightweight orchestration, it can fit into devices with a small footprint. Cloudify also supports multiple container services

(Kubernetes, Docker Swarm) on bare metal to allow flexible software packaging and upgrades on the edge device.

Real Life Use Case

Cloudify is used today to orchestrate and manage the future satellite network of a leading satellite communication providers. In this specific use case the endpoint can be ships, vehicles, or airplanes and the challenge is handling both low-footprint resources available at the edge with low-bandwidth and high cost satellite network medium, as well as unreliable network communication.

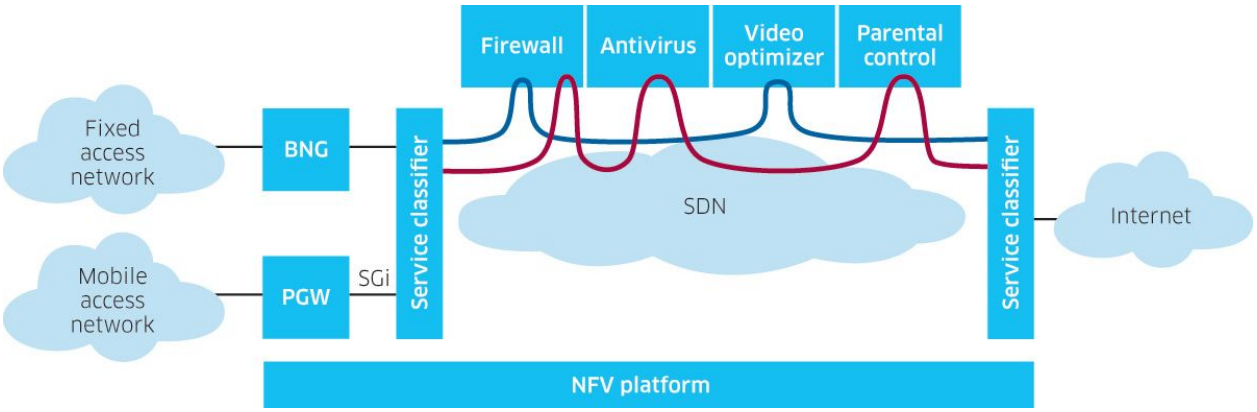


Real Life Use Case: Managing mobile fleet through satellite network

To mitigate these challenges Cloudify uses a smart/autonomous edge architecture, based on local Cloudify/ARIA and Kubernetes. The local edge handles most of the installation, configuration, and maintenance such as upgrade, healing, scaling, etc without dependency on the central manager. In this manner the communication and dependency on the central manager are minimized. Having said that, the central manager maintains a global view of the state of all the edge devices and provides a single control point to manage all the edge devices including the process of maintaining continuous upgrades and more.

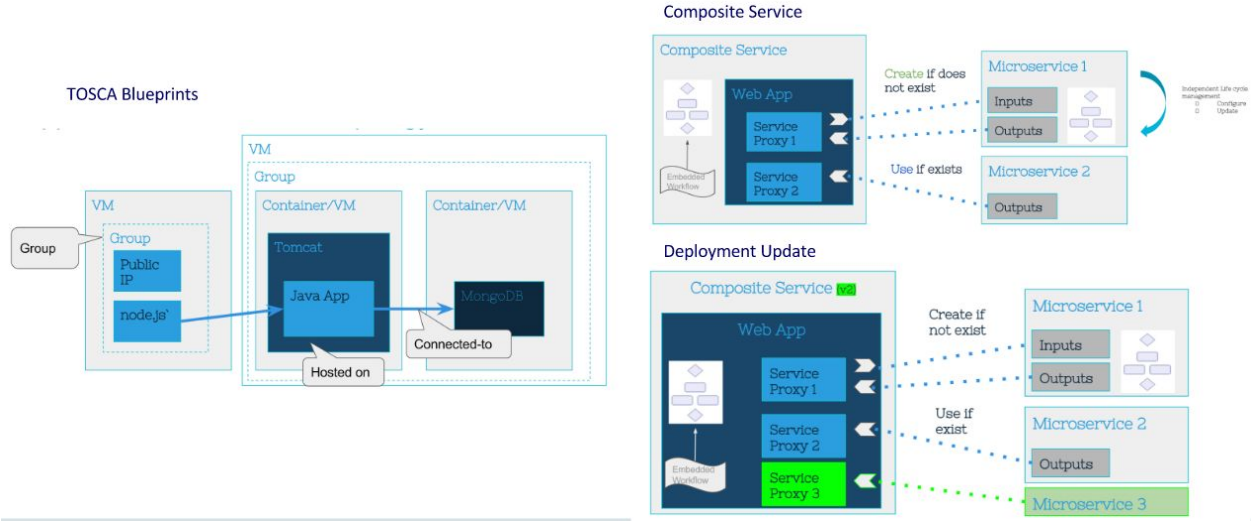
Service Chaining

According to SDxCentral, “Network service chaining, also known as service function chaining (SFC) is a capability that uses software-defined networking (SDN) capabilities to create a service chain of connected network services (such as L4-7 like firewalls, network address translation [NAT], intrusion protection) and connect them in a virtual chain. This capability can be used by network operators to set up suites or catalogs of connected services that enable the use of a single network connection for many services, with different characteristics.”



Typical service chaining architecture (Source: SDxCentral)

Cloudify uses a cloud-native approach based on a microservices pattern to allow more software-driven service chaining that is decoupled from the specific implementation of the underlying network device or SDN. This decoupling from the underlying network gives the flexibility of supporting service chaining on both a physical or virtual networks as described below:



Cloud-native service chaining (microservices) with TOSCA and Cloudify

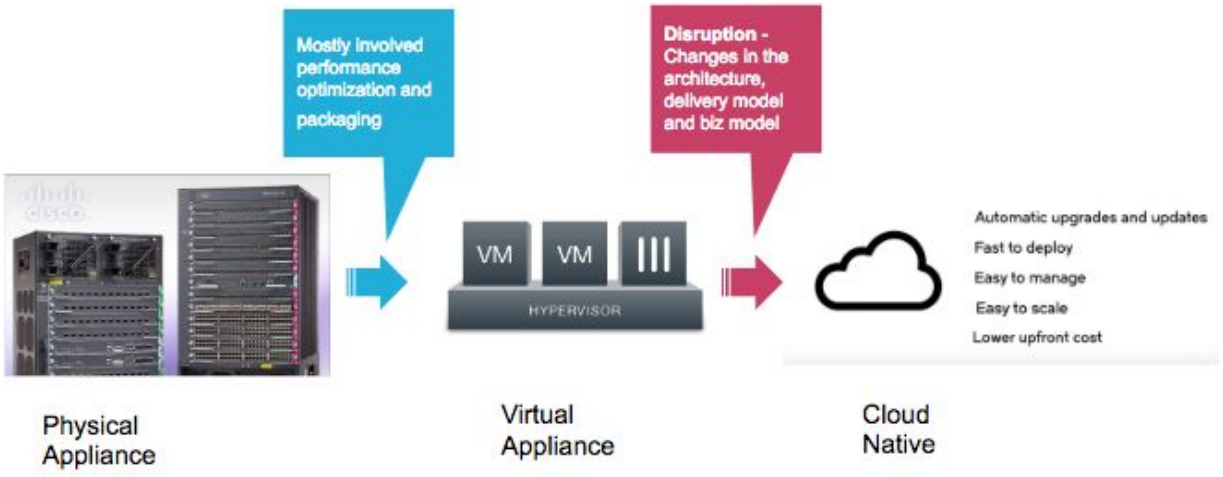
With this approach a service can be described in a single TOSCA blueprint. The TOSCA blueprint provides a rich modeling language to describe the service's interdependencies and workflow operations.

Service chaining is accomplished through the composition of multiple services and passing contextual information between them to allow chaining of the network configuration. The service composition is also defined in a TOSCA blueprint, the only difference being that the elements in this template represent the endpoints of other services.
Blueprint update allows adding or removing services dynamically from this chain. This method of service chaining is known as overlay service chaining. There are cases where it's still required to call the SDN or vLAN network directly. This is known as underlay service

chaining. Cloudify allows a combination of overlay and underlay service chaining by providing direct access to the network services as part of the built-in plugins.

Cloud-Native VNFs

Many existing network functions such as routers, firewalls, load balancers and such, have gone through the first transition from physical appliance to virtual appliance. While this transition required mostly performance optimization to the hypervisor, and other configuration changes, it still does not come close to the capabilities of cloud-native VNFs.



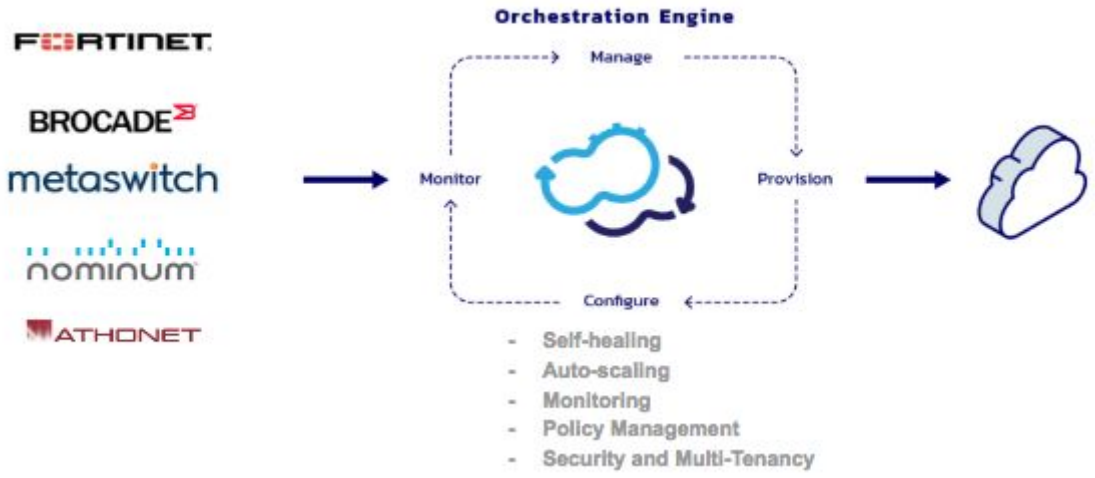
The VNF Disruption: Moving from virtual appliance to cloud-native VNF

While the NFV revolution is still underway, the transition to Cloud-Native VNFs has now begun its disruption of the NFV world, touching on both changes to the architecture (to accommodate hyper-scale and multi-tenancy) as well as a business model that needs to be more consumption-based, rather than fixed.

Many of the requirements for automating the deployment, configuration, scaling etc of cloud-native VNFs can be done in a generic fashion that is not bounded to a specific VNF.

Cloudify provides such a generic engine.

Cloudify & ARIA Cloud-Native Support for Existing and New VNFs



Using Cloudify and ARIA as a light, embeddable VNFM

In Cloudify, a specific VNF can be modeled through a standard TOSCA template. Once that's done the process of automating the deployment of that VNF into a multi-VIM environment, scaling it, and handling any other specific workflows, such as upgrade, can be automated through the Cloudify engine.

Cloudify was also built for embeddability from its inception and therefore designed in an open, lightweight, and highly componentized architecture that allows VNF vendors to embed it and integrate as part of their own management stack. That includes the ability to plug in their own API extensions, workflows, logging, monitoring, etc.

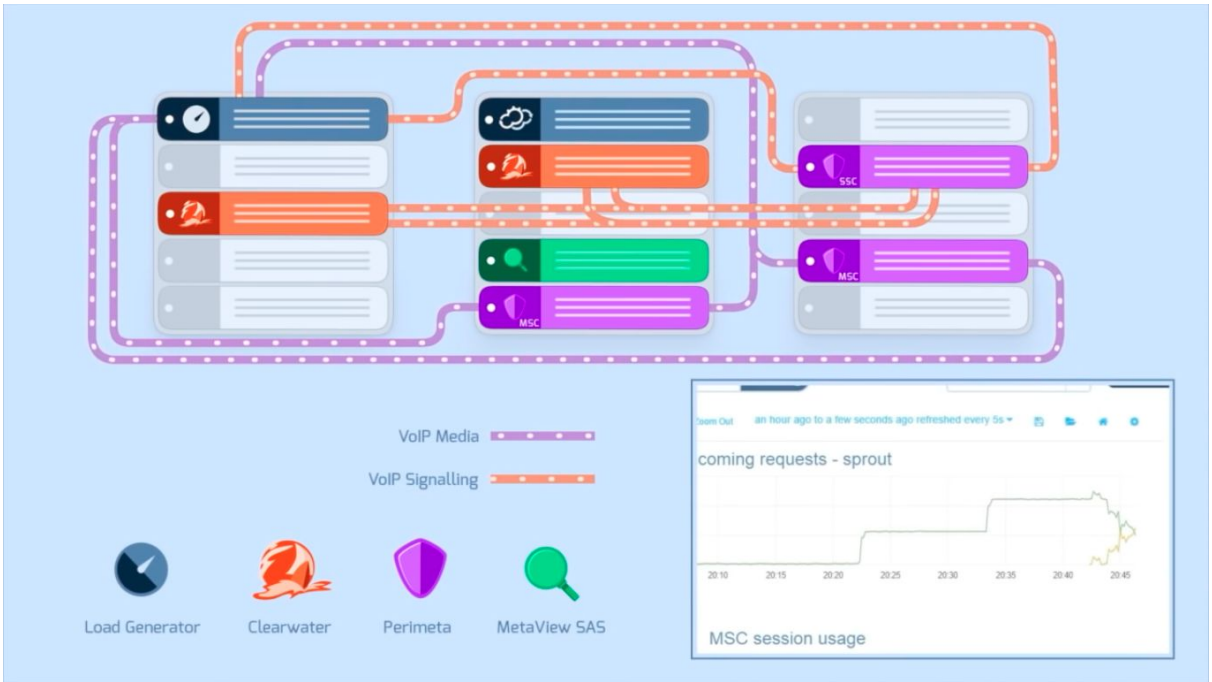
To make Cloudify even more lightweight, simple, and open we launched the ARIA project. ARIA provides a single library TOSCA engine that can be utilized in the same manner as other DevOps tools such as Ansible, Terraform, and the like. ARIA is also an Apache project under the Apache governance model, the most permissive open source model. Along with the support of standard TOSCA modeling, these factors significantly reduce the lock-in risk of using ARIA.

As of version 4, Cloudify also extended its degree of componentization into the management UI which is now based on the React framework. This new UI framework can be easily customized by adding custom widgets and pages, as well as allowing complete white-labeling of the UI under the VNF provider's brand.

Cloudify also comes with a fairly flexible licensing model starting from a completely free and open source offering to a back-to-back support model with the VNF vendor. The company also launched a specific, cloud-native VNF program that was built to reduce risk to VNF vendors by tying expense of the transition to success in revenue-generating production deployments.

Real Life Cloud Native VNF Use Case

As of today a growing number of VNF vendors such as MetaSwitch, Fortinet, and Brocade started supporting Cloudify and integrating it into their own cloud management solutions. A great example of such a case can be seen in this MetaSwitch demo.



Cloud Native ClearWater IMS using Cloudify

Enterprise NFV

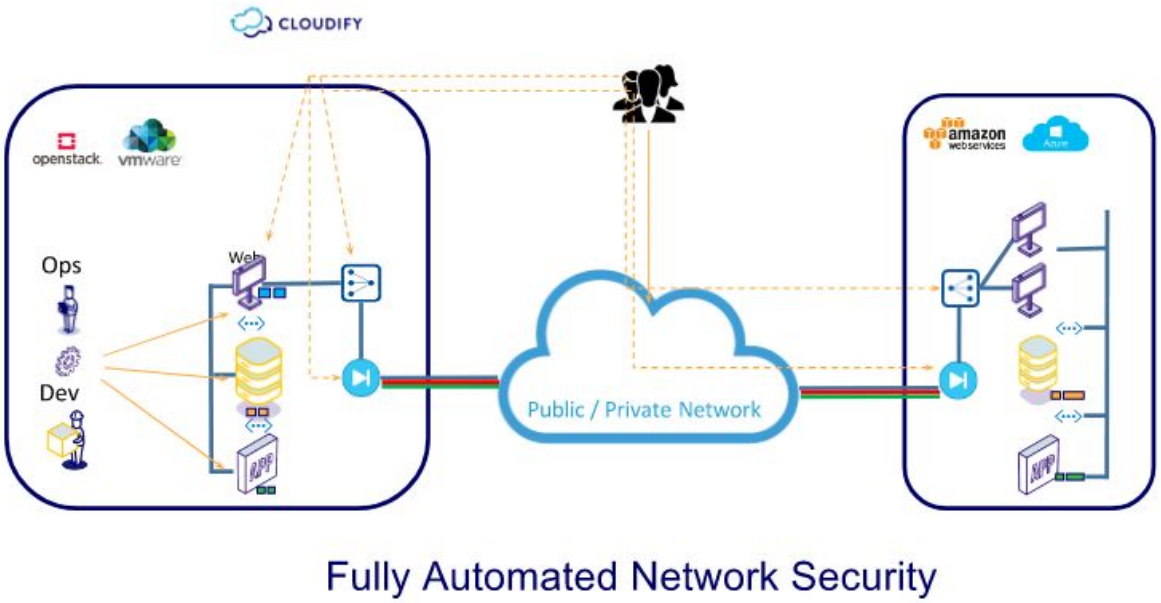
As a result of the enterprise transformation to cloud, there began a transition of enterprise infrastructure into virtual infrastructure on private or public cloud.

Network virtualization has been overlooked during this transformation, mostly because network is significantly more complex to virtualize than compute or storage, as it is comprised of many services such as routers, firewalls, load balancers, network cards etc., and doesn't fit into a single box.

Network virtualization has reached a maturity level where it make sense for enterprises to adopt it as part of their overall cloud strategy.

According to a recent survey, 85 percent of enterprises have a multi-cloud strategy. The move to a multi-cloud datacenter architecture makes network automation and virtualization even more critical as it becomes clear that the manual approach is significantly more complex, and, more importantly, vulnerable as quite often manual configuration implies that port definition, VPN connection, and firewall rules would have to be open to fit the wide range of applications rather than be driven by the application-specific needs.

Cloudify comes with built-in network orchestration that automates the network configuration as part of the application lifecycle.



Benefits:

- Security - Application driven netowrking allow to tighten the network configuration around the application needs. That include open VPN, port, and firewall rules only when needed and based on the specific application requirements.
- Operational efficiency - removes the need for manual intervention
- No Network Left Behind - Fully automated: network configuration becomes part of regular DevOps processes ensuring the firewall rules, load-balancer configuration etc are maintained as part of the application life-cycle and are therefore removed when the application no longer needs them. In this we we can ensure not just that the right configuration is set but also that there are no leftovers which could become later a security hole of its own.
- Preemptive network security - having the network and application as a bundle open the door for preemptive network security policy. For example in the case of a malicious attack users can set a policy to shut down certain part of network or even move the relevant part of application into a different location.

Final Notes

Cloudify has proven itself as one of the pioneers in the NFV and network automation market. Cloudify has been working over the past few years to build a truly open orchestration

product, ecosystem, and business model that is aimed specifically at delivering the true value behind the NFV transformation.

Cloudify is also a leading player in the open NFV movement through its participation in ONAP, contributing its core orchestration, ARIA as an open-governance, open-source Apache project, as well as driving the TOSCA standard to fit real-life NFV use cases.

The Cloudify product has now gained enough success and momentum proving it to be a fairly mature solution with NFV deployments among the highest of any service provider.

In addition, Cloudify continues to innovate not just technologically, but also in its business model and delivery strategy by introducing a new orchestration-first approach to NFV which provides at least 10x faster time to market and lowers costs when compared with the infrastructure-first approach.

Cloudify has also developed a strong partnership DNA and is now partnering with leading infrastructure players such as VMware and Intel.

Appendix A: Reference Material:

- Light Reading report covering Cloudify/ARIA as part of the overall NFV projects
- OPNFV eBook covering a use case using Cloudify
- Analyst report covering the NFV landscape and puts Cloudify in a fairly leading position amongst Cisco, HP etc..
- How Cloudify Enabled a Telco to Create a Fully Automated, Managed CPE Service - A Use Case
- Open vCPE Design Patterns with TOSCA and Cloudify
- Edge Computing with Cloudify (Based on real life use case with Top Satellite Communication Provider)
- An Open Source, Dynamic, and Integration-Based vCPE/SD-WAN Orchestration Service Built with Cloudify
- Openness Is the True Path of NFV
- Orchestrating Brocade vCPE and Metaswitch SBC VNFs on VMware Using Cloudify
- Cloudify Program Cuts Risk to VNF Providers With Consumption-Based Revenue Model for Cloud-Native VNF Development