

# IxNetwork Virtual Edition (VE)

## Virtualized Network Performance Testing

### Problem: The Many Unknowns of Virtualizing Networks, Services, and Functions

Cloud computing and Network Functions Virtualization (NFV) are creating a new paradigm of user experience. Users expect immediate access to a wide range of media-rich applications and services, instantly, from any location. Integrating virtualization across servers within a data center is key to creating an adaptable cloud network. Service providers are looking to accelerate the deployment of these new services, while reducing capital and operating expenses, and integrating NFV into their network. These new services require thorough testing to ensure functionality, performance, security, and reliability of the applications and devices, as well as the new infrastructure, to ensure it can deliver the touted advantages.

### Solution: Reliable Testing of Network Migration from Physical to Virtual

IxNetwork VE is designed to test the functional and performance testing of physical and virtual network infrastructure, capacity, scalability, and convergence by using scaled protocol emulation and traffic. IxNetwork VE can emulate protocols for routing and switching, data center Ethernet, software-defined networking (SDN), broadband access, and industrial Ethernet. It provides a flexible traffic generation and analysis solution to validate physical and virtual devices and networks at scale in 1 Gbps, 10 Gbps, and 100 Gbps increments. For data center / cloud computing environments, IxNetwork VE can benchmark the performance of virtualized servers by simulating data center traffic between virtual machines

### Highlights

- Test the most critical components of virtual and physical products, including functionality, conformance to standards, and performance.
- Accelerate time to market by conducting functional tests early in the development lifecycle.
- Pinpoint and isolate data center deployment and performance issues by using Keysight virtual test tools' flexible deployment that can be easily moved, changed, or scaled up and down.
- Assess how VM mobility impacts application reliability and scalability.
- Validate NFV migration by testing within OpenStack-based private clouds.
- Leverage subscription-based licensing that enables low startup cost and flexibility of pay-as-you-grow OPEX model.

# IxNetwork <sup>VE</sup>



(VMs). It enables the ability to deploy virtual test ports inside virtualized network devices, for end-to-end testing of NFV implementations.

The IxNetwork VE subscription model is aligned with enterprise project-based IT OPEX funding requirements. Acquire the tools quickly, scale up and scale down as project needs demand, and deploy anywhere with virtualization speed and simplicity.

Visit [keysight.com](http://keysight.com) for more information on the IxNetwork VE product.

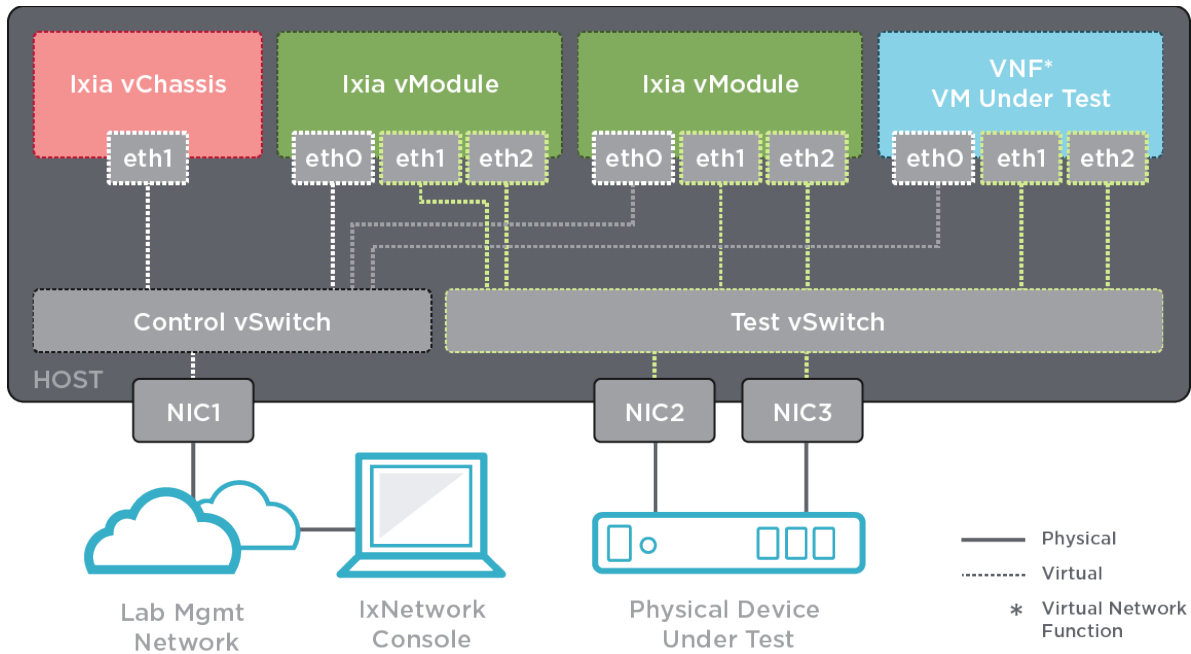


Figure 1. IxNetwork VE deployment for both virtual and physical device testing

## Key Features

- Provides comprehensive protocol coverage across a large set of networking technologies.
- Includes Routing / Switching, MPLS, Broadband Access, Data Center Networking, and SDN.
- Powerful traffic generation capabilities with DPDK Performance Acceleration for L23 Traffic.
- Hundreds of application traffic flows for Stateful L47 Traffic enabled by the AppLibrary engine.
- Powerful statistics engine with high level aggregated views as well as detailed drilldown views.
- Common IxNetwork user interface and experience across both Hardware / Virtual products.
- Easy transition between Hardware / Virtual platforms through common configurations and scripts.
- Enables end-to-end testing from a single pane of glass across virtual and physical environments.
- Comprehensive hypervisor support for standalone hypervisors such as VMware ESXi and KVM.
- Comprehensive orchestration support in Private Clouds based on VMware vCenter / OpenStack.
- Ability to operate in Public Cloud environments with Amazon AWS Marketplace availability.
- Includes Virtual Machines with Virtual Chassis / Virtual Load Module / Virtual Test Appliance roles.
- Provides software optimized for protocol emulation and traffic generation in virtual environments.
- Flexible all-inclusive subscription licensing model reduces startup cost and enables easier growth.

- Common Licensing Server shared among IxLoad VE, IxNetwork VE, and BreakingPoint VE.
- Full automation capabilities with REST, TCL, Perl, Python, and Ruby API support.

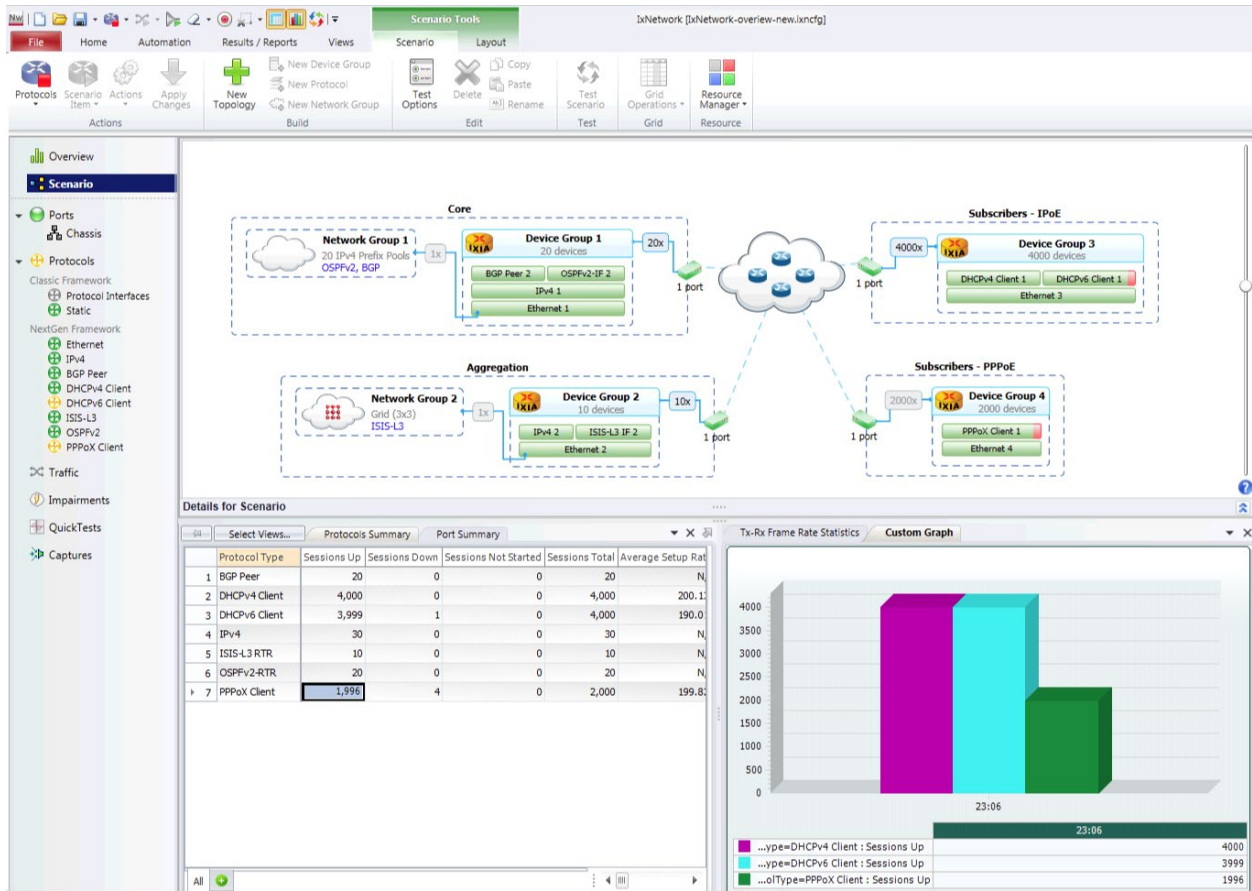


Figure 2. IxNetwork real-world network topology viewer with per-session protocol drill-down

## Specifications

IxNetwork VE features, functions, and capacities for the Keysight Virtual Chassis, Keysight Virtual Load Modules, and Keysight Virtual Test Appliance:

Feature	Virtual Chassis	Virtual Load Module	Virtual Test Appliance
Maximum # of Virtual Ports	128	32 *	8
Maximum # of Virtual Load Modules	32	N / A	1
Maximum # of Simultaneous Users	32	1	1
Guest OS	Based on CentOS 7 / 64-bit / Linux 3.10 Custom Kernel		
vCPU	2 vCPUs	4 vCPUs *	4 vCPUs *
Memory	4 GB RAM	4 GB RAM *	4 GB RAM *
Disk	8 GB	2 GB	8 GB
<p>* A note on resource allocation with DPDK Performance Acceleration. In this mode, a maximum of 8x Virtual Ports can be used per Virtual Load Module / Virtual Test Appliance. For optimal performance, we recommend that you allocate 2 vCPU / 2 GB RAM for management functions and additional 2 vCPU / 0.5 GB RAM for each Virtual Port. The minimum resources are 4 vCPU / 4 GB RAM. The recommended values for various numbers of Virtual Ports are as follows:</p> <ul style="list-style-type: none"> <li>• 1x vPort: 2 vCPU / 2 GB RAM (Management) + 1 x 2 vCPU / 0.5 GB RAM (Test) = 4 vCPU / 4 GB RAM</li> <li>• 2x vPort: 2 vCPU / 2 GB RAM (Management) + 2 x 2 vCPU / 0.5 GB RAM (Test) = 6 vCPU / 4 GB RAM</li> <li>• 4x vPort: 2 vCPU / 2 GB RAM (Management) + 4 x 2 vCPU / 0.5 GB RAM (Test) = 10 vCPU / 4 GB RAM</li> <li>• 8x vPort: 2 vCPU / 2 GB RAM (Management) + 8 x 2 vCPU / 0.5 GB RAM (Test) = 18 vCPU / 6 GB RAM</li> </ul>			

IxNetwork VE distribution format and packaging for Manual Deployment Scenario (by using the platform specific tools for deploying the Virtual Edition products):

Platform	Virtual Chassis	Virtual Load Module	Virtual Test Appliance
VMware ESXi	OVA	OVA	OVA
VMware vCenter	OVA	OVA	OVA
KVM / stand-alone	QCOW2	QCOW2	QCOW2
KVM / OpenStack	QCOW2	QCOW2	QCOW2
Microsoft Hyper-V	N / A	N / A	N / A
Docker Container	N / A	N / A	N / A

IxNetwork VE distribution format and packaging for Automatic Deployment Scenario (by using the Deployment Wizard within the client applications for creating large scale deployments with ease):

Platform	Virtual Chassis	Virtual Load Module	Virtual Test Appliance
VMware ESXi	SH	SH	N / A
VMware vCenter	OVA	OVA	N / A
KVM / stand-alone	SH	SH	N / A
KVM / OpenStack	N / A	N / A	N / A
Microsoft Hyper-V	N / A	N / A	N / A
Docker Container	N / A	N / A	N / A

### Qualified and Compatible Environments

IxNetwork VE is designed to work best when used in a qualified environment. Our recommendation is to always use one of the qualified versions of the virtualization platforms.

IxNetwork VE is also compatible with different environments. In case there are issues encountered in these environments, Keysight will make reasonable efforts to address them, but cannot guarantee specific outcomes or results. In such rare cases, the proposed solution is to use a qualified environment.

Category		Qualified		Compatible
<b>Hypervisor and Host OS</b>		VMware vSphere ESXi 6.X KVM over CentOS 7.X KVM over Ubuntu 18.04 LTS		VMware vSphere ESXi 7.X KVM over CentOS 6.X KVM over CentOS 8.X KVM over Ubuntu 16.04 LTS KVM over Ubuntu 20.04 LTS KVM over RHEL 6.X KVM over RHEL 7.X KVM over RHEL 8.X
<b>Management and Orchestration</b>		VMware vCenter 6.X OpenStack Stein (vanilla distribution)		VMware vCenter 7.X Other OpenStack-based platforms (vanilla distributions) Other OpenStack-based platforms (vendor-specific distributions)
<b>Network Connection and vNIC Driver</b>	<b>Virtual Switch</b>	VMXNET3 VIRTIO	(on VMware) (on KVM)	N / A
	<b>PCI-PT</b>	Intel 1G: Intel 10G: Intel 10G / 25G / 40G: Mellanox 10G / 25G / 40G: Mellanox 50G / 100G / 200G:	– IGB * – IXGBE – I40E – MLX4 / MLX5 – MLX5	Cisco 10G ENIC*
	<b>SR-IOV</b>	Intel 1G: Intel 10G: Intel 10G / 25G / 40G: Mellanox 10G / 25G / 40G: Mellanox 50G / 100G / 200G:	– IGBVF * – IXGBEVF – I40EVF – MLX4 / MLX5 – MLX5	Cisco 10G ENIC*
<b>Virtual Switch Model</b>		Virtual Standard Switch Virtual Distributed Switch Linux Bridges Open Virtual Switch Open Virtual Switch	(on VMware) (on VMware) (on KVM) (on KVM) (on OpenStack)	Linux Bridges (on OpenStack)
<b>Physical CPU</b>		DPDK Capable CPU Required		
* DPDK Performance Acceleration not supported by Intel 1G / Cisco 10G NIC connected in PCI-PT / SR-IOV.				

## Network Protocols

IxNetwork emulates a wide variety of networking protocols. By using the IxNetwork test application, each Keysight virtual test port is capable of emulating thousands of routers or bridges with millions of reachable networks and hosts. Users can easily scale the size of emulated topologies by adding additional hardware or virtual test ports. Combined with traffic generation and QoS measurement capabilities, the hardware load modules and virtual load modules verify advertised topologies and networks for reachability and QoS performance.

Technology	Protocol
<b>Interfaces</b>	MAC, VLAN, IPv4 (ARP, PING), IPv6 (NDP, SLAAC, PING)
<b>Routing and Switching</b>	BGP4 / BGP4+, OSPFv2 / OSPFv3, ISISv4 / ISISv6, EIGRP / EIGRPv6, RIP / RIPng, BFD, IGMP / MLD, PIM-SM / PIM-SSM, STP / RSTP / MSTP, PVST+ / RPVST+, Link Aggregation (LACP)
<b>Software Defined Network</b>	OpenFlow, Segment Routing, BGP Link State (BGP-LS), PCEP, VXLAN, EVPN VXLAN, OVSD, GENEVE, BGP FlowSpec, BGP SR TE Policy
<b>MPLS</b>	RSVP-TE P2P / RSVP-TE P2MP, LDP / LDPv6 / mLDP, LDP L2VPN (PWE / VPLS), BGP VPLS / VPWS, L3VPN / 6VPE, 6PE, BGP RFC3107, MPLS-TP, MPLS OAM, EVPN / PBB-EVPN, Multicast VPN Rosen Draft, NG Multicast VPN
<b>Broadband and Authentication</b>	PPPoE / L2TPv2, DHCPv4 / DHCPv6, ANCP, IPv6 Autoconfiguration (SLAAC), IGMP / MLD
<b>Industrial Ethernet</b>	Link OAM IEEE 802.3ah, CFM IEEE 802.1ag, Service OAM ITUT-Y.1731, PBT / PBB-TE, ELMI, TWAMP
<b>Data Center Ethernet</b>	DCBX / LLDP, FCoE / FIP, TRILL, Cisco FabricPath, SPBM
<b>Application Traffic</b>	Hundreds of AppLibrary flows inside IxNetwork-AppLibrary

## Traffic Capabilities

IxNetwork VE supports traffic generation and measurement that ensures precision and performance. The sophisticated traffic generator is also tightly integrated with the Control Plane protocols.

Traffic Generator	Specification
<b>Configuration</b>	Advanced Traffic Wizard—steps by steps wizard assisted traffic configuration Quick Flow Group—granular control of packet sequence and variations

Traffic Generator	Specification
<b>Scale</b>	Generate up to 4 million trackable flows by using IxNetwork Configure up to 16,000 unique Flow Groups—each with a unique transmit profile Up to 256 Flow Groups per-port Up to 4,096 trackable receive flows per port
<b>Dynamic Controls</b>	Change frame rate and frame size on the fly
<b>Traffic Types</b>	IPv4, IPv6, MPLS multi-labels, Ethernet, VLAN, provider bridges (Q-in-Q), provider backbone bridges (MAC-in-MAC), PPP, L2 MPLS VPN, L3 MPLS VPN, VPLS, 6PE, 6VPE, multicast, multicast VPN
<b>Source/Destination Ports Mapping</b>	One-to-one, many-to-many, fully meshed
<b>Routes Mapping between Peer Ports</b>	One-to-one, fully meshed
<b>Flow Grouping</b>	Build flow groups based on packet content (for example, QoS or VLAN ID)
<b>Traffic Profile</b>	<ul style="list-style-type: none"> <li>• Frame Size: Fixed, increment, random, IMIX, custom IMIX, Quad Gaussian distribution, auto</li> <li>• Rate: Percent line rate, packets/sec, L2 bit rate (bps, Bps, KBps, MBps)</li> <li>• Payload pattern: Increment byte / word, decrement byte / word, random, custom</li> <li>• QoS: TOS, DSCP, IPv6 Traffic Classes, 802.1p, MPLS EXP</li> <li>• Dynamic: Traffic supports gratuitous ARP - auto Re-ARP</li> </ul>
<b>Per-Flow Traffic Tracking</b>	Single or multi-field tracking of any field, including QoS (TOS / DSCP), VLAN, source MAC address, destination MAC address, source IP address, destination IP address, MPLS label, MPLS flow descriptor, streams, Source / Destination IP pair, Source / Destination MAC pair, custom packet tracking
<b>Real-Time Flow Filtering and Flow Detective</b>	Real-time filtering of flows based on tracking settings with user-defined criteria. Single out best / worst performing flows based on Rx count, min / max / average latency, timestamp, real-time packet loss by using sequence, identify dead flows
<b>Packet Editor</b>	Edit packet header fields and payload
<b>Flow Control</b>	N / A



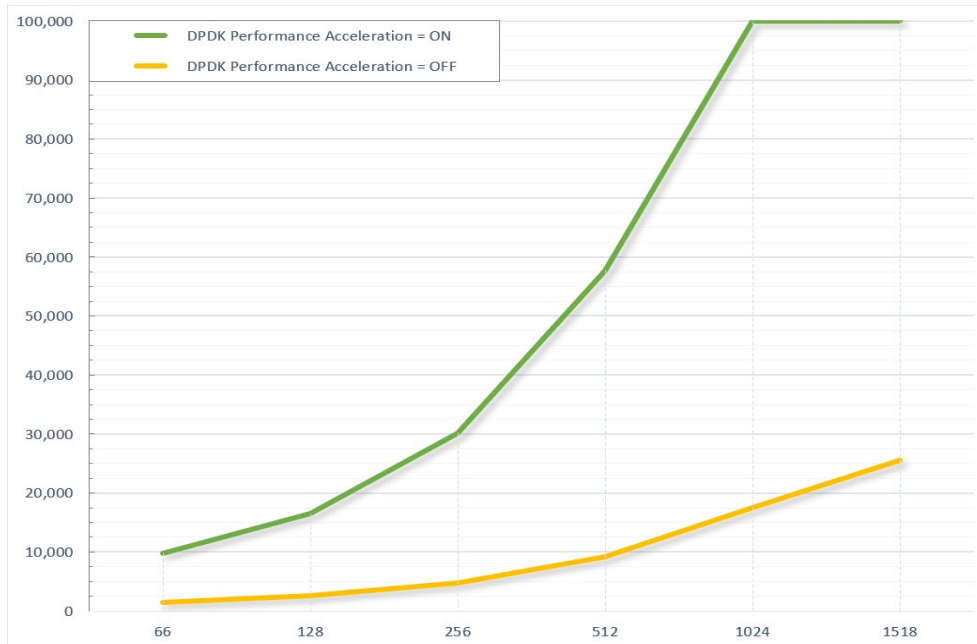
Traffic Generator	Specification
<b>Packet Editor</b>	Header field value editing <ul style="list-style-type: none"> <li>• Add tracking: Increment, decrement, list, user defined, default, link/unlink with other header fields</li> <li>• Payload editing: Track user defined traffic flows</li> <li>• Custom editing: Increment byte/word, decrement byte/word, repeat, fixed, user defined</li> </ul>

Measurement	Specification
<b>Loss</b>	Track Tx frames, Rx expected frames, Rx frames, Rx bytes frame delta loss %
<b>Rate</b>	Tx frame rate, Rx frame rate, Rx rate (bps, Bps, Kbps, Mbps)
<b>Latency</b>	IxNetwork VE latency measurements are based on NTP
<b>Sequence</b>	Small error, big error, reverse error, last sequence number, duplicate frames, sequence gaps
<b>Time Stamps</b>	First and last timestamp per flow
<b>Packet Loss Duration</b>	Estimated time without received packets calculated by frames delta at the expected Rx rate

## Traffic Performance

IxNetwork VE implements DPDK Performance Acceleration for the L23 Stateless Traffic Engine. Using the DPDK Traffic Engine results in increased Data Plane performance which is required to validate the latest generation Virtual Network Functions. The traffic throughput is increased by a factor of 5x thanks to the DPDK Performance Acceleration.

Frame Size	DPDK Performance Acceleration = OFF		DPDK Performance Acceleration = ON	
Bytes	MPPS	L1 Rate MBPS	MPPS	L1 Rate MBPS
64	2.49	1,672	14.19	9,760
128	2.46	2,914	13.89	16,443
256	2.23	4,932	13.66	30,155
512	2.22	9,460	13.55	57,673
1,024	2.21	18,475	11.97	99,982
1,518	2.20	27,082	8.12	99,945



The performance numbers were benchmarked on a hardware platform composed of Dell R6525 / 2x AMD EPYC 7302 CPU @ 3.00 GHz / 128 GB RAM / Mellanox ConnectX-5 2x 100G NIC / PCI Express 4.0 with SR-IOV NIC connection and KVM / Ubuntu 20.04 LTS hypervisor. The traffic profile has one unidirectional IPv4 flow between 1x TX VM / 1x RX VM. Total resources required across 1x Virtual Chassis (2 vCPU / 4 GB RAM) and 2x Virtual Load Modules (4 vCPU / 4 GB RAM each) add up to 10 vCPU / 12 GB RAM.

## Test Results—Statistics Viewer

The IxNetwork statistics viewer is a powerful tool for viewing and analyzing real-time results and generating test reports.

- Aggregate statistics are shown hierarchically, with the ability to drill down to group-level and flow-level statistics
- Different modes to view traffic statistics—Instantaneous, Cumulative, or both
- CSV files can be used to capture a single results view, or at the global level, to capture all results in real-time; an integrated CSV viewer is provided to view large-result files

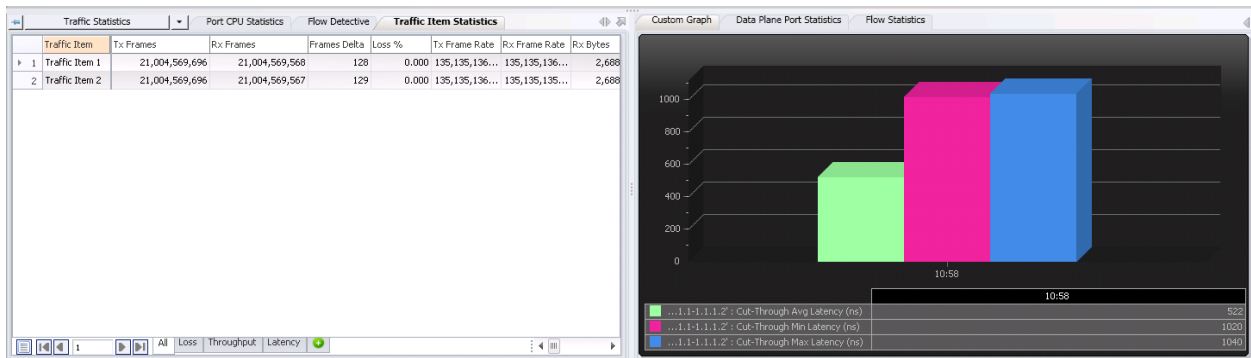


Figure 3. Statistics Viewer

Function	Statistics
Global Protocol	Port-level protocol counters
Port	Port mode, speed, frame and data rate, OAM statistics
Tx-Rx Frame Rate	Tx-Rx frame rate graph
Port CPU	Port CPU utilization and statistics
Data Plane Port	Port-based frame counts and rate excluding control-plane traffic
Traffic Item	Statistics provide an aggregate of all the flows in the Traffic Item
User Defined	User-defined view is used for drill-down to user-defined tracking options
Flow Statistics	Flow-level measurements
Flow Detective	Filtering and sorting based results

## Resource Manager

Often expertise for different protocols lies within different members of a testing team. A common pain-point for our customers was the lack of a collaboration tool to aid them in incrementally building configurations. With the Resource Manager, users can now piece-meal their configurations together. The Resource Manager allows users to save different pieces of their configurations, like protocols and traffic elements, and then build a configuration by re-using saved elements in their current configuration.

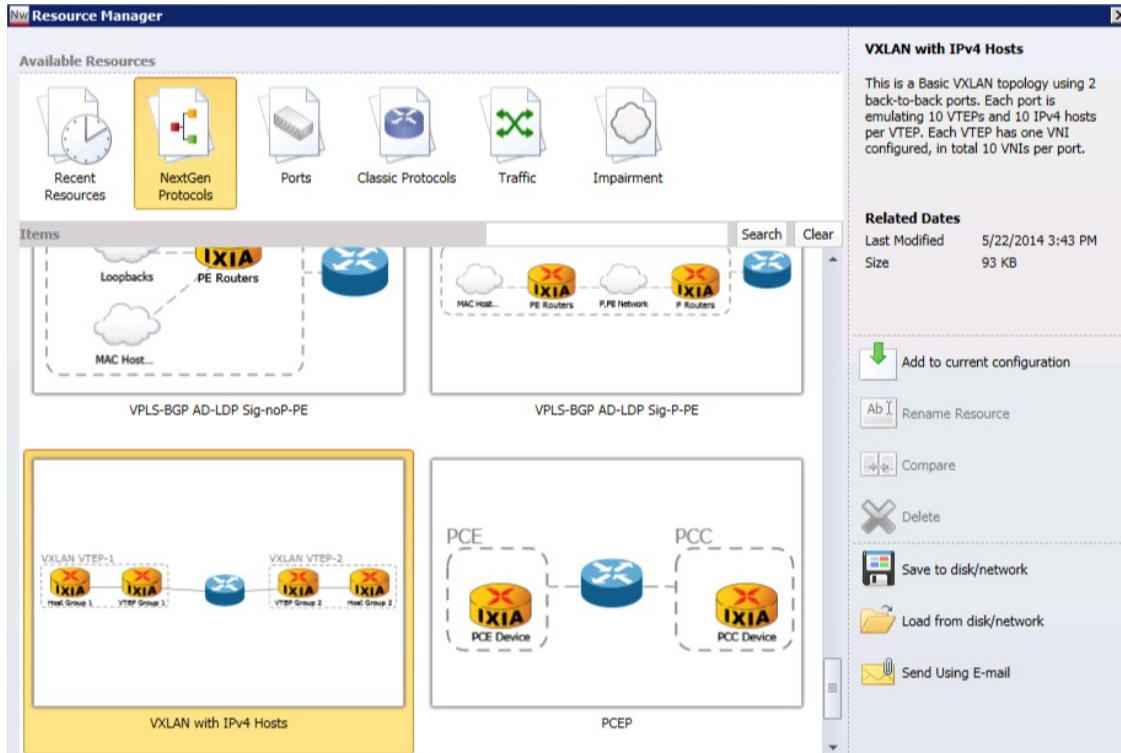


Figure 4: Resource Manager

It also allows users to clearly see changes made to their resources/configurations by using a 'diff' functionality within the application. Using the Resource Manager is a powerful way to collaborate and quickly build expertise with a team.

## Reports

Building a test-results report requires test data. IxReporter introduces a new database, referred to in the application as an 'object model.' The object model is populated by a testing application (like IxNetwork) with the test configuration parameters and the test results. All of these 'objects' can be included in a report, usually in a table or chart. With this powerful concept, tables and charts can be created that combine statistics and configuration information as well as have multiple protocols.

## Automation

IxNetwork provides powerful GUI-based automation with the Test Composer™ and QuickTests™. It also has a robust feature set for GUI-to-script and API-based automation. IxNetwork's automation is simplicity at its best. Test scenarios are set up by using IxNetwork's step-by-step GUI, and then a single button-press generates a TCL test script. Scripts may be modified and combined in any fashion. When the script is run, the IxNetwork GUI watches the execution—providing real-time statistics and state information.

Types	Test Requirement	Detail
QuickTest	Scalability	<ul style="list-style-type: none"><li>Standards-based IETF RFC test methodologies, as well as a custom mode for user-defined performance tests</li><li>Easy-to-use, configurable, pre-packaged tests</li><li>Generate detailed reports of results</li></ul>
Macro Recorder	Functionality	<ul style="list-style-type: none"><li>'Click-thru automation' means no more scripting</li><li>Rapid capture of manual test cases</li><li>Capture steps that cause a failure for reproducibility</li></ul>
Test Composer and Tweakables	Regression	<ul style="list-style-type: none"><li>GUI-based solution to automate test actions</li><li>Detailed control over test execution without Tcl expertise</li><li>Complete access to the Tcl API with easy UI</li><li>Edit 'Macro Recorded' steps for customization of GUI captured events</li></ul>
ScriptGen	Regression	Provides an easy, one-click GUI-to-script generation
Low-Level and High-Level APIs	Functionality and regression	<ul style="list-style-type: none"><li>For Tcl scripting experts</li><li>One-click GUI to TCL script conversion available (ScriptGen)</li><li>Complete access to and control over test configuration</li><li>REST, Tcl, Perl, Python, and Ruby API support</li></ul>

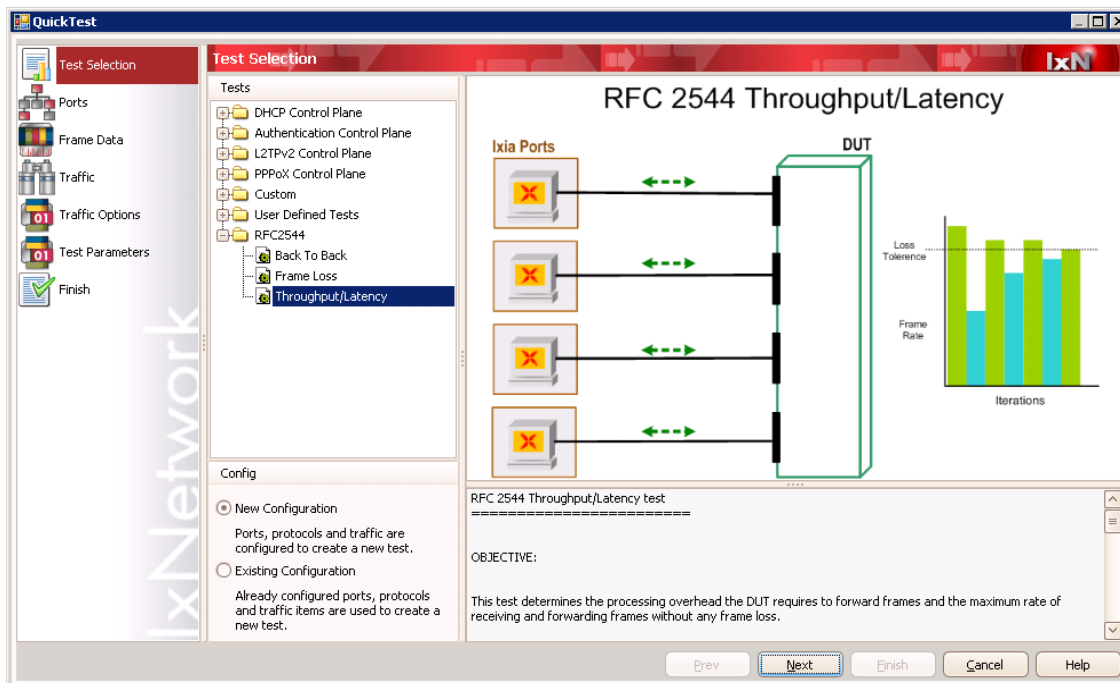


Figure 5. QuickTest end-to-end wizards

QuickTest	Tests
<b>RFC 2544 Tests</b>	Throughput and latency, frame loss, back-to-back
<b>RFC 2889 Tests</b>	Broadcast Rate, Congestion Control, Frame Error Filtering, Fully Meshed, Many to One, One to Many, Partially Meshed
<b>RFC 3918 Tests</b>	Aggregated Multicast Throughput, Burdened Group Join Delay, Burdened Multicast Latency, Forwarding Latency, Group Join/Leave delay, Mixed Class throughput, Multicast Group Capacity, Multicast Group Pattern Verification, Scaled Group Forwarding
<b>ITU-T Y.1564 Service Activation</b>	Service Configuration, Service Performance
<b>Asymmetric Data Performance</b>	Throughput / Latency, Frame Loss
<b>Control Plane Tests</b>	Session setup rate, session capacity
<b>Converged Data Center</b>	Cloud Performance
<b>OpenFlow</b>	Failover Performance, L2 Address Learning, L3 Address Learning, Switch Flow Table Capacity
<b>Custom Tests</b>	Continuous run, fixed duration run, incremental, throughput (binary search)

QuickTest	Tests
User-Defined Tests	Tests defined in Test Composer

## Built-in Data Capture and Analysis

Internet protocols are complex—multi-protocol emulations even more so. IxNetwork includes a built-in tool that captures the control-plane traffic along with data-plane traffic, merging both into a single capture file. IxNetwork allows you to trigger and filter control- and data-plane packet captures based on user-defined packet field.

## Technology Solutions

Visit [keysight.com](http://keysight.com) for More Information on IxNetwork and Keysight Virtualization Solutions

- IxNetwork Overview—L2/3 Network Infrastructure Performance Testing
- IxNetwork Virtual Edition (VE)—Virtualized Network Performance Testing
- IxNetwork Industrial Ethernet Test Solution
- IxNetwork Routing and Switching Test Solution
- IxNetwork Broadband Test Solution
- IxNetwork Data Center Ethernet Test Solution
- IxNetwork MPLS Test Solution
- IxLoad Virtual Edition (VE)—Virtualized Multiplay Services Testing
- BreakingPoint Virtual Edition (VE)—Virtualized Application and Security Testing
- Cloud Peak—Virtualized Infrastructure Benchmarking

## Ordering Information

### 939-9510

IXIA IxNetwork VE Tier-0 1G Subscription License. Includes the IPv4 / IPv6 interfaces in IxNetwork VE for the purchased term. Supports no Control Plane and up to 1 Gbps throughput per unit.

### 939-9501

IXIA IxNetwork VE Tier-1 1G Subscription License. Includes all protocols supported in IxNetwork VE for the purchased term. Supports low scale Control Plane and 1 Gbps throughput per unit.

### 939-9502

IXIA IxNetwork VE Tier-2 1G Subscription License. Includes all protocols supported in IxNetwork VE and all IxNetwork QuickTests for the purchased term. Supports medium scale Control Plane and 1 Gbps throughput per unit.

**939-9503**

IXIA IxNetwork VE Tier-3 1G Subscription License. Includes all protocols supported in IxNetwork VE, all IxNetwork QuickTests, IxNetwork-FT, and AppLibrary for the purchased term. Supports high scale Control Plane and 1 Gbps throughput per unit.

**939-9523**

IXIA IxNetwork VE Tier-3 10G Subscription License. Includes all protocols supported in IxNetwork VE, all IxNetwork QuickTests, IxNetwork-FT, and AppLibrary for the purchased term. Supports high scale Control Plane and 10 Gbps throughput per unit.

**939-9620**

IXIA IxNetwork VE Tier-0 100G Subscription License. Includes the IPv4 / IPv6 interfaces in IxNetwork VE for the purchased term. Supports no Control Plane and up to 100 Gbps throughput per unit.

**939-9621**

IXIA IxNetwork VE Tier-1 100G Subscription License. Includes all protocols supported in IxNetwork VE for the purchased term. Supports low scale Control Plane and 100 Gbps throughput per unit.

**939-9622**

IXIA IxNetwork VE Tier-2 100G Subscription License. Includes all protocols supported in IxNetwork VE and all IxNetwork QuickTests for the purchased term. Supports medium scale Control Plane and 100 Gbps throughput per unit.

**939-9623**

IXIA IxNetwork VE Tier-3 100G Subscription License. Includes all protocols supported in IxNetwork VE, all IxNetwork QuickTests, IxNetwork-FT, and AppLibrary for the purchased term. Supports high scale Control Plane and 100 Gbps throughput per unit.



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