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Applying Thought

An Integrated Validation Approach to SDN & NFV

Key challenges, implementation strategies and the road ahead.

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Abstract

As a matter of convention, network elements and applications are managed independently and the absence of a real-time communication on making changes either to network elements or applications results in several challenges. SDN attempts to address many of these challenges by allowing independent innovations at control-data planes and providing a comprehensive view and programmability of the network.

NFV on the other hand, looks at alleviating the challenges of building and maintaining a "physical network" such as heavy Capex, proprietary hardware, long deployment cycles, fast obsolescence resulting in frequent hardware replacements by virtualizing network node functions to run on Commercial Off-The-Shelf (COTS) hardware platforms.

This paper discusses the synergies that SDN and NFV bring in and the problems affecting enterprises and service providers in their efforts towards the creation of an efficient SDN / NFV infrastructure. It also details the ideas, plans and processes behind a new Validation Approach necessary for a virtualized environment.

Introduction

Traditionally a "physical network" of interconnected nodes and applications presents a number of debilitating challenges to enterprise and network operators:

» Ever-increasing proprietary hardware management

» Heavy upfront investment

» Delayed service deployment cycles

» Rapid device obsolescence driving frequent hardware replacements

» Specialized workforce requirements

SDN and NFV are geared to tackle the challenges mentioned above. While SDN centralizes network control, NFV answers the problems of a physical network by virtualizing entire classes of network node functions.

SDN - NFV: A Synergistic Relationship

Despite the possibility of implementing NFV without a SDN and vice-versa, the effective combination of the two can potentially unlock significant value. By integrating SDN and NFV into a composite whole, control and data planes can be clearly segmented; operators can optimize performance, simplify compatibility challenges with current deployments and facilitate ease of operation and maintenance procedures. Figure 1.1 illustrates the SDN and NFV relationship.
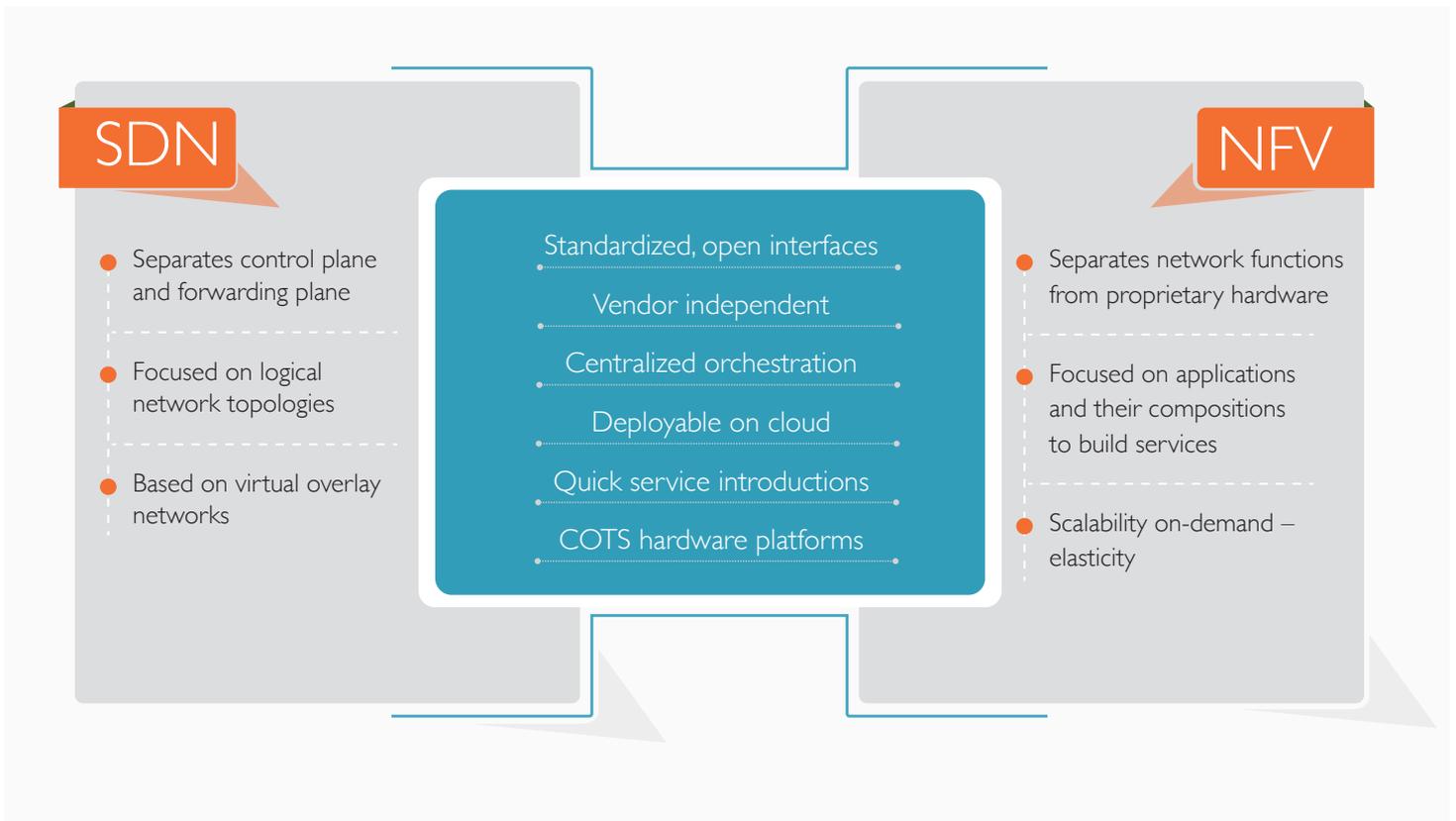
SDN

- Separates control plane and forwarding plane
- Focused on logical network topologies
- Based on virtual overlay networks

Standardized, open interfaces

Vendor independent

Centralized orchestration

Deployable on cloud

Quick service introductions

COTS hardware platforms

NFV

- Separates network functions from proprietary hardware
- Focused on applications and their compositions to build services
- Scalability on-demand – elasticity

Figure 1.1: SDN and NFV Relationship

Further NFV can also offer support to SDN by providing the essential infrastructure upon which the SDN software can be implemented. Additionally, NFV works in close alignment with SDN objectives to use commodity servers and switches

Key challenges affecting SDN - NFV adoption

Before outlining the Validation Approach, let's take a look at the major challenges that a robust SDN - NFV blueprint must overcome:

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	Openness and Standardization	Most traditional network equipment vendors' approach to Open SDN does not reflect ideas like open code, architecture and adherence to standards like ONF, ETSI, etc.
	Performance Management	Migration to generic COTS-based hardware involves the minimizing performance degradation on latency, throughput and processing overheads.
	Co-existence and Compatibility	For existing IT and SDN / NFV executions to converge, the SDN and NFV implementation must co-exist with the operator's legacy equipments and be compatible with their OSS, BSS, Element and Network Management Systems.
	Portability and Interoperability	Interoperability and portability between multiple vendor solutions and standards is crucial for a SDN/NFV orchestration. It establishes the ability of NFV to load and execute virtual appliances in different but standardized data center environments, provided by different vendors for different operations.
	Tools	Absence of standard tools to measure SDN/NFV functionality and performance on reliability, stability and portability poses a challenge to the adoption of SDN and NFV.
	Skill sets	As the industry moves towards cloud deployment, the availability of skilled man power with the ability to design, build, support, validate and manage a new software-centric carrier network over a long time is a major challenge.

Table 1.1: Key Challenges to SDN - NFV

The shift from a hardware-focused implementation to a hardware and software based cloud-centric approach poses a major challenge for SDN and NFV validation. SDN and NFV mostly relies on COTS hardware platforms and this implies a fundamental revision of traditional testing methodologies.

Further, there are several new validation challenges which arise due to a plethora of factors - Multi-vendor software, protocols and API inter-operating in COTS environment.

While engineering the validation solutions for SDN and NFV, a number of qualitative and quantitative criteria and dependencies need to be evaluated:

» What kind of server resources - memory & CPU - must be allocated for each function?

» Should resources be optimized for specific functions?

» Can the platform ensure composite compatibility and successful co-existence between the SDN-enabled infrastructure and existing legacy networks?

» Where will the NFV be deployed? Will NFV location affect service delivery due to network delays?

» How can SDN and NFV be rendered scalable? Is automation required? And how would this be integrated with the Cloud?

Given the above environment, it is essential to introduce a robust and reliable validation approach for the smooth migration of network functions and programmable and scalable network to the cloud environment.
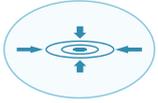
Integrated approach to SDN - NFV validation

As we move proven network functions such as routing, policy, firewall, DPI and many other from physical hardware-based appliances to running on unproven virtualized server platforms, it necessarily calls for the complete re-validation of previously deployed network functions along with Network Function Virtualization Infrastructure (NFVI) and network orchestration components.

The network orchestration may primarily consist of SDN controllers which deliver a complete view of the network and has the flexibility to provision, manage and de-provision network elements according to NFV orchestrator's instructions.

Typically SDN controllers are connected to cloud orchestration frameworks via appropriate North Bound APIs (e.g. Neutron Module in OpenStack); hence an integrated validation approach is necessary to ensure end-to-end network services. Figure 1.2 depicts the integrated SDN & NFV framework.
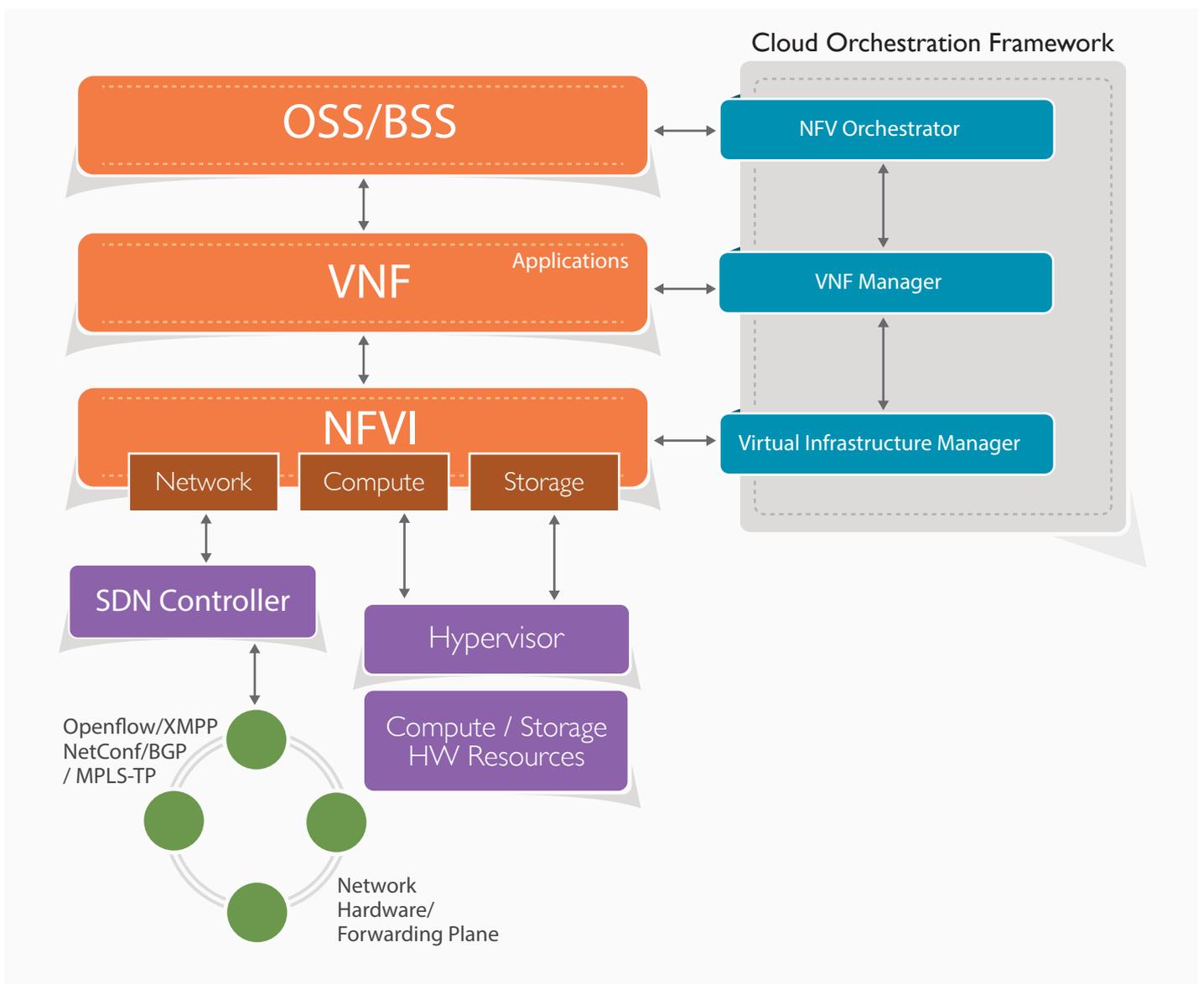

Figure 1.2: NFV Blueprint

The fundamental pivots of a SDN - NFV validation approach

As we begin to appreciate the many factors influencing an effective SDN - NFV Validation Approach, let's look at the focus test areas involved therein:

Cloud infra [NFVI] validation
– hypervisors, compute, storage

- Performance and scale
- Security
- Interoperability
- Identity and access managment
- Reliability and disaster recovery scenarios

Network layer validation
– SDN control plane, data plane, SDN APISV

- Protocol conformance
- Functionality
- Scale and performance
- Interoperability
- Security
- API functionality and integration

API validation across NFV layers

- Compatibility
- Functionality
- API Performance and Consistency
- API Environment Security

VNF security validation

- Vulnerability and penetration tests
- DDoS, packet filters, dynamic and intelligent ACLs
- Security between VNFs
- Auditing of security event logs
- Identity and access management
- Tenant isolation

Management and orchestration layer validation

- SW/HW provisioning & management
- DC resource pool management
- Log, alarms & accounting management
- Federation of DC resources
- Template / SW repository
- Catalog, configuration management database (CMBD)
- Domain management
- Customer / user management
- Catalog management
- Capacity management
- Bulk provisioning and on-demand scaling
- Multi-tenancy scenarios

Layer validation

- Individual VNF functionality
- Life cycle management - on-boarding, provisioning and tear-down of VNF
- Service chaining
- Validation of forwarding graphs
- End-to-end services validation
- Elasticity
- Multi-vendor inter-operability
- Reliability and disaster recovery scenarios
- Performance and scale scenarios

Table 2: Integrated Validation Approach and Focus Test Areas

The Way Forward

SDN and NFV have together created a new paradigm for network operations and services. New levels of innovation, which were not possible earlier with existing legacy systems, have come to the front. Many operators are now testing, demonstrating Proof of Concepts (PoCs), learning, and making the push towards commercialized services in contained domains.

Virtualization demands a complete overhaul in the validation approach - an integrated and layered approach for SDN - NFV is of immense importance for ensuring cost-effective and successful transition of box-based appliances and their functionalities into a virtualized network environment.

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