JUNIPER PARAGON ACTIVE ASSURANCE DATASHEET

Product Overview

The transition to hybrid virtual/ physical networks and service chains introduces new points of failure. Traditional service assurance techniques, which collect counters and telemetry data from devices in the infrastructure, are not designed to determine whether a service is properly working from the end user's perspective. Furthermore, traditional assurance solutions have limitations in helping service operations centers (SOCs) assess the real customer experience over the lifetime of the service. With Paragon Active Assurance, customer-facing teams can automate turn-up testing processes and gain continuous end-to-end service quality insights to proactively enhance the customer experience.

Product Description

Juniper® Paragon Active Assurance (formerly known as Netrounds) is a programmable, active test and service assurance platform for physical, hybrid, and virtual networks. Unlike passive test and assurance approaches, Paragon Active Assurance uses active, synthetic traffic to verify application and service paths at the time of delivery and throughout the life of the service.

Service delivery teams leverage Paragon Active Assurance to verify new service deployments and changes. Paragon Active Assurance verifies and ensures that services are configured correctly the first time. It also validates service changes to make sure they do not impact service performance. By automating initial service verification and testing, service delivery teams reduce time to revenue, lower operating expenses associated with service delivery, and reduce failed service delivery rates.

Network operations teams use Paragon Active Assurance to identify, understand, troubleshoot, and resolve issues before customers notice them. The visibility into service performance provided by Paragon Active Assurance reduces incident resolution times by as much as 50%, resulting in greater customer satisfaction and retention.

Paragon Active Assurance provides a fully integrated solution for multilayer, multidomain service life-cycle management, letting you verify that each provisioned service works when delivered and continues working throughout its lifetime. It also reduces manual efforts through automation, significantly decreasing operational costs and improving operating margins.

Architecture and Key Components

Leveraging a virtual, cloud-ready platform, Paragon Active Assurance is easy to deploy and adopt, enabling you to start small and scale as your business needs grow.

The core component of Paragon Active Assurance is a cloud-ready multitenant Control Center, which provides a user-friendly Web portal GUI where operations staff can run on-demand tests and view real-time and aggregated results as well as key performance indicators (KPIs) and service-level agreement (SLA) monitoring metrics. The Control Center includes a feature-rich cloud API allowing external operations support systems (OSS) and Network Functions Virtualization (NFV) orchestrators to easily automate distributed activation tests or monitoring scenarios.
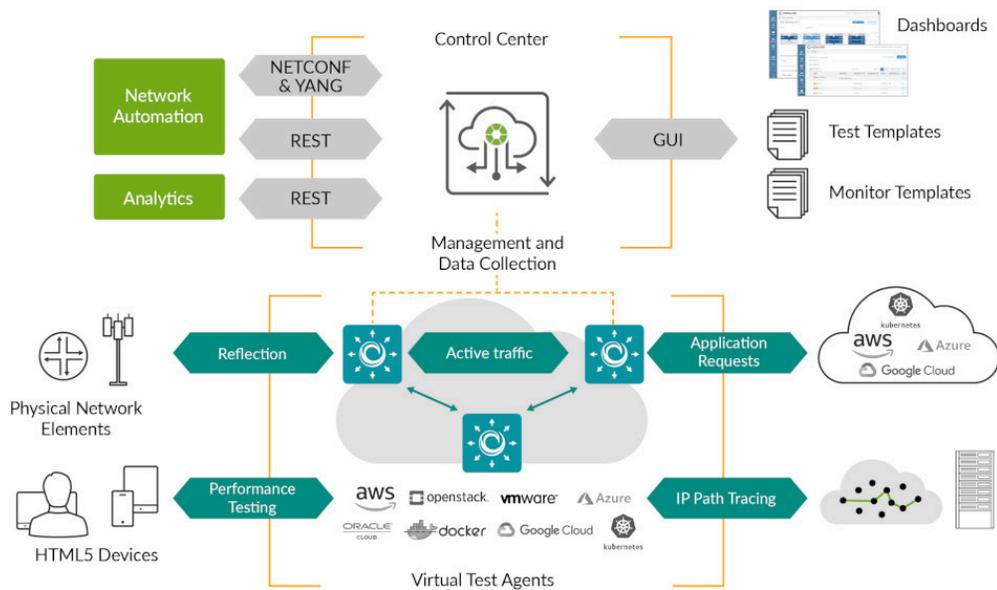
Figure 1: Paragon Active Assurance architecture

The Control Center remotely controls Paragon Active Assurance software-based and traffic-generating Test Agents, which provide distributed measurement metrics for service activation testing, quality monitoring, and troubleshooting. It also displays detailed, real-time results and statistics actively measured by the Test Agents and reflector streams across multiple applications, services, and interfaces. Test Agent capabilities include service activation (Y.1564, MEF 48), network performance (UDP, TCP, Y.1731, TWAMP, path trace), Internet performance (HTTP, DNS), rich media (IPTV,OTT video, Netflix, VoIP telephony, and SIP), as well as support for controlling Wi-Fi interfaces, and performing remote packet inspection.

Test Agents may be placed in strategic locations across your network for continuous quality monitoring. They may also be installed on demand for more temporary purposes, such as activation testing of newly deployed services. Test Agents are available in several formats: as software to be run as a virtual machine on a hypervisor, as a container application, or as a software appliance for installation on dedicated x86 hardware.

Key Capabilities

Real-Time Aggregated Views of Monitoring and Tests

Paragon Active Assurance calculates and visualizes errored seconds (ES) and SLA compliance indicators. Aggregated result views show large numbers of distributed active measurements. Measured data can be presented down to 1 second resolution, with an historical timespan adjustable from the last 15 minutes to years in the past.
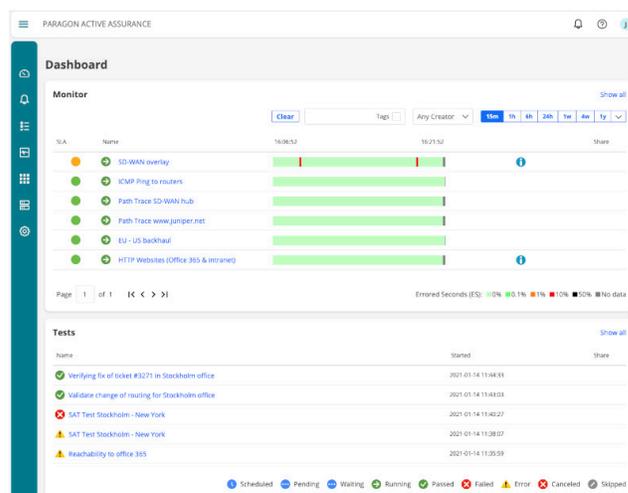

Figure 2: Real-time aggregated views of monitoring and tests

Periodic Reports and Alarm Generation

SLA compliance is presented for each quality monitoring scenario and periodic test in comprehensive and configurable reports. These reports can be scheduled and e-mailed to stakeholders at custom intervals, or they can be retrieved programmatically through the Control Center's API. Alarms with multiple severity levels (critical, major, minor, warning) can be sent as SNMP traps.
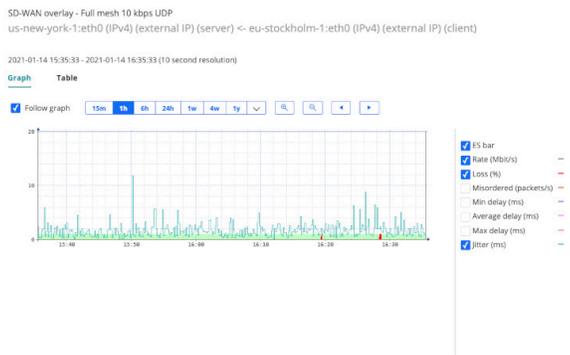

Figure 3: SLA monitoring

Dynamic Test Agent Inventory

Test Agents automatically discover and register Control Center login servers. Test Agents appear as resources in the inventory once launched by the NFV orchestrator or OSS, or connected physically to the network.

Test Agents can be tagged for simple grouping and structuring. Test Agent interfaces can be configured remotely from the Control Center.
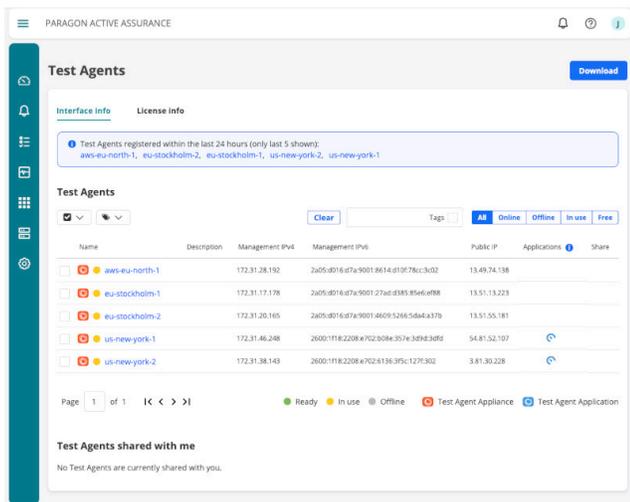

Figure 4: Inventory of Tests Agents registered with the Control Center

Builder GUI for Scenarios and Templates

The Paragon Active Assurance Web GUI has an intuitive test sequence builder which can be used in the service design process. SLA compliance thresholds can be set for each monitoring scenario.

Test building blocks can be saved as reusable templates, where parameters can be left to be defined at runtime. Tests and monitoring sessions can be triggered by the OSS through APIs.
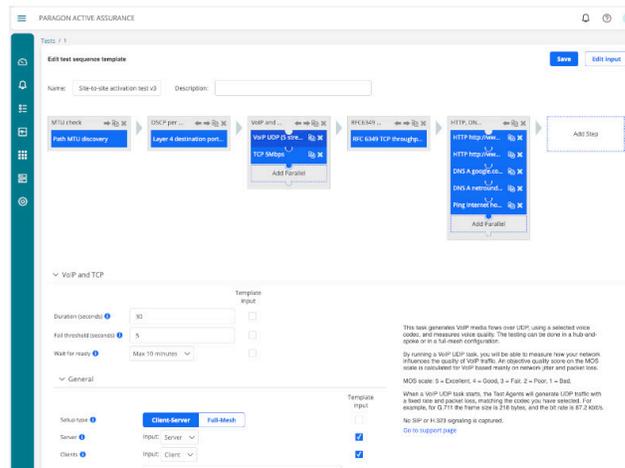

Figure 5: Test Templates Builder

Sharing and Collaboration

Test and monitoring scenarios and templates, active Test Agents, and all test results and reports obtained can be freely shared among users in the same multitenant Control Center. Also, unique URLs can be shared to external users, with or without password protection enabled.

Key Benefits of Paragon Active Assurance

Paragon Active Assurance offers the following benefits:

- Integrated, dynamic solution for full multilayer, multidomain service life-cycle management—Combined service activation testing, quality monitoring, and troubleshooting provide fully orchestrated assurance.
- Virtualized and cloud-ready—Flexible deployment and elastic scaling on all major modern virtualization platforms allows you to start small and scale.
- Easy to get started—Software-only and hosted components allow for smooth introduction, enable immediate use, and bring instant value.
- Automation through well-documented complete API—Simple integration of fulfillment and assurance workflows eliminates manual work and reduces cost of complex integration.

Features and Benefits

Control Center

The Control Center is either hosted by Juniper Networks and offered as a Software as a Service (SaaS) solution or deployed on premises in a private cloud. In either case, it displays both second-by-second and aggregated real-time results, as well as KPIs and SLA monitoring metrics.

Table 1. Features and Benefits of Control Center

Feature	Benefit
Feature-rich cloud API for distributed on-demand tests and live monitoring of end-user KPIs	Enables closed-loop, fully automated workflow by providing KPIs of actual end-user experience to service orchestrators/OSS
Centralized storage and aggregation of test results and SLA monitoring metrics	Allows effortless handling of hundreds or even thousands of concurrent measurements across your network
Web portal for creation and initiation of test scenarios and automation templates	Supports design time and runtime dynamic test processes, as well as remote troubleshooting
Real-time KPIs, dashboards, and drill-down charts	Provides real-time actionable insights into how your network and services perform from a customer perspective
Centralized and dynamic inventory of distributed, traffic-generating Test Agents	Presents a consolidated user interface for all Test Agents—no need to manage Test Agents individually
Remote updates of Test Agent software	Reduces maintenance costs with remote and automated updates, keeping your Test Agents up to date
Emulated 5G user equipment and gNodeB	Validate that 5G network services and slices deliver on SLAs by testing through the 5G core functions and user plane

The Control Center has a wide range of built-in core features that are exposed over either an intuitive Web portal user interface or a complete read/write API. The Web portal is used for test design, on-demand initiation of tests, remote troubleshooting, and real-time reconfiguration of service assurance scenarios and thresholds. The API is used by external systems such as OSS and NFV orchestrators to dynamically launch new Test Agents and initiate activation tests and quality monitoring scenarios.

The Control Center can be made available in two ways—hosted in the Amazon AWS public cloud infrastructure or installed on premises or as a private cloud solution. Both deployment options share the same core features, Web portal, and API.

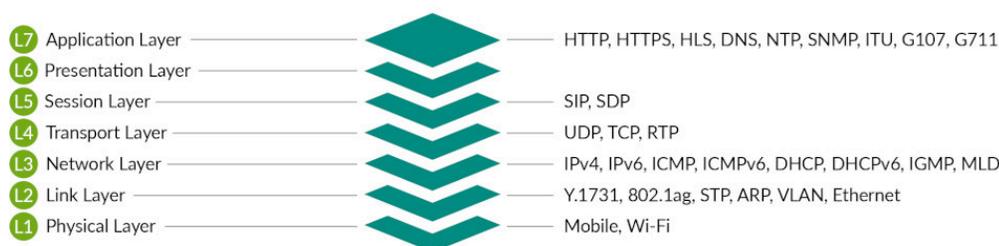|		
L7	Application Layer	HTTP, HTTPS, HLS, DNS, NTP, SNMP, ITU, G107, G711
L6	Presentation Layer	
L5	Session Layer	SIP, SDP
L4	Transport Layer	UDP, TCP, RTP
L3	Network Layer	IPv4, IPv6, ICMP, ICMPv6, DHCP, DHCPv6, IGMP, MLD
L2	Link Layer	Y.1731, 802.1ag, STP, ARP, VLAN, Ethernet
L1	Physical Layer	Mobile, Wi-Fi

Figure 6: Supported protocols by OSI layer

Test Agents

Test Agents actively generate authentic traffic and analyze detailed, real-time measurements across multiple applications, services, and interfaces. Test Agent capabilities include measurement of network performance (UDP, TCP, Y.1731, TWAMP), IPTV and over-the-top (OTT) video, including Netflix stream speed tests, and Internet (HTTP, Ping, HTML5 Performance Tests), as well as VoIP and Session Initiation Protocol (SIP) telephony, mobile radio, Wi-Fi, and remote packet inspection.

In addition to deploying the Test Agent for TWAMP reflection based testing of multivendor devices, specifically for Junos devices, the Test Agent can also collect TWAMP session results from measurements done by the Juniper Routers using the NETCONF protocol to evaluate errored second thresholds and report back to the Control Center on SLA adherence based on delay, jitter, loss and other performance metrics.

All Test Agents are controlled and updated remotely through the Control Center. The Control Center in turn can be accessed through a Web GUI or through a cloud API.

External OSS and NFV orchestrators easily automate distributed activation tests and quality monitoring through a feature-rich cloud API to the Control Center. Network operations staff access the user-friendly Web interface as a test design environment, as well as for on-demand tests, quality monitoring, and real-time visualizations.

Table 2. Features and Benefits of Test Agents

Feature	Benefit
Genuinely software-based	Suitable for both virtualized and traditional networks
Instant remote Test Agent deployment	No need for field efforts using expensive hardware tools
Traffic generating capabilities	Activation tests, quality monitoring, and remote troubleshooting from the end-user perspective
Versatile features and tools	Complete system for assessing end-user experience
Centrally managed	Consistent interface and back-end for users and orchestrators

Product Options

Hosted: The Control Center is hosted in the Amazon AWS public cloud infrastructure and managed by Juniper Networks. This solution scales transparently and elastically with the number of Test Agents deployed; there is no need for any involvement from you as a Juniper Networks customer. The server software and the repository of Test Agent software are always kept up to date.

On Premises: The Control Center is deployed on premises in your own data center environment, either on bare-metal servers or on existing private cloud infrastructure, and is managed either by your organization or by Juniper Networks as a managed service. The option of deploying a TimeScaleDB for direct queries from an external dashboard is available.

Hosted Option	On-Premises Option
Deployed as a securely hosted SaaS solution in the Amazon AWS public cloud infrastructure	Installed on premises in private cloud infrastructure or private data centers
Offers a flexible subscription business model	Offered as licensed software
Operated and managed by Juniper Networks as part of the subscription agreement	Operated and managed by Juniper Networks as a service or managed by Juniper customer
Scales from single Test Agent deployments to nationwide or multinational rollouts	Starts at deployments of 10+ Test Agents to nationwide or multinational rollouts
Subscriptions correspond to one individual tenant account in the hosted, multitenant Control Center	Dedicated multitenant solution with individual dashboards for the service provider and their enterprise cus-tomers
Frequent updates for Control Center software, as well as for repository of software for all Test Agent types	Update frequency determined by customer for Control Center, as well as for repository of software for all Test Agent types
User authentication handled by Control Center	User authentication can optionally be done against an LDAP or TACACS+ server

Specifications

Control Center Interfaces

Interface	Description
Northbound user interface towards operations staff	**Browser GUI towards Web portal** • Native HTML with JavaScript • HTTPS for secure access to Web portal • Support for all common Web browsers: Chrome, Firefox, Internet Explorer, Opera, and Safari • Mobile browser support • HTTP basic authentication • Multi-user support with different user levels and credentials

Interface	Description
Northbound API towards OSS and NFV orchestrators	**REST** • Follows REST API best practices • Web browsable; extensive documentation **NETCONF and YANG** • Support for service modeling with YANG • Network Configuration Protocol (NETCONF) supported for mapping YANG specifications onto easy-to-use interfaces **STREAMING API** • Kafka event streaming API available for data export from on-premise deployments
Southbound interfaces for remote control and configuration towards active Test Agents	**Test Agents** • Firewall-friendly communication, initiated by Test Agents towards Control Center • Local storage on Test Agent in case Control Center is temporarily unreachable • Secure control protocol using SSL between Control Center and Test Agents

Test Agent Types

Test Agents come in three main varieties.

Test Agent Software Appliance

The Test Agent Software Appliance is integrated with an optimized Debian Linux OS. The appliance can be packaged and delivered in a number of ways:

- **Dedicated Test Agent**—Test Agent Software Appliance is downloaded by the customer and installed on customer-provided x86 hardware.
- **Test Agent Virtualized Network Function (TA VNF)**—Test Agent image is downloaded by the customer and run as a virtual machine (VM) on a hypervisor.

These options have identical traffic-generating capabilities and differ only in terms of packet performance, which is determined by available CPU resources and interface speeds.

Test Agent Application

The Test Agent Application consists of software and can be packaged and delivered in two ways:

- **Test Agent Application**—Consists of software downloaded by the customer and is installed as an application on a Linux machine.
- **Test Agent Cloud-Native Network Function (TA CNF)**—The Test Agent Application can optionally run as a container in any environment that supports it. The containerized application is in a position to approximate very closely the performance of other applications running on the same virtual machine.

Test Agent Natively Pre-integrated into Junos® OS Evolved-based Network Equipment

The Test Agent natively pre-integrated in Junos OS Evolved-based network equipment gives network operators an easy way to use active testing, monitoring, and troubleshooting on the data plane. It goes beyond traditional embedded test functionality for basic TWAMP and Y.1731 use cases by providing more fine-grained measurements for richer network KPIs. Test Agent supports UDP, TCP, HTTP, DNS, Ping, PathTrace, IPTV, and OTT video.

Test Agent Software Appliance—Downloadable Software for Standard x86 Hardware

	HDD	Bootable USB
Usage	Permanent installation on physical block storage device (HDD)	Live booting from USB memory stick for temporary transformation of any x86 PC hardware into a Test Agent
Delivery format	Delivered as installation ISO image	Delivered as raw disk image
RAM requirement	256 MB minimum; 512 MB recommended	
Storage requirement	4.1 GiB	Min. 4.1 GiB storage on USB memory
Recommended network interface cards (NICs)	Intel NICs recommended	
NIC driver support	Same as supported by Linux Debian	

Test Agent Virtual Network Function—Downloadable Software for Hypervisors

Below is a comparison of the various Test Agent virtualized network function (TA VNF) formats.

Test Agent VNF Delivery Form

	Raw/Qcow2	Open Virtualization Format (OVF)/Virtual Machine Disk (VMDK)	Amazon Machine Image (AMI)	Virtual Hard Disk (VHD)	Google Cloud Platform (GCP)
Type	Preinstalled and bootable appliance				
Delivery format	Raw or Qcow2 disk image	VMDK disk image plus OVF file	AMI	VHD disk image	GCP image
Orchestration support	OpenStack Heat Orchestration Templates (HOT) using cloud-init	VMware vCloud Director, VMware Integrated Open-Stack (VIO)	AWS CloudFormation templates	Azure ARM templates	Google Deployment Manager
Hypervisor support	KVM	VMware vSphere	Xen	Azure Hypervisor	Google Cloud Platform
Example platforms	OpenStack				
Download image size	Raw: 4.1 GiB /gzipped raw: 176 MiB / Qcow2: 463 MiB	OVA: 190 MiB / VMDK: 210 MiB	4.1 GiB	4.1 GiB	4.1 GiB
Minimum machine type requirement	Minimum: 1vCPU / 256 MB Recommended: 2vCPU / 4 GB	Minimum: 1vCPU / 256 MB Recommended: 2vCPU / 4 GB	Minimum: t3.nano Recommended: c5.large	Minimum: B1ms Recommended: D2	Minimum: f1-micro Recommended: n1-standard-2
RAM and storage requirements	RAM: 256 MB minimum; 512 MB recommended Storage: 2 GB				
SR-IOV, PCI pass through	Not required, but could improve accuracy and performance				
NIC driver support	Same as supported by Linux Debian	Same as supported by Linux Debian and VMware tools	Same as supported by Linux Debian	Same as supported by Linux Debian	Same as supported by Linux Debian

Test Agent Application—Linux Application and Cloud-Native Network Function (CNF)

Below is a comparison of the Test Agent Application deployed as a Linux application and the same entity deployed as a container (CNF) for X86 and ARM Processor Architectures.

	Test Agent Application	Test Agent CNF
Type	x86-64, ARM-64 (aarch64), ARM-32 (arm71) Linux application	x86-64 container
Delivery format	tar.gz package	Docker Hub or tar.gz package
Orchestration support	Application arguments	Kubernetes
Hypervisor support	N/A	Docker
Example platforms	N/A	AWS, GCP, Azure
Download size	< 10 MB	< 100 MB
RAM and storage requirements	RAM: 128 MB Storage: 10 MB	RAM: 128 MB Storage: 100 MB
SR-IOV, PCI pass through	N/A (uses host OS networking stack)	
NIC driver support	N/A (uses host OS drivers)	

Test Agent Functionality

Technology	Test Functionality
General Network Support	
Transport modes	Bridged Ethernet IEEE 802.1q VLAN IPv4 over Ethernet IPv6 over Ethernet
Physical link configuration	Duplex setting (full or half) Speed setting (10 Mbps-10 Gbps) MTU size (64-9000 bytes)
Media access control (MAC) addresses	Per physical port or VLAN Factory default User-defined
Bridge setup	Bridge physical ports and/or VLANs Multiple bridges (maximum 4 per Test Agent) IP hosts assigned to bridges
VLAN setup	Per physical port (maximum 125 per Test Agent) Full VLAN range (1-4095) Priority code point (0-7)
IP host setup	Multi-host (maximum 125 per Test Agent), one host per physical port or VLAN Separate routing tables per host DiffServ code point (0–63) Static addressing (gateway, DNS) DHCPv4, DHCPv6, stateless address autoconfiguration (SLAAC) DHCPv4 vendor class Use of IP host for management
DHCPv4 server setup	DHCPv4 server for other clients Per physical port or VLAN Network range Network prefix length Gateway and Domain Name System (DNS)
Interface status	Per physical port or VLAN Current speed/duplex Current MAC and IP address TX and RX packets TX and RX bytes
Supported Standards by OSI Layer	
L1—Physical Layer (dedicated Test Agents Software Appliance)	IEEE 803.2i: 10BASE-T IEEE 802.3u/x: 100BASE-TX IEEE 802.3ab: 1000BASE-T IEEE 802.3ae: 10GBASE-SR/LR IEEE 802.3ac: 1522 byte "Q-tag" IEEE 802.11g/n/ac: Wi-Fi/Wireless LAN ETSI/3GPP: GPRS/EDGE/UMTS/LTE
L2—Link Layer	RFC 826: Address Resolution Protocol (ARP) IEEE 802.1q: VLAN IEEE 802.1p: Protocol for Traffic Prioritization IEEE 802.1ad: QinQ, VLAN Stacking IEEE 802.1ag: Ethernet Loopback RFC 2131: Dynamic Host Configuration Protocol, DHCP RFC 3046: DHCP Relay Agent Information Option ITU-T Y.1731: OAM Functions and Mechanisms for Ethernet-based Networks ITU-T Y.1564: Ethernet Service Activation Test Methodology MEF 6.1.1: Layer 2 Control Protocol Handling

Technology	Test Functionality
L3—Network Layer	RFC 791: IPv4 RFC 2460: IPv6 RFC 792: ICMP RFC 2236: Internet Group Management Protocol, Version 2 RFC 3376: Internet Group Management Protocol, Version 3 RFC 5481: Packet Delay Variation Applicability Statement RFC 3393: IP Packet Delay Variation Metric for IP Performance Metrics RFC 2474: Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers RFC 2680: One-way Loss Ratio RFC 2679: Minimum One-way Delay RFC 6703: Mean One-way Delay (section 5.2) RFC 5357: A Two-Way Active Measurement Protocol (TWAMP)—Full and Light
L4—Transport Layer	RFC 736: User Datagram Protocol (UDP) RFC 793: Transmission Control Protocol (TCP) RFC 3550: RTP: A Transport Protocol for Real-Time Applications
L5—Session Layer	RFC 3261: SIP: Session Initiation Protocol RFC 3551: RTP Profile for Audio and Video Conferences with Minimal Control RFC 3266: SDP: Session Description Protocol RFC 3264: An Offer/Answer Model with the Session Description Protocol (SDP) RFC 3515: The Session Initiation Protocol (SIP) Refer Method RFC 3891: The Session Initiation Protocol (SIP) "Replaces" Header RFC 5216: The EAP-TLS Authentication Protocol (Extensible Authentication Protocol—Transport Layer Security) RFC 5281: Extensible Authentication Protocol Tunneled Transport Layer Security Authenticated Protocol Version 0 (EAP-TTLSv0) PEAPv0/EAP-MSCHAPv2: Protected EAP
L7—Application Layer	ITU-T G.711: Pulse Code Modulation (PCM) of Voice Frequencies RFC 1901, 1908, and 2570: SNMP v2 and v3 ITU G.107: The E-model: A Computational Model for Use in Transmission Planning ETSI TR 101 290: Digital Video Broadcasting (DVB); Measurement Guidelines for DVB Systems RFC 6959: Source Address Validation Improvement (SAVI) Threat Scope RFC 7230: Hypertext Transfer Protocol—HTTP/1.1 RFC 1305: Network Time Protocol (Version 3) RFC 1034: Domain Name System
Internet Performance Measurement	
General	Request/response-based One-armed (single Test Agent) Distributed (multiple Test Agents)
HTTP	HTTP server (URL target) Time between requests Response code validation Response content validation Time to first byte received Page load times Download rates
DNS	DNS server Lookup address Time between requests DNS record type response validation (A, AAAA, CNAME, MX) Response time measurement

Technology	Test Functionality
ICMP (Ping)	IP hosts (targets) Time between requests Payload size (64-9000 bytes) DiffServ code point (DSCP) prioritization Time-to-live Hop-by-hop detection of IP hosts
HTML5 Performance Tests	Test Agent as HTML5 performance test responder Tests initiated from browsers Test duration TCP port Number of concurrent TCP sessions Access control through IP filters

Network Performance Measurement

Technology	Test Functionality
General	Test Agent to Test Agent traffic generation Point-to-point Hub and spoke Custom mesh topologies Destination port (UDP and TCP) Unidirectional or bidirectional Configurable rate (Mbit/s) DSCP and PCP header marking
UDP	Unicast or multicast Generated output bandwidth Packet size (64-9000 bytes)
VoIP-like UDP	MOS scoring (1-5) 20 concurrent calls per Test Agent Codec emulation: G.711, G.723, G.729, GSM-EFR Media transport generation, not signaling
Stateful TCP	Number of point-to-point sessions Output rate limitation for each direction
Multi-session TCP	Number of point-to-point TCP sessions
TCP throughput testing	RFC 6349: Framework for TCP Throughput Testing
Quality of Service (QoS) policy profiling	Multi-stream generation in each queue Mix of UDP and TCP to measure queue build-up Profile generated for each traffic stream
Y.1731/802.1ag	ITU-T Y.1731 Ethernet Loopback, ETH-LB ITU-T Y.1731 Delay Measurement, ETH-DM ITU-T Y.1731 Synthetic Loss Measurement, ETH-SLM Participating maintenance association end points (MEPs) as input list Maintenance group entity (MEG) level (0-7) Unavailable Seconds (UAS) per ITU-T Y.1563 Packet size (64-9018 bytes)
TCP throughput testing	RFC 6349: Framework for TCP Throughput Testing
QoS policy profiling	Multi-stream generation in each queue Mix of UDP and TCP to measure queue build-up Profile generated for each traffic stream
Y.1731/802.1ag	ITU-T Y.1731 Ethernet Loopback, ETH-LB ITU-T Y.1731 Delay Measurement, ETH-DM ITU-T Y.1731 Synthetic Loss Measurement, ETH-SLM Participating MEPs as input list MEG level (0-7) UAS per ITU-T Y.1563 Packet size (64-9018 bytes)

Technology	Test Functionality
TWAMP	RFC 5357: Two-way Active Measurement Protocol TWAMP Light (RFC 5357 App. I) UAS per ITU-T Y.1563 Packet size (87-9018 bytes) Hardware timestamping
UDP loopback	Reflector device configured to loop back UDP packets in hardware Very high throughput achievable
BWPing	Bandwidth and response times measured between Test Agent and router/switch Uses Internet Control Message Protocol (ICMP) echo request/reply mechanism Achieves high data throughput
Path trace	ICMP and/or UDP echo packets sent with increasing time to live (TTL) Measures delay, jitter, and loss for each hop Continuous detection of network paths Indicates each BGP AS discovered along path

IPTV and HTTP Streaming Video

Technology	Test Functionality
General	Request/response-based Emulate single client (one Test Agent) Distributed (multiple Test Agents) Inline with traffic (interception)
IPTV Moving Picture Experts Group (MPEG)	Joining of multicast channels Test Agents and input channels selection MPEG transport stream analysis MPEG loss (continuity counter) Peak cell rate (PCR) and real-time polling (RTP) packet jitter Table errors (PAT and PMT) Missing PID detection
IPTV MPEG inline	Interception of Internet Group Management Protocol (IGMP) pass through Stream analysis of MPEG transport stream
IGMP channel zapping time	Continuous join and leave cycle Selection of channels to cycle Join and leave delay measurements
HTTP video streaming (OTT)	Apple HTTP Live Streaming (HLS) URL input for source of video Detection of buffer underrun Loop feature for static videos
Netflix streaming	Measure over HTTPS: -Download speed (Mbits/s) to Netflix server -Upload speed (Mbits/s) to Netflix server -Errored seconds due to low bandwidth
IGMP join/leave test	Checks if users can join and receive data on allowed multicast channels (and no others)
Multicast group limit test	Checks that a user can only join a specified maximum number of multicast channels

Technology	Test Functionality
VoIP and SIP Telephony	
General	Hub and spoke Point-to-point SIP account inventory
SIP signaling	Registration and un-registration Invite and hang up Cycle length
RTP media stream quality	MOS scoring (1-5) Rate Packet loss Packet misorderings Voice codec (G.711 A-law, G.711 µ-law, GSM)
Remote Packet Inspection	
General	Packets intercepted remotely from Test Agents Standard "tcpdump" filters Standard "pcap" files
Direct packet capture	Filtered packets forwarded from individual Test Agent to local Wireshark application
Packet capture through server	Filtered packets forwarded from group of Test Agents to Control Center for storage and centralized retrieval
Transparency	
General	Packet mangling and network transparency/QoS tests
L2 transparency—Ethertypes	Layer 2 transparency for various Ethertypes and logical link control (LLC)/Subnetwork Access Protocol (SNAP)
L2 transparency—Custom Ethertype	Checks that specified Ethertype passes through network
L2 transparency—VLAN	Verifies transparency for given VLAN tag, VLAN priority (PCP), and DSCP
L2 transparency—Custom VLAN	Checks that packets with given VLAN tag and priority (PCP) are not modified by network
L2 transparency—Ethernet control protocols	Checks transparency for Link Aggregation Control Protocol (LACP), Extensible Authentication Protocol over LAN (EAPoL), and Multiple VLAN Registration Protocol (MVRP)
L2 transparency— IP	Verifies IPv4 header integrity as well as IP multicast, checking that IP packets are not dropped
L2 transparency—IPv6	Verifies IPv6 header integrity
L2 transparency—MAC address limit	Checks that number of MAC addresses is between a given minimum and maximum
L2 transparency—multicast	Verifies that multicast packets are not dropped (STP and MPLS protocols)
DSCP remapping	Verifies expected remapping of DSCP values between two points in a network
Layer 4 destination port DSCP remapping	Same as preceding but with specific UDP or TCP destination ports indicated
Path MTU discovery	Determines path maximum transmission unit (MTU) between two Test Agents
Security	
General	Tests primarily designed for Layer 3 networks Focused on: man-in-the-middle (MITM) attacks; denial-of-service (DoS) attacks; abuse-tracking of end users Test Agent acting as either customer or ISP
DHCP starvation	Checks that a customer can only obtain a limited number of IPv4 addresses
Fragmented DHCP packets	Checks that switch drops fragmented DHCP packets before they reach the control plane
Fragmented TCP/UDP headers	Checks that switch drops IPv4 and IPv6 packets with fragmented TCP or UDP headers
Management protocol scanning	Checks that management protocols are unavailable at customer ports

Technology	Test Functionality
Router redundancy protocol listening	Checks that Virtual Router Redundancy Protocol (VRRP)/ Common Address Redundancy Protocol (CARP), Gateway Load-Balancing Protocol (GLBP), and Hot Standby Routing Protocol (HSRP) are unavailable at customer ports
Routing protocols	Checks that routing protocols are not available on customer ports
Spanning Tree Protocol (STP)	Checks that STP is not available on customer ports
Wi-Fi	
General	Uses Intel Wi-Fi NIC (IEEE 802.11g/n/ac) if available on the host platform Measurement and logging of basic Wi-Fi metrics Network and access point switching capability
Wi-Fi switcher	Configuration of MAC address, MTU, SSID, BSSID, type of authentication and cipher 802.11n (High Throughput): enable/disable; 40 MHz channels: enable/disable; Miscellaneous Control Subsystem (MCS) indexes allowed 802.11ac (Very High Throughput): enable/disable; MCS indexes allowed; maximum number of MIMO spatial streams Frequency bands—2.4 GHz, 5 GHz: enable/disable Short Guard Interval (SGI): on/off Low Density Parity Check (LDPC): on/off
Wi-Fi logger	Received signal strength indicator (RSSI) TX bitrate, RX bitrate (theoretical maximum) TX and RX MCS indexes used Guard interval used Number of TX and RX MIMO streams TX retries
5G user equipment/gNodeB emulation	
General	Uses synthetic traffic from emulated user equipment and gNodeBs Verifies end-to-end 5G services and slice instances to deliver expected KPIs, for example, one-way latency measurements, jitter, or service response time
Emulated 5G user equipment/gNodeB traffic	Supports traffic encapsulated in a GTP tunnel Supports IPsec over GTP
5G core testing	Test from the distributed 5G RAN through the 5G core network functions, for example, Access and Mobility Management Function (AMF), Session Management Function (SMF), User Plane Function (UPF)

Ordering Information

Please contact your Juniper Networks sales representative for ordering information.

About Juniper Networks

At Juniper Networks, we are dedicated to dramatically simplifying network operations and driving superior experiences for end-users. Our solutions deliver industry-leading insight, automation, security, and assurance to drive real business results. We believe that powering connections will bring us closer together while empowering us all to solve the world's greatest challenges of well-being, sustainability, and equality.

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