WHITE PAPER

Communications Service Providers
Quality Assurance

Happiest Minds Raises Bar for SDN/NFV Quality Assurance

The company's Virtualized Networks Validation Service uses an integrated approach to test software and hardware performance in an NFV-enabled SDN environment.

Testing and validation of network software is an important element of deploying next-generation network functions virtualization (NFV)-based services. NFV disaggregates a single function network appliance into multiple software functions running on Intel® architecture-based servers. This creates dependencies between software from multiple vendors that can impact performance. And while there are industry standards that govern most of these software elements, it's important to validate the implementation of that standard in the context of a complete NFV solution. Happiest Minds, an Intel® Network Builders ecosystem partner, has developed a software defined networking (SDN)/NFV validation and testing service using its own framework that is based on open source network validation tools and other internally developed components.

Testing Complexities of SDN/NFV Networks

To keep up with growing data volumes expected from new services, communications service providers (CommSPs) are rapidly evolving their networks to embrace flexible and agile network services using NFV and SDN. These CommSPs are offering a broader range of high-throughput data services, from streaming video to virtual reality and augmented reality. Future applications will be even more latency and throughput sensitive and will need the agility, coverage, and flexibility provided by NFV/SDN.

With network agility, these CommSPs can remotely deploy services and better manage the service lifecycle, including deployment, termination, and any service scaling that happens in between. With improved scalability, CommSPs can expand services remotely to meet temporary or permanent increases in demand—and then scale back down if required.

NFV and SDN are critical technologies in this evolution. In an NFV network, network services are deployed using virtual network function (VNF) software, which is deployed on top of an NFV infrastructure running on several Intel® architecture-based servers. This solution is cost effective because it replaces dedicated servers with commercial off-the-shelf (COTS) servers that, in many cases, can support deployment of multiple services. However, virtualized services may introduce risks due to the potential for a VNF to not get adequate compute or memory resources in a shared environment.

As a result, virtualized network services require a testing and validation strategy that is markedly different from the erstwhile testing of physical network functions. Some of the important testing challenges that face NFV/SDN environments include the following:

- **Standardization and uniformity:** To keep a competitive advantage, some telecom equipment vendors do not fully implement open code architecture and adherence to standards like Open Network Foundation (ONF), European

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Telecom Standards Institute (ETSI) Open Platform for NFV (OPNFV), and others in their VNFs, resulting in potential interoperability challenges.

- **Performance:** With the migration to COTS hardware, CommSPs have to ensure that deployments optimize performance, latency, throughput, and processing.
- **Co-existence and compatibility:** SDN and NFV implementations must co-exist with a CommSP's legacy equipment and be compatible with their current OSS/BSS and network management systems.
- **Interoperability and portability:** Interoperability and portability between multiple vendor solutions and standards is crucial for orchestration of SDN/NFV services. Management and network orchestration (MANO) layer software should be able to load and orchestrate different VNFs from different vendors in a standard virtualized data center environment.
- **Tools and certification:** The availability of standardized test tools and frameworks to measure SDN/NFV functionality and performance is just emerging and not yet extensively deployed or understood.
- **Expertise:** Limited availability of skilled labor with NFV test, validation and automation expertise in a continuously evolving environment.

Choosing a Validation Approach

Happiest Minds has used an integrated approach to an NFV-enabled SDN system that comprises (1) a vertical layer test that validates VNFs, the network, and the security layer and (2) a horizontal approach that tests the data plane, control plane, and management application plane. This approach is defined by the following functional testing areas:

Vertical Layer

- **Network applications:** Tests assurance topology, service orchestration, and deployment.
- **VNF:** Tests VNF onboarding, functionality, service chaining, and life cycle management.
- **NFV infrastructure (NFVI):** Tests OpenFlow protocol conformance, SDN controller functionality, southbound and northbound API functionality, scale and performance, and interoperability.
- **Security:** Tests secure control channel, northbound interface authorization/authentication, and SDN controller security.

Horizontal Layer

- **Data plane:** Tests the throughput, latency, scalability, and other parameters like flow latency, TCP flows between hosts, UDP parallel sessions, etc.
- **Control plane:** Validates and measures the SDN controller, CPU utilization, response time, and flow drop rates through traffic injection. The tests utilize an SDN controller that is connected to several virtual data plane elements.
- **Management plane:** Tests onboarding time for REST API, GUI-based provisioning, CLI-based provisioning and stress tests management plane processing.

Happiest Minds Virtualized Networks Validation Service

The Happiest Minds Virtualized Networks Validation Service focuses on creating test validation and test automation frameworks and accelerators for both horizontal and vertical layer testing. However, because most of the current customer requirements are centered on hardware validation, this service concentrates on the vertical layer testing.

The service embraces a DevOps methodology for continuous integration and testing. Most virtualization and SDN-based networks support DevOps models, and having constant validation capabilities is critical to creating, building, testing, and deploying the various software components in an agile, automated, efficient, and service-oriented manner.

There are four phases of the service: test planning, test labs/scenario setup, test execution, and test reports. The test types covered are development test (dev-test), functional test, system test, performance, and customer use case validation for both first office application (FoA) and established services.

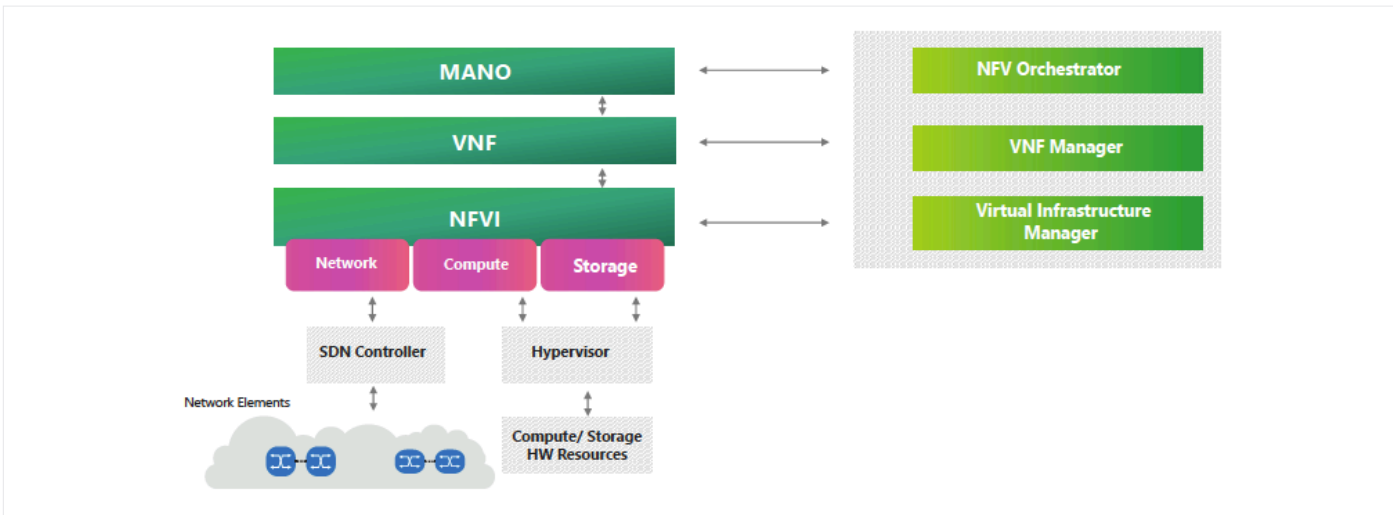

Figure 1. Happiest Minds' integrated approach to SDN / NFV testing.

As shown in Figure 1, the service addresses the challenges of validating functionality and performance of NFVI, VNFs, MANO solutions, and SDN.

Happiest Minds has created its validation approach to tackle these elements using open source software and internal homegrown tools that include a test framework, test cases, and test stimuli to measure the performance of a VNF in a virtualized environment. The combined solution is designed to verify virtual infrastructure compliance.

The Happiest Minds testing service may also be used to characterize the performance of an NFV infrastructure (NFVI). Using the service allows both telecommunications equipment manufacturers (TEMs) and CommSPs to validate VNF key performance indicators (KPIs) before the VNF is put into the network.

Happiest Minds has leveraged both open source test suites and homegrown test cases to validate the NFV infrastructure and carry out VNF testing in a virtualized environment while following the standards set by OPNFV, ETSI, and others. Upon executing the test cases, the required test setup is launched using topology.yaml file, which includes launching a number of VNFs using a VNF descriptor, connecting VNFs via virtual link descriptors (VLDs) and checking the connectivity. Further, based on the test case procedure, the service loads the configuration file onto VNFs and traffic profiles as well. Traffic is sent or received using software-based traffic generators such as PRoX, TRex, and others.

Happiest Minds' vertical layer testing approach consists of the following areas:

- NFVI testing – hypervisors, computer, storage
- Network layer testing
- API validation across NFV layers
- NFV security testing
- MANO layer testing
- VNF layer testing
- SDN controller security testing

Customer Implementations

The Happiest Minds virtualization validation service is optimized for both telecom equipment manufacturers (TEMs) and CommSPs. TEMs can use the software for testing VNFs before they become generally available to customers. This can be done when the software is first launched as well as any time new functionality or a patch is issued. For one of its TEM customers, Happiest Minds has implemented its vertical testing approach for validation of the client's cloud solution that utilizes Intel architecture-based servers. The objective was to validate and automate the multiple vendor VNFs for onboarding and functionality, and then to benchmark their performance using the client hardware across various configuration modes.

Metrics/KPIs measured and validated by Happiest Minds Virtualization Validation Service

VNF KPIs

1. CPU statistics
2. Memory bandwidth
3. Network KPIs, inpackets, outpackets, throughput, latency, packet_in, packet_drop, packet_fwd

NFVI KPIs

1. Compute
   a. Latency for memory/cache (read/write operations), processing speed (instructions per second)
   b. Processing speed (instructions per second)
   c. Processor and memory availability
2. Network
   a. Packet delay (jitter) between VMs and NFVI nodes
   b. Latency delay between VMs and NFVI nodes
   c. Maximum throughput between VMs, number of connections, number of frames transmission/receive
   d. NIC and link availability
3. Storage
   a. Latency for storage read/write operations
   b. Throughput for storage read/write operations
   c. Maximum sequential and random read/write input/output operations per second
   d. Storage/disk size, block size, disk availability

CommSPs can use the Happiest Minds service for validating the networking equipment once it is set up in the network but before it is commissioned. The goal for the CommSPs is to ensure that the networks deliver the SLAs that are promised to the customer.

Powered by Intel® Xeon® Scalable Processors

Because most of its customers utilize Intel architecture-based servers for their virtualized services, Happiest Minds has developed its virtualized validation service using Intel® Xeon® Scalable processor-based servers.

Intel Xeon Scalable processors are designed for communications networks that need scalability, agility, programmability, and security across ever-growing data volumes—from the network core to the edge. Intel Xeon Scalable processors are the next-generation platforms for cloud-optimized, 5G-ready networks. With an open architecture that scales and adapts to handle the demands of emerging applications, the platform provides a foundation for agile networks that can operate with cloud economics, be highly automated and responsive, and support rapid and more secure delivery of new and enhanced services. Intel Xeon Scalable processors deliver a highly trusted infrastructure platform with new and improved features for deeper platform and data security.

The service also relies heavily on the open source Data Plane Development Kit (DPDK). DPDK software libraries improve packet processing speeds and help scale performance as processor core count and performance increase

Conclusion

Consistent VNF performance and functionality in a dynamic virtualized environment is driving the need for SDN/NFV validation services. By utilizing open source tools with its own custom test scripts, Happiest Minds has developed a validation service that can evaluate the entire vertical NFV and SDN stack for performance and interoperability with all layers of virtualization. The company is intently focused on the CNTT Test Specification Committee, which incorporates inputs from the Linux Foundation and OPNFV, so that they can continue to enhance their test methodologies.

About Happiest Minds

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. The company leverages a spectrum of disruptive technologies such as Big Data Analytics, AI & Cognitive Computing, Internet of Things, Cloud, Security, SDN-NFV, RPA, Blockchain, and more. 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 the U.S., UK, The Netherlands, Australia and Middle East.

About Intel Network Builders

Intel® Network Builders is an ecosystem of infrastructure, software, and technology vendors coming together with communications service providers and end users to accelerate the adoption of solutions based on network functions virtualization (NFV) and software defined networking (SDN) in telecommunications and data center networks. The program offers technical support, matchmaking, and co-marketing opportunities to help facilitate joint collaboration through to the trial and deployment of NFV and SDN solutions. Learn more at http://networkbuilders.intel.com.

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