



Real-time Analytics, Assurance and Optimization Using Hybrid and Virtualized Solutions

White Paper

Overview

Network automation, the evolution to virtualization and cloud, massive traffic increases, IoT, Increasing service velocity and revenue growth... These are just some of the challenges facing both service providers and enterprises as part of today's complex service life-cycle. In addition, consumers are demanding that services are always on and always available and that everything is connected. In response, the industry is deploying ultradense, massively scalable, cloud-enabled and automated networks that can deliver the required intelligence, low latency, and high bandwidth services needed today and into the future.

Virtualization is bound to transform how business services are deployed and managed, and it is not just about evolving to an innovative technology that offers more capacity and new functionality - it will revolutionize how businesses and their customers interact with the networks, and how flexible and nimble future networks will be. For example, consider a situation where there is an opportunity for a service provider to offer an application which demands enhanced quality of service (QoS) with ultra-low latency, high security, for a small group of users with varying capacity requirements. It can be a deployment challenge to manage such requirements in a physical network where resources may not be shared, and creating separate network slices may not be possible without significantly impacting other customers and resources.

Virtualizing network functions offers service providers and enterprises the flexibility and agility to launch new services and break away from costly and time-consuming network upgrades on proprietary networks. However, to truly achieve the benefits of network virtualization, service providers need solutions that can help them deploy, activate, and manage new services in a cost-effective and time-sensitive manner. This means service activation, performance monitoring and all other vital support functions must also be

virtualized so that they can manage network service level agreements (SLAs) in real time.

One thing that we all realize is that virtualization is not going to happen overnight. With significant investments in physical networks, service providers will transition from physical networks to virtual networks in a targeted phased approach to ensure a seamless transfer that does not negatively impact customer experience and profitability. It is essential for service providers to continue to offer the highest QoS on their physical networks while they embark on their journey towards virtualization, which means they need test solutions that can evolve with their network without causing significant disruption and cost.

The VIAVI Network Integrated Test, Real-time analytics and Optimization (NITRO) solution is the first real time intelligence platform that connects testing and activation data from instruments with software-based planning, provisioning, assurance and optimization applications, working seamlessly across mobile, fiber, cable, cloud and enterprise networks. Leveraging the value of current investments in VIAVI instruments and software solutions, NITRO addresses both the needs of separate business teams as well as the evolution to automated end-to-end service delivery across a common platform. NITRO enables network owners to dynamically meet customer expectations for quality of experience through increased automation of workflows, improved visibility across physical and virtualized networks, and insights to drive evolution to the network of tomorrow.

In this paper, we will discuss different use cases for hybrid and virtualized network test solutions for different network segments such as mobile and enterprise networks and how they can help service providers throughout the network life cycle.

Phases of Network Life Cycle

Whether a service provider is deploying a completely new network, or upgrading some parts of the network or just expanding network capacity, it is essential to do proper planning and design, and not doing so can cause significant CAPEX and OPEX loss. For example, in a wireless network, strategically adding new sites requires service providers to have the right solution to identify where the coverage and capacity is needed, so they can significantly improve their return on investment (ROI). The VIAVI NITRO Platform can help service providers pinpoint performance-challenged areas to help service providers maximize their ROI and deliver the best QoS for their customers. Similarly, for every phase of the network life cycle, having the right test and assurance solution can tremendously improve CAPEX and OPEX returns. In general, following are the key phases of the network life cycle:

1. Plan/ Design
2. Build/Certify
3. Service Activation
4. Performance Monitoring
5. Network Management
6. Optimization/Self-Optimization

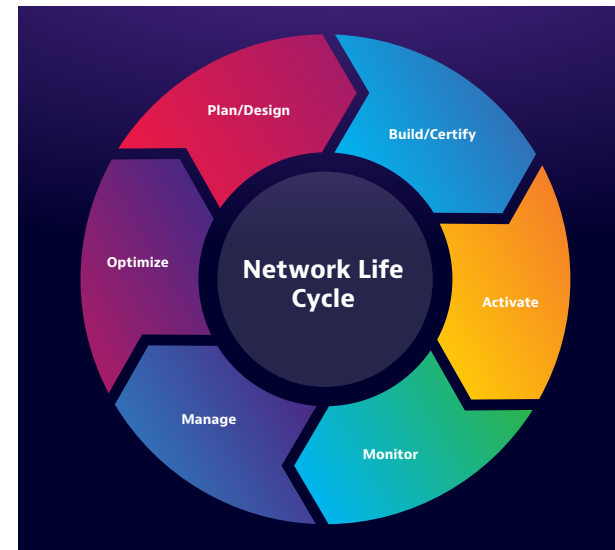


Figure 1 : Network Life Cycle

During these phases, different workgroups may be engaged, from planning and installation to management and optimization. But having the ability to have an end-to-end view of the network, with health reports from the birth of a network node to in service assurance analytics, can help significantly reduce network downtime and performance issues, improving QoS and profitability.

Benefits of Virtualized Network Testing and Assurance

Faster reaction time

Applying the same NFV techniques to network test and service assurance enables network operators to test on-demand or as an integrated part of the service roll-out. Instead of dispatching a technician carrying specialized equipment to perform a test on site (which could take days), things like service activation and performance tests can be run remotely and automatically, when required.

Cost Efficiencies

Historically, network monitoring and test systems required their own proprietary hardware platform. Those platforms were custom built and did not scale quickly with growing network traffic.

Current software-based agents combined with new data collection methodologies enable operators to leverage the non-proprietary platforms they're already deploying (for virtual network functions). No additional hardware is needed and testing scales rapidly with network and traffic growth. The result is that operators can exponentially increase the number of test points deployed in their networks – providing dramatically increased visibility and performance data at a fraction of the historical cost.

Open Architecture

Open interfaces at multiple levels allow network operators to integrate assurance-solution components into various system nodes, and open APIs allow service providers to capture data from multiple probes and virtual agents - enabling them to create a comprehensive end to end report of the health of the whole network.

Automation

Service providers are doing their best to meet performance targets and SLAs by making macro-level adjustments to networks to achieve incremental improvements in performance. Today's service activation and optimization solutions are not scalable for future next-generation networks. What is needed is a way to automate network performance to create major leaps in optimization on a granular level, while also decreasing OpEx and freeing up staff to maintain the infrastructure and plan for expanding the network to deliver greater capacities. Virtual agents and probes can enhance real-time and predictive analytics capability and can also make and implement recommendations to ensure end user experience is not compromised.

Test and Measurement Virtualization Challenges

Just like network function virtualization, virtual test and measurement is not without obstacles. Service providers need to ensure test solutions continue to support both their existing investments (interoperability) and a streamlined ability to test and assure hybrid configurations of physical and virtual networks.

Some of the key challenges for the evolution of test and measurement in the NFV world can be summarized as follows:

Solution Integration within an Open Ecosystem

- Evolving technology capabilities and standards
- Continuous innovation in an open architecture using open and defined software APIs

Virtual Traffic Visibility

- Low overhead mechanisms for virtual traffic access
- Performance at scale
- Hypervisor overhead/shared resource contention
- vSwitch performance

Support for Both Hybrid Configurations of Physical and Virtual Networks

- Continue to support and integrate static test and measurement solutions while moving forward with virtualized networks

To combat these challenges, standardization efforts have been taking place at the Internet Engineering Task Force (IETF), the result of which was published in RFC7594, called a framework for large-scale measurement of broadband performance (LMAP). The LMAP framework includes standards-based open APIs that offer flexibility and modularity in developing new applications, and has three basic elements: measurement agents (MA), controllers, and collectors. This effort will help accelerate the development of an MA ecosystem.

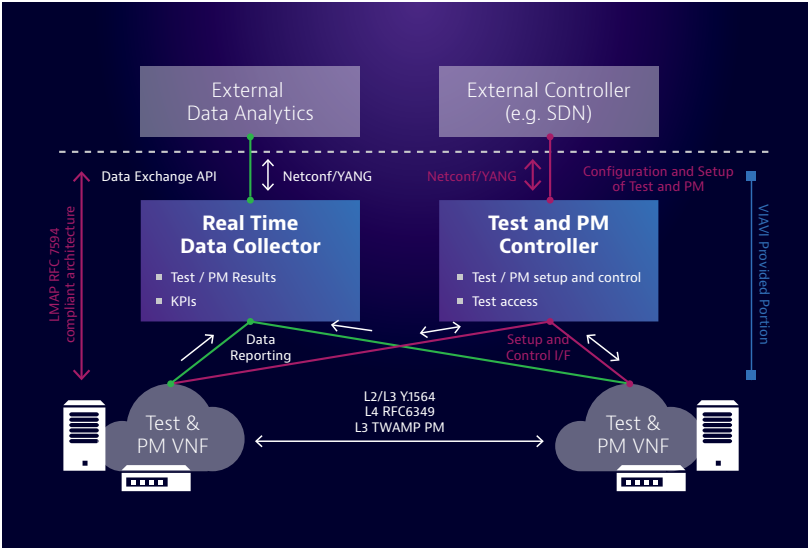


Figure 2: LMAP compliant architecture

Why NITRO?

Today, legacy fixed and mobile networks have fragmented workflows where network operation teams and their test and assurance solutions consists of siloed instruments and systems that don't talk to each other and are separated depending on the network life cycle phase and domain. To deliver on the promise of network virtualization, where agility of new service launch and self-optimization are the corner stones, network test and assurance across the different nodes of the network need to be in complete harmony - where data from physical instruments, probes and virtual test agents can be analyzed in a real-time fashion and services related decisions can be made in a much timelier manner with reduced work force requirements.

VIavi has been working closely with service providers to help them transition from proprietary network frameworks to open standards-based cloud architectures. The VIavi NITRO platforms ensures that service providers' physical network investments are protected. Our standards based solution is designed to perfectly integrate with our hand-held instruments. This allows for continued support of an operator's installed base of physical networks as they migrate to a hybrid physical and virtual network infrastructure.

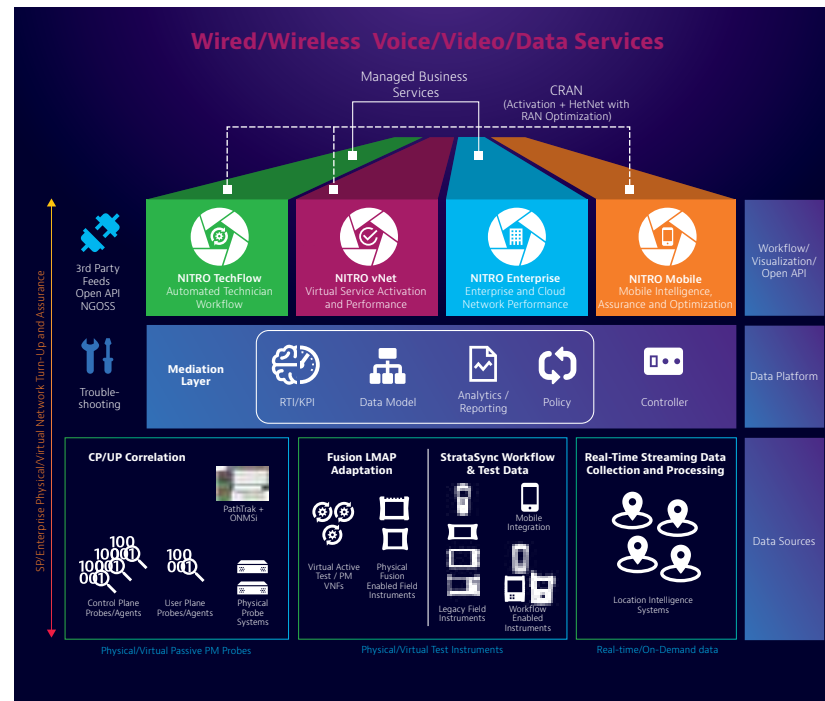


Figure 3: NITRO platform

There is no question that SDN and NFV will radically transform how networks are built and operated and how services are delivered and consumed. Having the ability to offer logical network slices will allow operators to offer networks on an as-a-service basis and will prepare them for a wide range of use cases. Some of these use cases include:

- Multi-tenancy
- Mobile Internet of Things (IoT) that connects billions of sensors and machines
- Ultra-fast-broadband that delivers gigabytes of bandwidth on demand
- Mission-critical communication that allows immediate feedback with high reliability and enables new applications like autonomous driving and remote surgeries

The VIAVI NITRO platform will allow service providers to:

- Automate test procedures for service activation for new network nodes and services
- Significantly reduce the need for service technician dispatches
- Troubleshoot immediately and quickly from a central location
- Transition from re-active to pro-active network assurance
- Create a self-healing network infrastructure
- Measure network and application performance and identify any SLA anomalies

Use Cases for the NITRO Platform:

The NITRO platform addresses the challenges of virtualization and the complexity of the life cycle demands of technologies and services, by integrating best in-class solutions for physical, virtual and hybrid networks. By leveraging our installed base in the service provider, enterprise, and cloud segment, NITRO provides visibility on who (is using), where (location), what (app), which (device) and how (good) the service is performing from activation through to management and optimization.

VIAVI, with its heritage in both instruments and systems, is uniquely positioned to deliver test, analytics and optimization solutions through an integrated platform that offers real business benefits, enabling automated networks for wireless, wireline, enterprise and cloud networks.

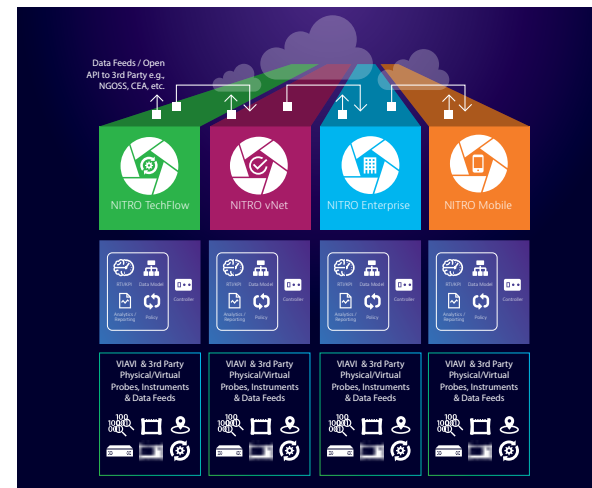


Figure 4: NITRO Applications for different technology segments

NITRO will be the foundation for four distinct solution sets:

- NITRO vNet — Virtual Service Activation and Performance
- NITRO Enterprise — Enterprise and Cloud Network Performance
- NITRO Mobile — Mobile Intelligence, Assurance and Optimization
- NITRO TechFlow — Automated Technician Workflow

NITRO solution suites can operate within independent technology silos (e.g. cable, enterprise, mobile) while NITRO architecture allows service providers, supporting multiple technologies, to have an end-to-end view across silos.

It will be worthwhile to discuss some of the use cases of test and assurance and how the VIAVI NITRO solution is helping service providers achieve their goals of maximizing profitability and maintaining best in class QoS.

Use Cases: NITRO Mobile

Before we discuss the value of NITRO Mobile solution let's review the work flows for the different silos in a mobile network environment. Initial installation of cell-sites is performed by contractors either working for the network equipment manufacturer (NEM) or the service provider. Once cell-sites are commissioned and after initial RF test and acceptance testing cell-sites are brought into service. From this point on cell-sites are either managed by the cell-site technicians either working for the service provider or managed service partner (MSP). Technicians at the Network operations center (NOC) are responsible for keeping an eye on the alarms and switch technicians are responsible for monitoring the performance of the backhaul and core network nodes such as MME, SGW, IMS etc. Depending on the size and coverage of the network, regional engineers and technicians work on their domain areas to make sure the overall network is performing well.

When an end user calls in with a QoS problem, RF engineers and cell technicians analyze key performance indicators (KPI) and alarms to check if the issue is a system-wide problem or an isolated problem. If the problem is system-wide, switch technicians and network engineering teams get involved. Even in the case of localized problem, RF engineers and technicians may have to do some field testing to perform a root cause analysis. The point of this discussion is that (1) multiple teams with different workflows get involved, (2) this overall troubleshooting process is slow and resource intensive, (3) not having the visibility across the network in a timely manner can significantly impact customer QoS and can cause churn. Assurance solutions today help in providing visibility into the core of the network, but fall short in building a comprehensive end-to-end view to pinpoint the failure point.

VIAVI NITRO Mobile delivers mobile intelligence, assurance and optimization for virtual and hybrid networks.

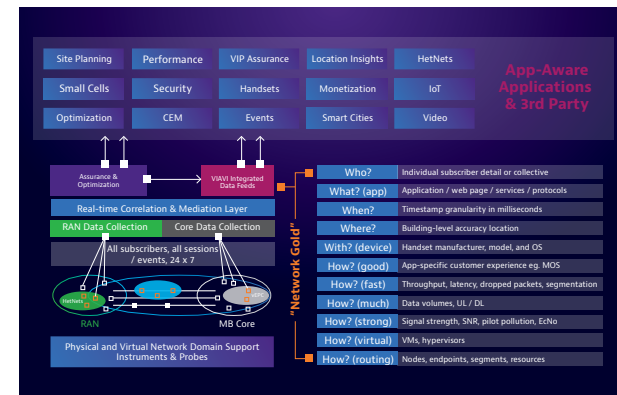


Figure 5: NITRO Mobile Solution

In VIAVI NITRO Mobile, physical and virtual probes and instruments, spread around the different network nodes, are capturing events and are constantly feeding these events to the mediation layer. A unified work flow creates a comprehensive view of the health of the network from the mobile through the core of the network and all the nodes and interfaces in between. Our solution can process hundreds of billions of events and can scale to meet the demands of virtualized and hybrid networks today and into the future. NITRO mobile offers subscriber centric automation to help service providers reduce OpEx while managing a much larger and heterogeneous network.

Example 1: NITRO Mobile Performance Solution for C-RAN (Customer QoS Negatively Impacted)

- 1: NITRO Mobile GEOperformance solution indicates a network service area with high drop-calls, low throughput and low QoS score
- 2: CPRIAdvisor data feed identifies RRHs within a C-RAN with potential interference issue, data indicates PIM issue at one RRH location
- 3: Virtual Test function indicating no issues on the backhaul
- 4: Mobile Network KPIs indicating performance issue with network links and protocols in core and access
- 5: NITRO Mobile Assurance feed indicates high packet retransmission rate
- 6: NITRO Mobile Assurance shows no issue at the different network interfaces, however, it does show poor RF performance
- 7: Field Tech resolves PIM root cause
- 8: Customer QoS and KPIs normalized

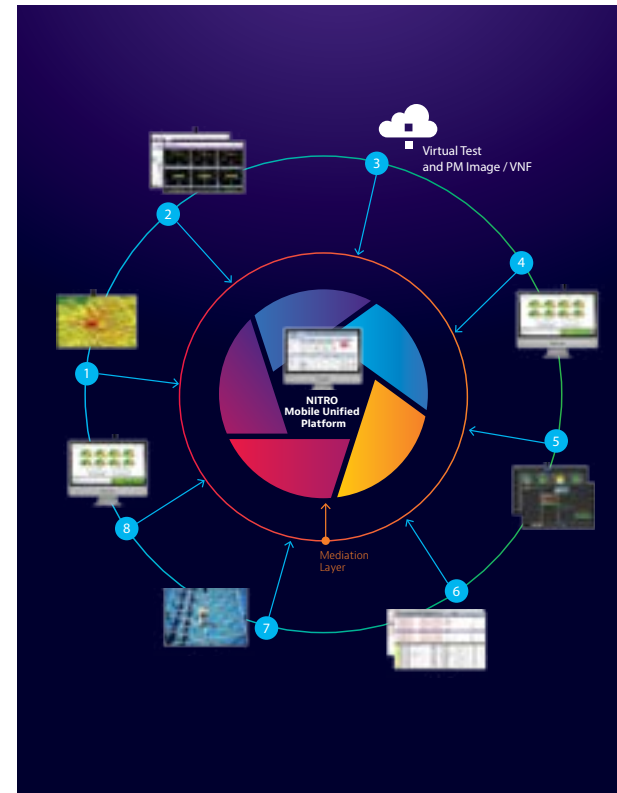


Figure 6: NITRO mobile Use Case 1 (Mobile user QoS issue)

Example 2: NITRO Mobile Deployment Solution (C-IoT Deployment)

- 1: Cells with C-IoT capability brought in service
- 2: CellAdvisor, a NITRO point solution data feed sent to the NITRO Mobile Unified platform mediation layer, results indicate out of cell interference
- 3: NITRO Mobile GEOperformance solution identifies performance degradation
- 4: NITRO Mobile Assurance feeds C-IoT packet information and identifies high retransmission rate
- 5: Parameter configuration made by engineers
- 6: CellAdvisor data feed results indicate interference issue resolved after parameter reconfiguration
- 7: NITRO Mobile Assurance solution indicates performance normalized
- 8: NITRO Mobile Assurance feeds C-IoT packet information to NITRO Mobile Platform indicates normal network behavior
- 9: Network KPIs monitored performance met, network KPI threshold normalized

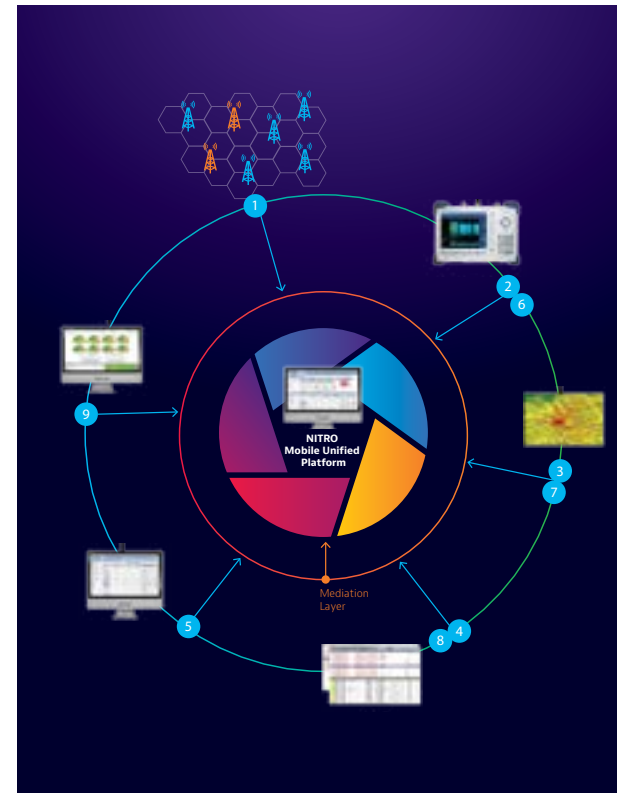


Figure 7: Figure 7 : NITRO mobile use Case 2 (C-IoT Deployment)

NITRO vNet:

VIAVI has been working closely with service providers to help them transition from proprietary network frameworks to open standards-based cloud architectures. To ensure that service providers' physical network investments are protected, The VIAVI NITRO vNet virtual service activation and assurance solution is designed to perfectly integrate with our hand-held instruments. This allows for continued support of an operator's installed base of physical networks as they migrate to a hybrid physical and virtual network infrastructure. As networks transition from physical to virtual, NITRO vNET solution will continue to support and integrate static test and measurement solutions while moving forward with virtualized networks.

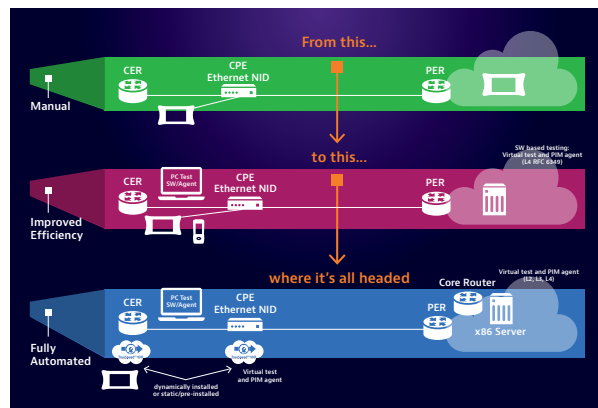


Figure 8: NITRO vNET solution

The VIAVI virtual test and service activation platforms offers the following standards-based layer-2 to layer-4 tests:

L2/L3 Y.1564 Service Activation and Troubleshooting

Service activation tests can be run between virtual agents or between virtual agents and loopback device like T-BERD/MTS. Up to 10 streams are supported.

L4 RFC6349 TrueSpeed™ Throughput Measurement

The VIAVI best-in-class TrueSpeed™ technology offers a standards-based RFC6349 (test and troubleshooting TCP throughput test that VIAVI co-authored) measurements that provide advanced circuit characterization, enabling service providers to efficiently identify and resolve layer 4 throughput issues.

Service providers can run this test either between virtual agents, virtual agents to PC clients, or between virtual agents and TBERD/MTS/ONX. Virtual test will provide throughput measurements and in-depth root cause analysis.

L3 Two-Way Active Measurement Protocol (TWAMP) PM

Tests can be performed between virtual agents, and offers full support for TWAMP, with up to 200 flows/agent indicating packet loss, packet delay, and packet delay variation measurements.

Use Case for Virtual Test

At a recent event sponsored by the Metro Ethernet Forum (MEF), several companies were asked to illustrate the concept of the Third Network. One demonstration was a proof of concept collaboration between five companies: Comcast Business, Tata Communications, Telecom Italia/Sparkle, ECI Telecom and VIAVI Solutions. This international team displayed how an end-user could visit a web portal, select a cloud service from a drop-down menu, then gain access to it via a private network connection within minutes—all provisioned without human intervention.

The bandwidth-on-demand requirement of the demonstration was provisioned between Baltimore, Maryland and Frankfurt, Germany on live production networks and orchestrated across multiple service providers across 6,000 km. Comcast Business, Tata Communications and Sparkle provided the originating network, the intermediate network and the direct connection into the cloud, respectively. ECI's EPIC platform (with fulfillment functionality developed as part of MEF's OpenLSO fulfillment project) provided the intelligence to seamlessly connect these disparate domains. NITRO vNET Fusion administered service activation testing and provided real-time verification data on whether the newly created service met defined SLA requirements.

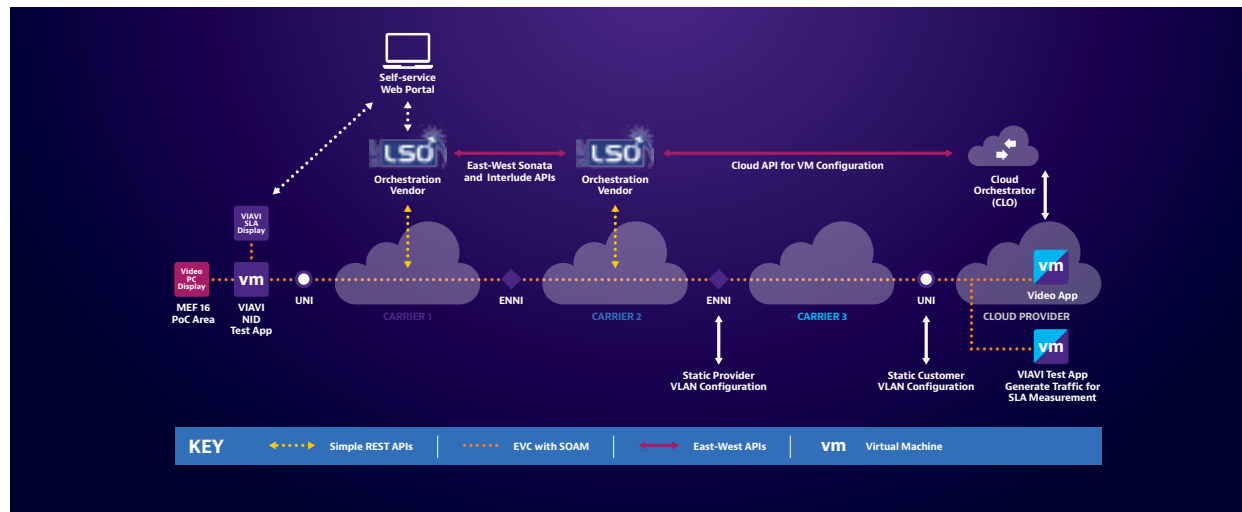


Figure 9: NITRO vNET solution

The VIAVI software-based test agents, deployed in virtual machines (VMs) at both ends of the connection, enabled the service activation testing and performance monitoring. The demonstration showed that by coupling the core virtualized network functions with the virtual test functions that support them, service providers can build automated network testing into activation workflows.

When NNIs (connections) between Comcast Business, Tata, and Sparkle had been established, a simple ping test was run between Frankfurt and Baltimore. At first glance it appeared that the network was up. A more sophisticated Y1564 throughput test on Layer 3 (IP layer) using The VIAVI virtual test agents confirmed the network connectivity, but also revealed that the link was experiencing a 15% packet loss. For the purposes of the demonstration, 15% packet loss was acceptable, but if that circuit had belonged to a paying customer, 15% could have resulted in an unsatisfied user. The loss was determined to be caused by buffer settings on one of the carrier's routers, which was easily corrected. This use case is a valuable example of the simple ping test leading to false conclusions—or at least inadequate conclusions—whether in a legacy or virtual network.

NITRO Enterprise use case:

NITRO Enterprise is a cloud-based monitoring solution that enables businesses to validate the performance of their hybrid IT environment. Employing virtual, cloud, or micro-appliance based agents, NITRO Enterprise performs ongoing proactive web-based service, VoIP, and network testing while facilitating domain problem isolation with on-demand ad-hoc troubleshooting agent deployment. NITRO Enterprise aids IT teams in maximizing application uptime and availability while optimizing the end-user experience.

End user experience can be negatively impacted by issues either with an application or network or the platforms hosting the applications. Having

the visibility to identify the root cause is essential for the IT organizations to quickly resolve those challenges and deliver a best-in-class end user experience. Still, in most cases, the visibility may be reactive - which impacts application and end user performance.

By correlating events across multiple physical probes and virtual agents distributed across the network, NITRO Enterprise provides a distributed analysis which includes: application performance analysis, application transaction analysis, comparison analysis, traffic flows, visibility into other environments and more, our solution also provides detailed information across multiple segments, multiple locations, and across heterogeneous environments.

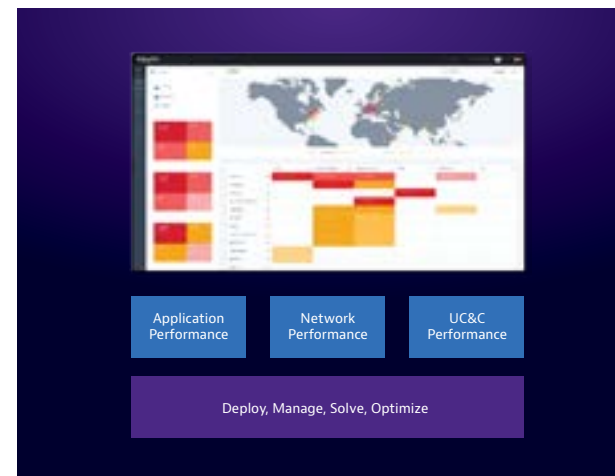


Figure 10: NITRO Enterprise

Conclusion

As service providers and enterprises continue their journey toward virtualization and automation, they need test and assurance solutions that can help them protect their existing investments and future-proof their ongoing investments.

The VIAVI Network Integrated Test, Real-time analytics and Optimization (NITRO) solution is the first network intelligence platform that connects test instrument data with software-based planning, provisioning, assurance and optimization, working seamlessly across mobile, fiber, cable, cloud and enterprise networks. NITRO delivers solutions for today's static networks and tomorrow's cloud-native, policy-driven, physical and virtual heterogeneous automated network life cycles while leveraging the value of current investments in VIAVI instruments and software.

Summary of NITRO key features and benefits:

- Integration of The VIAVI physical instruments and probes, currently enabling service providers to manage their networks-with virtual test agents
- Enabling service providers to make test and performance monitoring an integral part of their service creation chain using standardized methods and interfaces
- Collapsing the silos that exist in traditional physical network test architectures and providing deep insight across the various network entities
- Significantly improving service delivery and operations agility
- Improving the end user experience by increasing responsiveness
- Reducing CapEx/OpEx by automating service activation and assurance for the entire network life cycle

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