Enterprise NFV: Use cases, ROI and challenges

NFV primer and NFV architecture

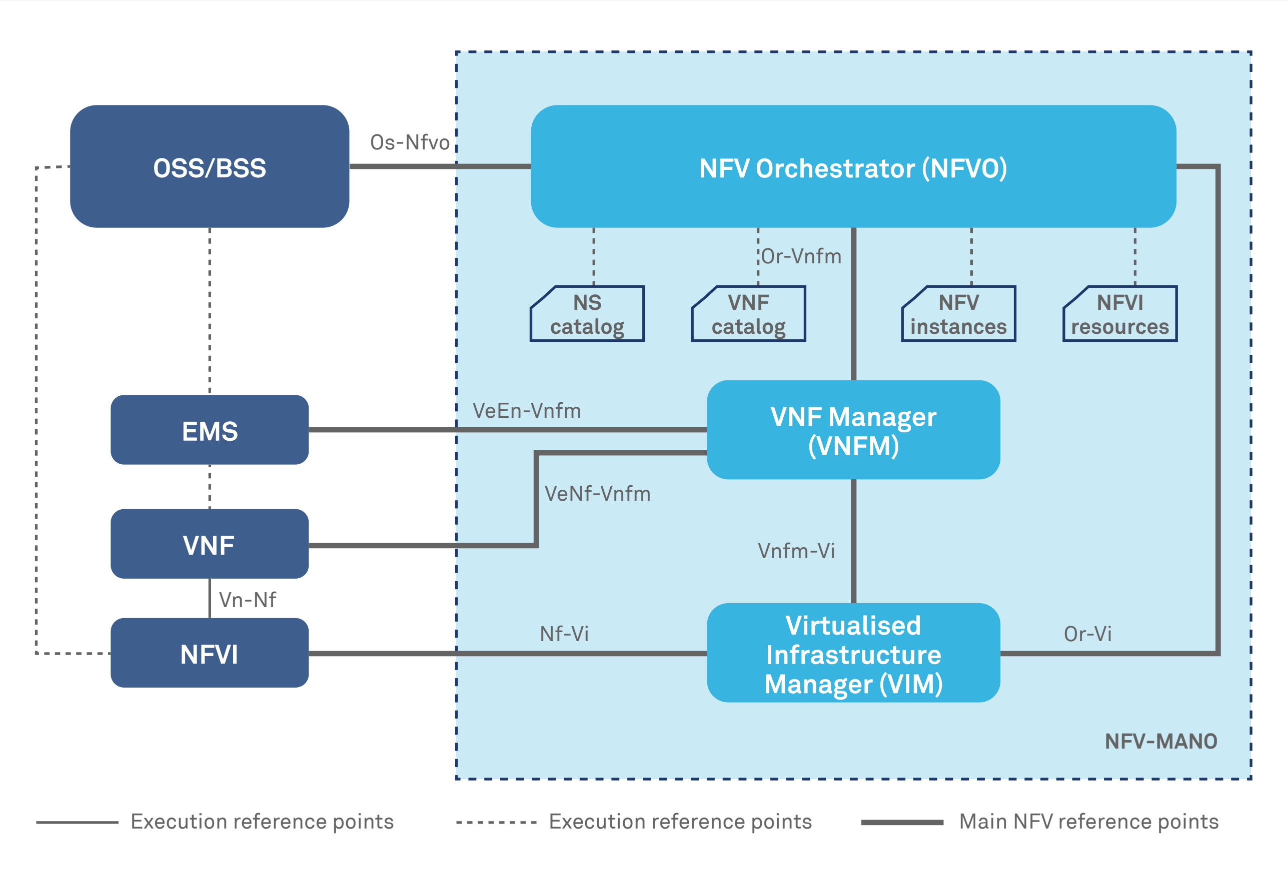
NFV, which is Network Function Virtualization, a concept that leverages the virtualization solution, e.g., ESX (from VMware), KVM (kernel-based virtual machine for Linux) to enable consolidation of many network services on to a standard high capacity server, storage, and network switches. It de-couples network function from the underlying hardware.

The following table list NFV main functional blocks with a brief explanation:

Functional blocks	Explanation
Virtual Network Functions (VNF)	A software code responsible for handling specific network function which can run one or more VMs on top of network infrastructure E.g., vSwitch, vRouter, vFirewall, DHCP, DNS, STB, CDN, CGNAT
Virtual Network Function Manager	Responsible for lifecycle of VNF, i.e. instantiate, scaling(In/Out), update/upgrade, termination, start/stopping, VNF states and operations, monitoring coordinates between VIM and NFVO via Or-Vnfm E.g., Tacker, NetCracker, Cisco, Nokia, Ericsson, Huawei
Virtual Infrastructure Manager (VIM)	Responsible for controlling & managing the NFVI resources, i.e. compute, storage and network resources. E.g., vSphere, Redhat, Mirantis, Oracle, OpenStack
Network Function Virtualization Infrastructure (NFVI)	• Delivers actual physical resources and software where VNFs are be deployed • Leverages virtualization layer, which logically partitions the hardware and resources, provided to VNF for their functioning • Works with VIM and VNFs along with NFV orchestrator • Interconnects compute and storage using networking E.g., White Box Switches, Redhat, VMware (ESXi, vSphere, VSAN), Brocade(Vyatta), Big Switch Networks (Big Cloud Fabric)
Network Function Virtualization Orchestration (NFVO)	• Creates end-to-end service combining different VNFs, that could be managed by different VNFMs • Can either directly work with VIM or NFVI resources without the need of VIM. • NFVO enables NFV solutions deployment either in one POP or across several POPs across multiple resources, for which it works with VIM • NFVO has access to resources and instances to create NFV Solution by utilizing VNF catalogues, network services catalogues, VNF instances, and NFVI resources • NFVO interacts with OSS/BSS of other companies E.g., OpenMano (Github, Telefonica), OPNFV, NSO Cisco, NCX Anuta, Cloudforms Redhat, VMware Cloudify, Cloudband Nokia, Contrail Juniper

The following figure depicts NFV MANO architecture as proposed by ETSI standards organization.

ETSI – NFV management and orchestration architecture



Ref: https//www.sdxcentral.com/nfv/definitions/nfv.mano/

If we were to have this framework from enterprise point of view, the OSS/BSS would play minimal or no role, because the end user is enterprise itself.

1. Various OEM NFV offerings

Let us glance through the NFV offerings that are available from different OEMs:

Vendor	NFVO	VNFM	VIM	NFVI	VNF
Cisco	NSO	Elastic Sevice Controller (ESC) Enterprise Service Automation	SDN controller – VTS Redhat Openstack	UCS servers ISR4000 ENCS-5400 Openstack: Virtualised Network, Compute, Storage	CSR1000V, XRv, ASAv, WSAv, vFirePower, vSCE, vISE NetScaler 1000v, vNAM, vWaaS, CUCM Nexus1kv, VPP/VTS
Juniper	Contrail Service Orchestration		OpenContrail/ Openstack, Contrail Cloud Platform, NorthStar Controller	NFX 250 MX-Series Edge Routers PTX Routers Service Control Gateways → NAT, DPI, Load-Balancing, MetaFabric Architecture Contrail Networking	vSRX, vMX 3rd Party VNFs

Vendor	NFVO	VNFM	VIM	NFVI	VNF
VMware	Cloudify, Amdocs		vCloud Director VIO NSX Manager vCenter	vCloud NFV: vSphere, vSAN, NSX, vRealize Operations, vRealize Logs	vCPE: Antivirus, Firewall, WAN Opti vIMS: IMS Core, Vocie Recording vProb: Correlation & Analytics vEPC: S-GW, MME, HSS, P-GW, PCRF Brocade Virtual Core Mobile (VCM)
Redhat	Openshift, Cloudforms and other following NFVOs: (Procera, Openet, Amartus)		Redhat Opentack Platform	RHEL – KVM (Real-Time) Redhat CEPH Storage OVS + DPDK, Open DayLight Big Switch Dell Power-Edge Servers	3rd Party VNFs, Container VNFs, vDDoS, vCPE, vEPC, vSBC, vRouter, vLB, vFW, VPCRF. vCDN vADC, vIMS

Vendor	NFVO	VNFM	VIM	NFVI	VNF
Ericsson	Cloud Manager		Cloud SDN Cloud execution environment Supports: Redhat Openstack Mirantis Openstack	BSP 8000 HyperScale DataCenter System 8000 Cloud Execution Environment	
HPE	NFV Director		Converged Infrastructure Manager (OneView, CMC)	HP Helion Openstack: (KVM HPE Servers, Storage, Networking)	HPE VNFs
Anuta	NCX		Openstack vCenter Xen, Microsoft	KVM, Hypervisor, XEN-hypervisor HyperV	Cisco CSR1000V Cisco Nexus1000V Cisco XRv VMware DVS Citrix Netscalar-VPX F5 BIG-IP Juniper vSRX Vyatta Router & FW Riverbed Steelhead WAN Opti
Openstack	Tacker		Openstack	Common x86 Server Platform	Native Firewall Native Load-Balancer 3rd Party VNFs

Vendor	NFVO	VNFM	VIM	NFVI	VNF
Nokia Networks	CloudBand Network Director	CloudBand Application Manager	CloudBand Infrastructure Software	Nuage Networks, KVM	Nokia VNFs 3rd Party VNFs
Oracle	Oracle Network Service Orchestrator	Oracle Application Orchestrator	Openstack, Vmware, HPE, Oracle, Dell	Servers, Storage and Networking	3rd Party VNFs
Avi Networks		Avi Vantage Platform	Openstack, VMware: (vCloud Director, NSX, vSphere, VIO) NuageVSP	ESXi KVM Cisco CSP 2100 Cisco Nexus 9000, Cisco ACI	Avi Service Engines
Fortinet			Openstack, VMware: (vCloud Director, NSX, vSphere, VIO)	FortiHypervisor	Fortigate VMX FW, IPS, NAT, DHCP, UTM, 3rd Party VNFs

References for the above tables: Reference 1 in Appendix-1

2. NFV use case and examples

There are several ways to categorize NFV use cases:

- Provider Vs. consumer
- Service oriented Vs. architectural

However, ETSI group has listed following significant use cases under respective logical groups:

Service oriented	Architectural
• Virtualization of mobile core network and IMS • Virtualization of mobile base station • Virtualization of the home environment • Virtualization of CDNs • Fixed access network functions virtualization	• Network functions Virtualisation as a Service • Virtual Network Function as a Service • Virtual Netwoprk Platform as a Service • VNF Forwarding Graphs

Ref: https://www.slideshare.net/opennetsummit/ons2014-andrea-pinnolanfvsdn-synergy

Category	Use cases
Network Access Control	• Campus NAC → E • Remote Office → E • M2M NAC → E • Unified Communication Optimization → E
Network Virtualization	• Data CenterVirtualNetworks → E & Cloud • Campus/Branch VirtualNetworks → E • Data Center Microsegmentation → E • Network Functions as a Service → Cloud
Virtual Customer Edge	• On-Premise vCPE → Telco • On-Premise vCPE (OTT) → Cloud • vCE (Telco) → Telco • vCE (OTT) i.e. Cloud CPE → Cloud
Virtual Core & Aggregation	• vEPC & vIMS → Telco • vPE → Telcom • GiLAN → Telcom • Mobile Network Virtualization → Telco/Enterprise
DataCenter Optimization	• Big Data Optimization → E • Mice/Elephant Flow Optimization → E/T/Cloud
Dynamic Interconnects	• BwoD → T/E • VirtualPrivate Interconnects/Clous Bursting → E/C • Dyamic Enterprise VPN → E • Cross Domain Interconnect → E/Cloud • Multi-Layer Optimization → Telco/Cloud

Ref: https://www.sdxcentral.com/sdn-nfv-use-cases/

3. Understanding NFV ROI

From the various studies and the surveys done by several research groups following critical findings have been highlighted in the year 2016 and 2017:

- IT spending have been stagnant
- Overall year-on-year revenue is relatively flat
- No change in staffing and seeing further downward trend, which means **"doing more with less."**
- The budget priorities focus is more towards following points:
  - Operational efficiency
  - Security
  - Business continuity
  - Mobile Device Management
  - Simplification and Automation of many internal IT processes

The above findings have been synthesized from various sources Reference 2 in Appendix-1

As per a study done by ACG Group[i]:

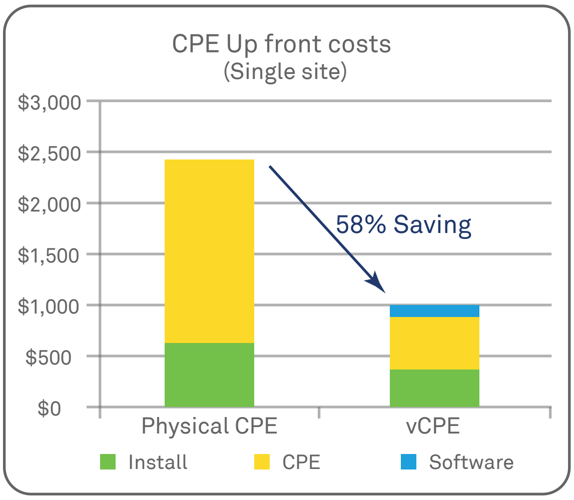
"An ROI analysis demonstrates the rapid payback and high ROI of a phased move to the common platform from the appliance-based approach. The low-cost NFV nodes of the common platform and ability to produce sustained labor productivity and asset efficiency gains are shown to achieve payback in under a year and produce more than 350 percent ROI over five years."

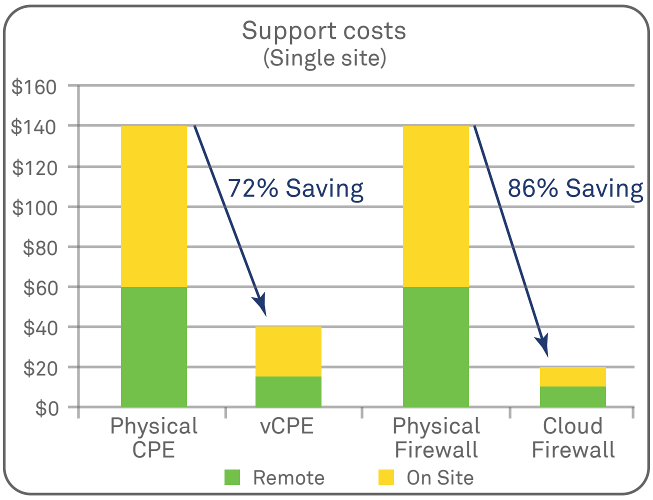
The considerable ROI return is mostly coming from:

- Lower cost of NFV nodes (standard x86 platform) versus appliance-based nodes
- Gain in productivity of the enterprise' design and deployment team
- Utilizing standard x86 means common platform for NFV, resulting in increase in efficiency of the asset management

In the year 2016, another study by ACG group on Business case on programmable NFV/SDN networks jointly with Juniper Networks came out with following findings based on NFV Use Cases:

a) Single-Site comparison achieved by virtualizing CPE
Up-front CPE costs are reduced by 58% and Virtualization reduced by support costs by 72%





The study was focused on a service provider typically serving 75,000 small, 5000 medium, and 2,000 large businesses. The unit cost of virtual CPE comes out to be 72% lower than traditional CPE.

b) Real-Time Network Self-Optimization

Self-Optimization is not possible with traditional network architecture because of many manual interventions. The study shows 27% TCO savings compared to a manual engineered network which comes lower cost per port, transport, and edge power savings. The automation reduces network engineering labor

c) Elastic Traffic Engineering

Elastic traffic engineering enables dynamic traffic optimization by having a global view of all possible paths in the network. This results in efficient utilization of capacity. In the study done, this use case realized 35% reduction in link CAPEX savings when compared with the present mode of operations.

4. NFV deployment challenges

Deploying NFV can be very challenging, and the crucial ones have been highlighted in ETSI* drafts:

1	Portability and Interoperability	Standard interface required to enable interoperability between various virtual network functions that will run on the standard x86 interface. Also, the VNF should be portable as it allows for optimal usage of the resources of the virtual appliances and their location
2	Performance Trade-Off	The resource need of the VNFs should be accurately known and matched with that of the underlying standard hardware since there will not be any customization of the platform to enhance specific functions such as throughput. There is a possibility of performance degrade if underlying virtualization technology is unable to allocate the required right CPU and memory resource to the several VNFs that could be running on it
3	Migration and Co-existence of traditional and compatibility with existing platforms	The migration to the NFV-based architecture is long duration process and mandates that VNFs and virtualized platform seamlessly interoperate with the legacy network appliances which may not be available in the virtualized form today
4	Management and orchestration	Instead of managing VNFs individually which could be deployed in several hypervisors, it is wise to have an orchestration layer which is compatible with OSS/BSS, Element management system. This is enabled by having all the VNF managers having standard North-bound interface towards the orchestration layer. This will also bring in the visibility in the underlying common pool of resources of computing, network, and storage provided by under lying NFVI components. SDN plays a key role as it allows all the functions to be defined in an abstraction manner dis-aggregating the data plane from the control plane
5	Automation	Every VNFs that will run on the common platform must support automation via standard application programming interfaces for the VNF manager and orchestration to configure and manage them in a collective fashion
6	Security & resiliency	There should be a compromise on the security and high availability when VNFs are being deployed on the virtualized platform. It should provide the same or even better security than the equivalent physical appliance. This requires various virtualization solutions to be compliant with the security standards
7	Network stability	Due to several VNFs running on the common platform, there will always be a fight for resources such as CPU, memory, and network leading to a possibility of severely impacting other VNFs. So a mechanism should be in-built that keeps checks and balances the network resources between different VNFs

8	Simplicity	The virtualized platform must be simple to operate and manageable from a centralized location and at the same time allowing orchestration of several VNFs
9	Integration	VNFs must run on any multi-vendor servers on any virtualization technology as this brings in a significant reduction in the integration costs and avoids vendor lock-in at all level of the infra. This brings up following key needs: The 3rd-party support which can resolve integration issues between multi-vendor platform, VNFs, and multi-vendor virtualization technology. Tools that can validate such kind of integrations

*ETSI - European Telecommunications Standards Institute, an institute that defines standards and drafts various technology. One of them is NFV

Conclusion

As explained in the above section the NFV transformation is not without challenges, but the economic benefits, one among the many benefits of NFV, outweighs the difficulty and hence it is of immense value to walk this path. It usually begins with the study of the current state of the infrastructure to identify the network components at a site. Then plan for a proof of concept and then full migration in a phase site-wise approach. Also, the integration of various solution components from multiple NFV OEMs, as per the reference architecture, will ensure a simplified, robust and open to further innovation via programming interfaces and a composite NFV solution.

About the author

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Ravindra K Botkar has 15+ years' experience in N&S, encompassing several project deliveries. He is currently part of GIS SDx team, as Principal Consultant. He has made key contributions to network automation of legacy and ACI via Python and Ansible, in addition to integration use cases around Openstack, Cisco and L4-L7 devices. His recent execution of Cisco ACI solution using automation for a bank in APAC has been widely acknowledged by Cisco. His current interests are in DC technologies and automation. He is currently architecting SDN solutions with specific focus on Open Networking.

5. Appendix-1

Reference 1:
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Reference 3:
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