

**A practical approach to validating  
Virtualized Networks  
enabled through SDN and NFV**



# Introduction

The technology landscape has evolved radically in the last few years and virtualization has been a god-send to organizations that are looking to drive down their capital and operational expenses while being able to respond to market needs much faster. Interestingly though, while Computing and Storage have progressed leaps and bounds by tapping into the potential of Virtualization, it is only now that Networking seems to be catching on in a major way.

Owing to the massive growth in user traffic due to ubiquitous 'digital transformation' occurring across various industries, global communications service providers are buckling up to improve customer experience by addressing this demand for data with large scale investments in network scalability.

Currently, network elements and their associated applications are based largely on proprietary hardware and managed independently with various layers of software. This creates a plethora of challenges in terms of network complexity, manageability, security, and an upsurge in operational costs.

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# The **NETWORKS** are Virtual but the Challenges are Real

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It goes without saying that there is a massive uptick in the number of organizations that are making long-term investments in the cloud. However, we're still in a transitional phase as we move towards a reality that is increasingly 'software defined' – whether it be networks or the underlying infrastructure. As we make this transition, there are a few critical challenges associated with managing complex heterogeneous virtual networks – some of these are:

- Limited availability of highly skilled Cloud resources
- Choice of Technologies and comprehensive end-to-end testing
- Security concerns due to perceived vulnerability

For the purposes of this white paper, we shall look to provide further insight into formulating the right testing approach for network virtualization.

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## **NFV** and **SDN** to the rescue

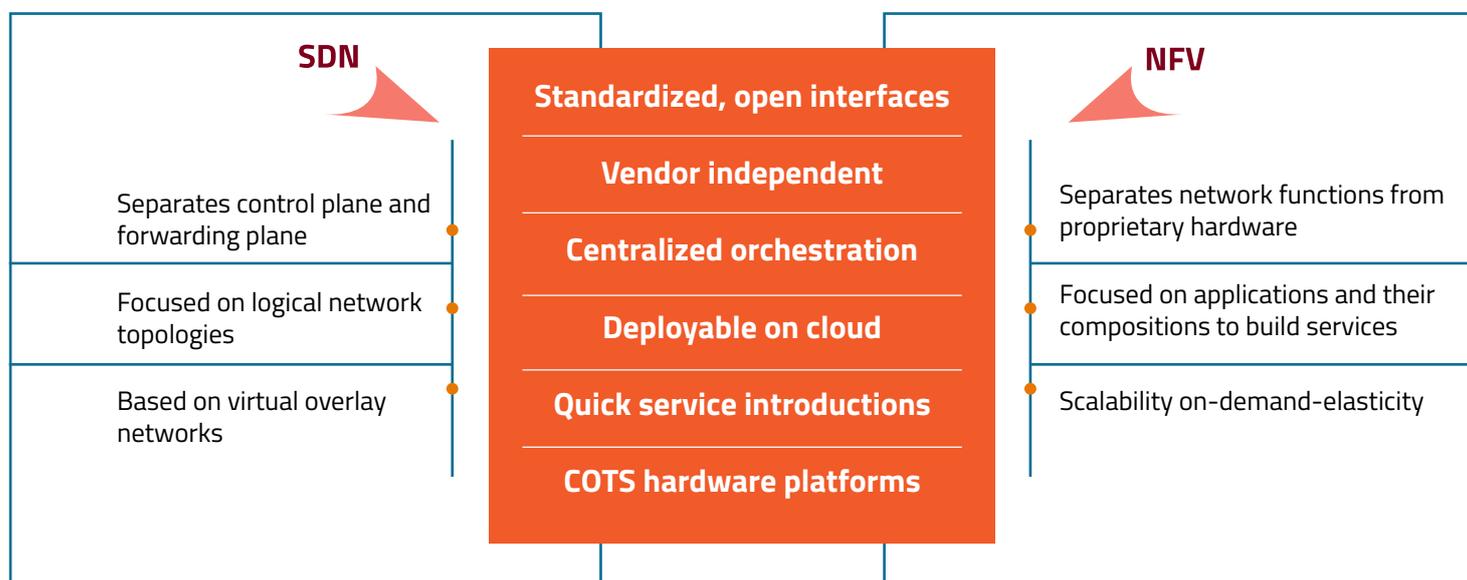
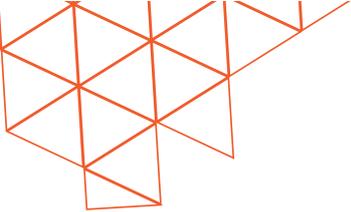
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As enterprises continue to migrate to the cloud, new age technologies like Network Function Virtualization (NFV) and Software defined Networking (SDN) have been increasingly adopted to resolve most of these challenges mentioned above.

Largely physical or box-centric networks incur huge capex and also involve proprietary hardware, time consuming deployment cycles and frequent obsolescence – all of which are addressed effectively by Network Function Virtualization. NFV involves virtualizing network functions and hosting them on a virtual Infrastructure consisting of hypervisors or containers, which are generally built on COTS servers.

Software Defined Networking (SDN) is centered around the idea of providing a centralized view of the network along with ensuring optimized management by creating distance between two crucial elements – the controlling plane and the forwarding plane.

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# **NETWORK** Function Virtualization necessitates a fundamental shift in **NETWORK DESIGN** and **TESTING**

Over the last couple of decades, Networking has been primarily hardware centric but there is now a paradigm shift from hardware-focused implementation to an integrated hardware and software cloud-centric approach. The journey to network virtualization requires a fundamental shift in the way the new age Network is designed & tested.

There are newer testing challenges popping up due to factors arising from multi-vendor software, protocols and APIs inter-operating in this environment.

One good practice to be adopted before designing a new testing approach would be to look deeply at the critical dependencies in designing an SDN or NFV solution. However, while migrating from an existing network to a virtual network, both networks have to be re-validated thoroughly.

# Evaluation Criteria for formulating an Integrated Testing Approach

- Server resources
- Capability of the proposed platform
- Backward compatibility and interoperability with existing networks
- Identifying specific network functions that need to be migrated
- Deciding the level of automation required
- Integration to the cloud
- Sensitivity to network delays affecting services
- Elasticity
- Performance & Scalability



## HAPPIEST MINDS has developed an INTEGRATED TESTING approach that delivers value

To tap into the benefits offered by disruptive technologies such as SDN and NFV, Happiest Minds has developed an integrated testing approach that is based on 3 key tenets viz **Vertical Layer Testing, Test Automation Framework and DevOps**.

**The Vertical Layer Testing approach** consists of areas created to deliver a virtualized network for deploying services anywhere, anytime across the NFV-Infrastructure layer - Virtual Network Functions (VNF) layer, the Management & Network Orchestration (MANO) layer integrated to the existing OSS/BSS system. This new approach brings in specific test focus points at each layer. Some of the areas are summarized on the next page -



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**1 NFVI**

vCompute, vStorage, vNetwork with hypervisor focused on IoT, performance & scale, security, disaster management and redundancy

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**2 Network Layer Testing**

SDN controller, Data plane, SDN API

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**3 API Validation**

and NFV Layers

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**4 VNF**

Functionality & validation

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**5 Management and Orchestration Layer**

Resource pools, alarms, SW provisioning, catalog and multi-tenancy scenarios

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**6 SDN security**

Control Channel, Infrastructure, NBI AA

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**7 NFV Security**

Compatibility, API, Functionality (ETSI GS NFV-SEC 001, 002, 013)

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A more elaborate view of the type of tests that need to be designed and executed are provided below. This gives a comprehensive view into what is covered in an integrated approach.



### Cloud Infra (NFVI) Testing – hypervisors, compute, storage

- Performance and scale
- Security (TPM)
- Interoperability
- Identity and access management
- Reliability and disaster recovery scenarios



### Network layer Testing

- SDN, OF Protocol Conformance
- SDN C Functionality
- South Bound and North Bound API
- Scale and performance
- Interoperability



### API validation across NFV layers

- Compatibility
- Functionality
- API performance and Consistency
- RestAPI functionality and integration



### NFV Security Testing

- Policy enforcement & validation
- VSF (Virtual Security Function)
- Functionality, Capability
- Security Monitoring Life Cycle
- Secure VNF Bootstrapping Protocol



### Management and orchestration layer Testing

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



### VNF Layer Testing

- Individual/VNF functionality
- Life cycle management – on-boarding, provisioning and tear-down of VNF
- Service chaining
- Validation of forward graphs
- End-to-end services validation
- Multi-vendor inter-operability
- Reliability and disaster recovery scenarios
- Performance and scale scenarios (RFC 2544, RFC 6349)



### SDN Controller Security testing

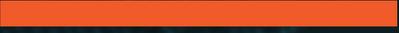
- Control Channel Layer
- Infrastructure Layer
- NBI Authorization/Authentication



The **second tenet** would be to **define automation goals** and identify a suitable test automation framework preferably one that is open source and is used in various ETSI NFV initiatives. This would ensure a higher level of re-use and garner greater support from the community by leveraging common components. Based on practical experience, there will be a need to create several keyword libraries for the various deployment use cases to make it more reliable. It's clear that an end to end test framework is necessary to ensure repeatability and regression apart from covering all the test scenarios incorporating CLI, API and GUI components.

The **last tenet** embraces the **idea of DevOps** to ensure continuous integration and testing. With an array of virtual elements, associated network functions and multi-vendor software, a well-defined DevOps approach integrated with the right test framework is essential to create, build, test and deploy the various software components in an agile, automated, quick, efficient, time bound and service oriented manner to mitigate risk.

## **SKILLS** required for **SDN and NFV TESTING**



The skills of Test engineers play a major role to ensure that products are shipped with a high level of quality and assurance. In the world of network virtualization, test engineers need to have both manual and automation skill-set test aspects which are collectively woven into the project. Furthermore, they need to have a networking background to be able to comprehend the impact on both legacy and new age implementations as they are interconnected in most customer designs. Some of the core skills needed for testing SDN and NFV are:

- Good knowledge on Datacom/IP Networking protocols
  - Ability to understand & ascertain Test requirements from Domain Use cases
  - Experience in Data Center and Telco Service Provider Technologies or Protocols
  - NBI and SBI API Interface testing experience
  - Expertise on different Functional and Non-Functional testing tools (Spirent, IXIA, iPerf, etc)
  - Python Programming
  - Skills related to troubleshooting & debugging, triaging network implementations & failure points
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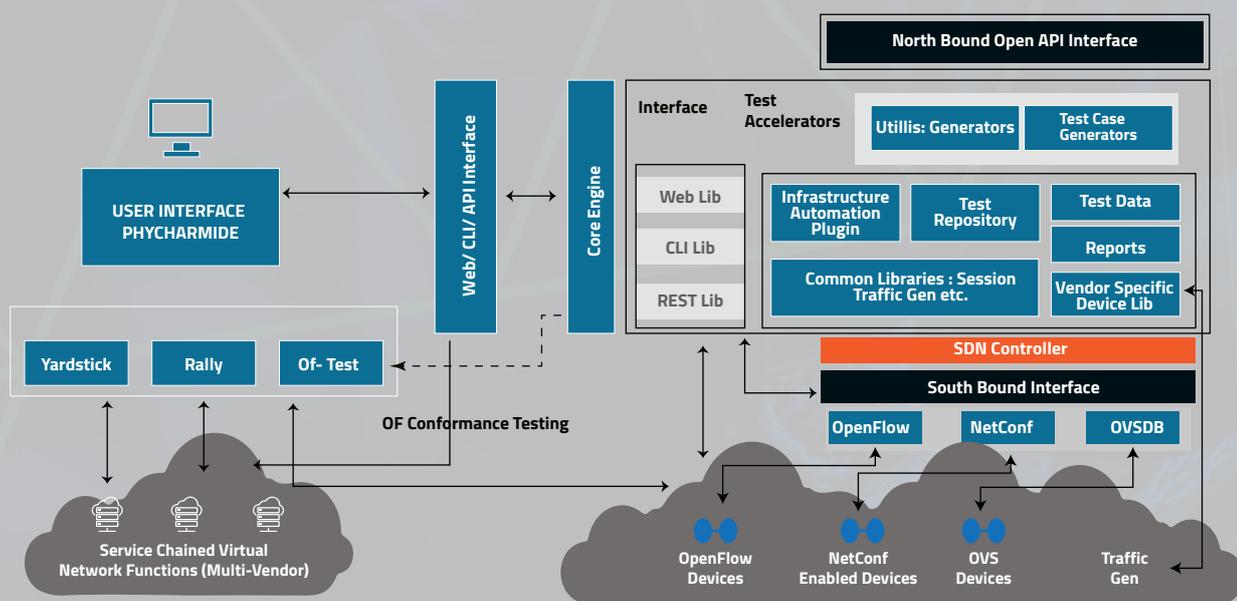
# Happiest Minds – We help you verify and validate **VIRTUALIZED NETWORKS** with a **HAPPY MIND**

Happiest Minds Technologies has invested in creating test, validation and test automation frameworks and accelerators as part of the Datacenter Testing service offerings portfolio. This covers verification and validation of the NFVI, NFVO and VNF, VNF-VNFM, MANO and all the other layers of the ETSI NFV reference Stack. The testing phases covers Test planning, Test Labs/scenario setup, Test Execution and Test Report. The Test types covered are Dev-Test, Functional Test, System Test, Performance and customer use cases validation apart from First Office Application (FoA) support.

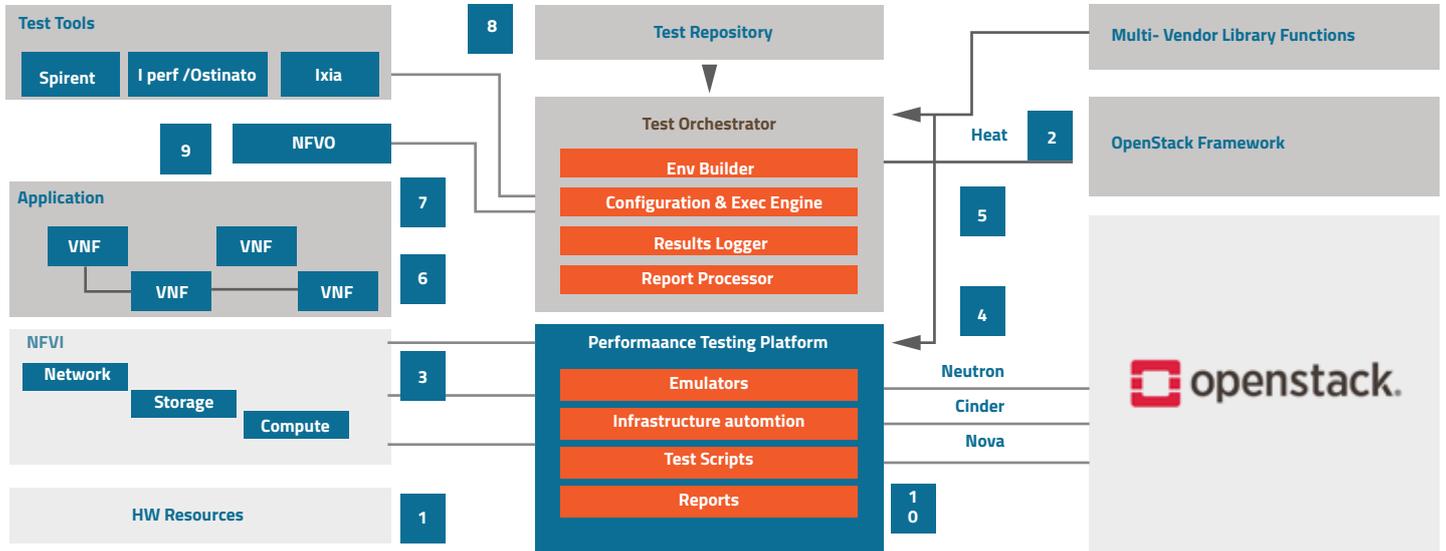
Happiest Minds has an independent Testing services practice dedicated focused specifically towards SDN and NFV. Some of our test frameworks and accelerators developed are shown below.

## Happiest Minds Testing Solutions to address SDN and NFV

### SDN Test Framework



# E2E VNF PRE-CERTIFICATION



## Case studies

With our testing approach, we at happiest minds work together with various organizations in understanding their unique requirements and to provide independent testing services across the SDN and NFV enabled products & services.

We have been working with customers providing comprehensive testing services covering the entire testing life cycle. Here we provide you with a look at how Happiest Minds have used their best practices and expertise to deliver Testing Services in SDN and NFV.

**High quality releases due to VNF certification for a leading high-tech and embedded systems provider**

## Challenge

The client didn't have a standardized testing process and lacked the required domain expertise to validate the multiple virtual network functions for their platform. They required us to test and validate the 3rd party VNF on their custom-built intel based platform and automate the test case scenarios.

## Solution

Using a collaborative approach Happiest Minds went beyond the client's brief and proposed a solution that comprised of -

- Test strategy/Test plan for the 5 VNF vendor products (vFirewall, vLoad balancer, vRouter, Fortigate, BIG LTM, Brocade)
- Integration with Openstack (Newton) and VNF onboarding
- VNF functional testing and performance Testing
- Preparing Test scripts (Python) using customer in-house framework & execution
- Test Reports and VNF specific reports

## Benefits

- Test Automation helped in reducing manual cycle times by almost 50%
- Increased cost optimization achieved through an off-shore partnership with a single vendor that provided an ideal mix of domain expertise, lab infrastructure and advanced test processes
- Greater operation efficiencies resulting from creation of VNFD template that led to the standardization of test processes

## Re-Engineering of SDN Test Framework for Leading TEM

### Challenge

The client roadmap involved transitioning to an SDN based model but there was no clear demarcation of the test data and test logic in the integration framework. They also faced other limitations like lack of interfaces and abstractions between functional blocks.

### Solution

- Re-engineering of the framework setting clear differentiation and functional blocks
  - Leveraging Open source tools, components, software based Traffic generators and test cases to create Test scripts for ODL and other controllers
  - Developed new utilities which aided in SDN-C API testing using JSON and Python
  - Test Plan creation and Test execution with Test Reports
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## Benefits

- Test Automation re-design helped in segregation of test frameworks and test scripts generation activities
- Continuous Test execution through integration of the framework with Jenkins/Jira, which resulted in Agile Testing
- Framework enhancement and extension helps to create new test scenarios
- Creation and re-usability of common functions helped in reducing test scripting efforts

# INTEGRATED TESTING – the bedrock of a successful SDN and NFV rollout



Testing is a critical success factor for SDN and NFV deployment. Therefore, a well thought out and integrated testing approach that is based on industry best-practices and is developed over time through proven expertise provides the much-needed predictability and assurance required for a successful SDN and NFV rollout. Adopting a multi-layered and integrated approach provides significant benefits related to early detection of bugs, improved test cycles through automation, increase in confidence levels, predictability of outcomes apart from identifying non-functional benchmarks, scalability and test reference designs/models, interoperability, improved security guidelines and finally adequate testing to ensure smooth delivery.

Network Virtualization demands a complete re-thinking of the testing approach - an integrated and layered approach for SDN - NFV is of immense importance in ensuring operational effectiveness and successful transitioning to a virtualized network environment. Happiest Minds is well positioned to be your trusted partner and guide you through every step of this journey – give us a call!

For more information, please reach out to us at [business@happiestminds.com](mailto:business@happiestminds.com)

### About Happiest Minds Technologies

Happiest Minds, the Mindful IT Company, applies agile methodologies to enable **digital transformation** for enterprises and technology providers by delivering seamless customer experience, business efficiency and actionable insights. We leverage a spectrum of disruptive technologies such as: Big Data Analytics, AI & Cognitive Computing, **Internet of Things**, Cloud, Security, SDN-NFV, RPA, Blockchain, etc. Positioned as “Born Digital . Born Agile”, our capabilities spans across product engineering, digital business solutions, infrastructure management and security services. We deliver these services across industry sectors such as retail, consumer packaged goods, edutech, e-commerce, banking, insurance, hi-tech, engineering R&D, manufacturing, automotive and travel/transportation/hospitality.

Headquartered in Bangalore, India Happiest Minds has operations in USA, UK, The Netherlands, Australia and Middle East.