

IxNetwork — Broadband Access and Authentication Test Solution

Validate with real-world subscriber and service mixes before you deploy

Highlights

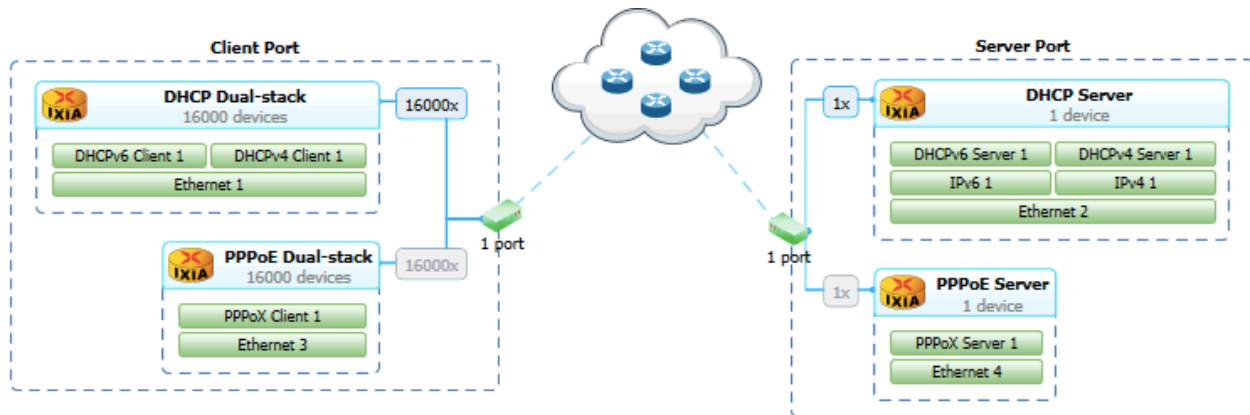
- Ensure smooth deployment by testing under realistic access network scenarios with mixed subscriber types over same link and mixed unicast and multicast services over emulated subscribers
- Stress-test and measure subscriber management capability KPIs
- Evaluate IPv6 readiness of handling IPv4, IPv6, and dual-stack subscribers as well as mixed IPv4 and IPv6 data traffic performance
- Benchmark data forwarding performance of asymmetric upstream and downstream in access network
- Ensure reliable service and user QoE by characterizing performance of multicast infrastructure for delivering IPTV and triple-play service
- Validate basic network security by testing port-based and web-based access control

Problem: Growing Internet Users and Services Challenge Access Network Capacity and Service-Level Agreements

Growing Internet users and exploding service offerings are challenging existing access networks. Service providers are struggling to upgrade their networks with careful capacity planning and IPv6 transition considerations. Subscriber management capability of edge aggregation devices and access networks need to be thoroughly qualified and field trials carried out to ensure smooth deployment with minimum down time.

Solution: A Comprehensive Test Solution to Ensure Dynamic and Robust Access Networks

Keysight's IxNetwork Broadband Access and Authentication test solution provides a rich set of emulations, including various subscriber protocols, unicast and multicast services, supplicants access control. It enables you to stress access networks under realistic conditions with mixed subscriber types and services to ensure thorough qualification of devices and services for smooth deployment with confidence of meeting subscriber SLAs.



IxNetwork Dual-Stack PPPoE and IPoE Subscribers emulation

Key features

- Emulates large number of PPPv4, PPPv6, Dual-Stack PPP subscribers, and intermediate agent over Ethernet and ATM, along with running services over emulated subscribers, to qualify subscriber management capability of edge aggregation devices like broadband network gateway (BNG) and broadband remote access server (BRAS)
- Emulates wholesale scenarios with PPP subscribers over L2TP to validate the capability of L2TP access concentrator (LAC) and L2TP network server (LNS) tunneling and terminating PPP subscribers
- Emulates IPoE subscribers including DHCPv4, DHCPv6, and dual-stack DHCP, along with running services over emulated subscribers to qualify subscriber management capability of edge aggregation devices like BNG and BRAS
- Emulate SLAAC (stateless address autoconfiguration) to test basic IPv6 host discovery and autoconfiguration capability
- Emulates ANCP-enabled access nodes, along with subscriber emulation to validate access node management and subscriber policy enforcement capability of edge aggregation devices such as BNG and BRAS
- Emulates IGMP/MLD queriers and receivers, and IPTV subscribers to qualify the effectiveness, performance, and robustness of multicast infrastructure
- Emulates IPv6 and dual-stack subscribers to validate IPv6 readiness of access network
- Realistic access network emulation with mixed subscriber types over same link, as well as mixed unicast and multicast services over emulated subscribers
- Packaged Asymmetric Data Performance QuickTest specially designed to benchmark data forwarding performance independently in upstream and downstream direction
- Emulates subscribers running over link aggregation with LACP bundle or static bundle to validate common access condition
- Emulates subscribers over EoGRE (or SoftGRE) to validate Wi-Fi offload use cases
- Automatic multicast tunneling (AMT) emulation qualifies the capability of AMT relay delivering multicast traffic to isolated unicast domain
- Emulates hundreds or thousands of supplicants with extensive set of controls and parameters to test authenticator at various scenarios
- Emulates vBRAS Control and User plane Separation Protocol (CUSP) to test Control Plane and User Plane separation of disaggregated Broadband Network Gateway (BNG), as per CMCC standards.
- The emulated vBRAS CP supports CUSP as control interface, VxLAN GPE as service interface and NETCONF as the management interface. It supports PPPoE, IPoE, Static subscribers and can act as L2TP LAC.
- Visit www.keysight.com for more details on IxNetwork

Specifications

PPPoX and L2TPv2

Standards

- RFC 1332 — The PPP Internet Protocol Control Protocol (IPCP)
- RFC 1334 — PPP Authentication Protocols (PAP)
- RFC 1570 — PPP LCP extensions
- RFC 1661 — The Point-to-Point Protocol (PPP)
- RFC 1877 — PPP IPCP extensions
- RFC 1990 — The PPP Multilink Protocol (MP) (limited control plane per N2X capability)
- RFC 1994 — PPP Challenge Handshake Authentication Protocol (CHAP)
- RFC 2364 — PPP over AAL5 (PPPoA)
- RFC 2516 — A method for transmitting PPP over Ethernet (PPPoE)
- RFC 2661 — Layer 2 Tunneling Protocol (L2TP)
- RFC 4241 — A model of IPv6/IPv4 dual stack internet access service
- IEEE 802.1q VLANs
- RFC 4862 — IPv6 stateless address autoconfiguration
- RFC 5072 — The PPP IPv6 Control Protocol (IPv6CP)
- DSL Forum TR-101 Migration to Ethernet Based DSL Aggregation draft-lihawi-ancp-protocol-access-extension-01
- RFC 5515 — Layer 2 Tunneling Protocol (L2TP) Access Line Information Attribute Value Pair (AVP) extensions

PPPoX emulation

- PPPoE, PPPoA, and PPPoEoA
- PPPoE with VLAN and stacked VLAN (up to 6 VLAN stacks)
- ATM: LLC and VC multiplexed encapsulation over AAL5
- Full PPPv6 and Dual-Stack PPP emulation, including DHCPv6oPPP
- LCP link control, IPCP/IPv6CP network control
- Authentication: PAP and CHAP (MD5) with unique usernames and passwords
- Keep-alive responses and requests
- Domain groups used to direct access to network port traffic
- Intermediate agent support
- Automatically detect and re-establish dropped PPP sessions
- Full session control:
 - Setup and teardown rates, with throttling
 - Retry attempts
 - Start/stop per session
 - Open/Close IPCP/IPv6CP
 - Restart failed sessions
 - Echo request/reply
- Global and per-port session setup and tear-down rate measurement
- Per-subscriber session state with session establishment time measurement
- PPP session flapping integrated with Test ComposerSwitch Config

PPPoX and L2TPv2

L2TPv2 emulation

- L2TPv2 LAC and LNS emulation
- Support for L2TPoE and L2TPoA
- Full PPPv6 and Dual-Stack PPP over L2TPv2 emulation, including DHCPv6oPPPoL2TP
- Multiple PPP sessions per L2TP tunnel
- Tunnel authentication with unique host names and secrets
- Hello requests and responses
- Full session control:
- Setup and teardown rates, with throttling
 - Retry attempts
 - Start/stop per session
 - Open/close IPCP/IPv6CP
 - Restart failed sessions
 - Echo Request/Reply
- Bearer type and capacity control
- Redial support
- Connection speed update (CSUN and CSURQ)

DHCPv4

Standards

- RFC 2131 — Dynamic Host Configuration Protocol
- RFC 2132 — DHCP Options and BOOTP Vendor Extensions
- RFC 3046 — DHCP Relay Agent Information Option
- RFC 3203 — DHCP Reconfigure Extension
- RFC 3527 — Link Selection sub-option for DHCPv4 Relay Agent Information Option
- RFC 5107 — DHCP Server Identifier Override Sub option

Protocol options

- DHCPv4 client
- Count
 - Renew timer
 - Rapid commit
 - User first server
 - Server address
 - Broadcast flag
 - Discover padding size
 - TLV profile (custom option)
 - Setup rate
 - Tear down rate
 - Max outstanding
 - Initial discover timeout
 - Discover reattempts
 - Client port
 - Server port
 - Renew on link up
 - Skip release on stop

DHCPv4

Protocol options

DHCPv4 client

- User first server
- Server address
- Broadcast flag
- Discover padding size
- TLV profile (custom option)
- Setup rate
- Tear down rate
- Max outstanding
- Initial discover timeout
- Discover reattempts
- Client port
- Server port
- Renew on Link up
- Skip release on stop

DHCPv4 relay agent

- Relay address
- Server address
- Option 82

DHCPv4 server

- Rapid commit
- Lease time
- Start pool address
- Pool address increment
- Pool size
- IP prefix
- Router
- First DNS server
- Second DNS server
- Echo relay info

Statistics

Protocol summary

- Sessions up
- Sessions down
- Sessions not started
- Average setup rate
- Average teardown rate

DHCPv4

Statistics

Per port

- Sessions up
- Sessions down
- Sessions not started
- Session total
- Discovers Tx
- Offers Rx
- Request Tx
- ACKs Rx
- NACKS Rx
- Release Tx
- Declines Tx
- Enable interfaces
- Addresses discovered
- Sessions initiated
- Sessions succeeded
- Sessions failed
- Teardown initiated
- Teardown succeeded
- Teardown failed
- Instantaneous setup rate
- Min setup rate
- Max setup rate
- Instantaneous teardown rate
- Min teardown rate
- Max teardown rate
- Average setup rate
- Average teardown rate
- Min establishment time
- Average establishment time
- Max establishment time

Per session

- Status
- Discovers Tx
- Offers Rx
- Request Tx
- ACKs Rx
- NACKS Rx
- Release Tx
- Declines Tx
- Address
- Gateway
- Lease time
- Lease establishment time

DHCPv6

Standards

- RFC 3315 — Dynamic Host Configuration Protocol for IPv6 (DHCPv6)
 - RFC 3633 — IPv6 prefix options for DHCPv6
 - RFC 3646 — DNS configuration options for DHCPv6
 - RFC 3736 — Stateless DHCP service for IPv6
 - RFC 4580 — DHCPv6 relay agent subscriber-ID option
 - RFC 4649 — DHCPv6 relay agent remote-ID option
 - RFC 4862 — IPv6 stateless address autoconfiguration
 - RFC 6221 — Lightweight DHCPv6 relay agent
 - DHCP reconfigure command support
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Protocol options

DHCPv6 client

- Renew timer
 - Rapid commit
 - TLV profile (custom option)
 - IA type
 - IA ID
 - IA T1
 - IA T2
 - DUID type
 - DUID enterprise ID
 - DUID vendor ID
 - Stateless mode
 - Assign WAN address from prefix
 - IANA count
 - IAPD count
 - Max # of addresses/prefixes per client
-

DHCPv6 relay agent

- Relay address
 - Server address
 - Interface-Id
 - Option 82
-

DHCPv6 server

- Rapid commit
 - First DNS server
 - Second DNS server
 - DNS domain search list
 - IA Type
 - Lease time
 - Lease time increment
 - Use custom times
-

DHCPv6

Protocol options

DHCPv6 server

- Renew time
- Rebind time
- DUID NAK mask
- DUID NAK pattern
- DUID ignore
- DUID ignore mask
- DUID ignore pattern
- Start pool address
- Pool address increment
- Pool size
- IP prefix
- Address match DUID
- Address DUID mask
- Address DUID pattern
- Address per IA
- Start pool prefix
- Pool prefix increment
- Pool prefix size
- Prefix length
- Prefix match DUID
- Prefix DUID start
- Prefix DUID increment
- Prefixes per IA

Statistics

Protocol summary

- Sessions up
- Sessions down
- Sessions not started
- Average setup rate
- Average teardown rate

Per port

- Sessions up
- Sessions down
- Sessions not started
- Session total
- Solicits Tx
- Advertisements Rx
- Advertisements ignored
- Request Tx
- Replies Rx
- Information request Tx

DHCPv6

Statistics

Per port

- Renews Tx
- Rebinds Tx
- Release Tx
- Enable interfaces
- Addresses discovered
- Sessions initiated
- Sessions succeeded
- Sessions failed
- Teardown initiated
- Teardown succeeded
- Teardown failed
- Instantaneous setup rate
- Min setup rate
- Max setup rate
- Instantaneous teardown rate
- Min teardown rate
- Max teardown rate
- Average setup rate
- Average teardown rate
- Min establishment time
- Average establishment time
- Max establishment time

Per session

- Status
- Solicits Tx
- Advertisements Rx
- Advertisements ignored
- Request Tx
- Replies Rx
- Information request Tx
- Renews Tx
- Rebinds Tx
- IP address
- GW address
- Lease time
- IP prefix
- Prefix length
- Lease time prefix
- DNS search list
- Establishment time

IPv6 Autoconfiguration (SLAAC)

Standards	<ul style="list-style-type: none">• RFC4682 — IPv6 stateless address autoconfiguration• RFC4681 — Neighbor discovery for IP version 6
Learned information	<ul style="list-style-type: none">• Address• Prefix• Gateway IP• Resolved gateway MAC

ANCP

Standards	<ul style="list-style-type: none">• draft-ietf-ancp-protocol-05• RFC 6320—Protocol for access node control mechanism in broadband networks• draft-ietf-ancp-protocol-access-extension-06• draft-lihawi-ancp-protocol-access-extension-01
Protocol options	<p>IP interface</p> <ul style="list-style-type: none">• Tester IP address• Gateway IP address• DUT IP address <p>ANCP access loop</p> <ul style="list-style-type: none">• Circuit ID• Access aggregation circuit ID binary• DSL VLAN allocation <p>ANCP NAS</p> <ul style="list-style-type: none">• NAS IP address• NAS aervice port• Keep-alive timeout• Keep-alive retries <p>Per port rate setup</p> <ul style="list-style-type: none">• Port-up rate• Port-down rate• Port resync rate <p>DSL distribution</p> <ul style="list-style-type: none">• Distribution percentage• DSL capabilities profile allocation• DSL resync capabilities profile allocation• DSL distribution

ANCP

Protocol options

DSL profile TLVs

- Actual rate upstream/downstream
- Minimum rate upstream/downstream
- Maximum rate upstream/downstream
- Attainable rate upstream/downstream
- Minimum net low power data rate upstream/downstream
- Maximum interleaving delay upstream/downstream
- Actual interleaving delay upstream/downstream
- Access loop encapsulation

Statistics

General statistics

- DSL lines up
- ANs established
- ANCP packets sent
- ANCP packets received
- ANCP bytes sent
- ANCP bytes received

Adjacency

- ANs established
- ANCP adjacency packets sent
- ANCP adjacency packets received
- ANCP adjacency bytes sent
- ANCP adjacency bytes received
- ANCP adjacency SYN sent
- ANCP adjacency SYN received
- ANCP adjacency SYNACK received
- ANCP adjacency SYNACK sent
- ANCP adjacency ACK sent
- ANCP adjacency ACK received
- ANCP adjacency RSTACK sent
- ANCP adjacency RSTACK received

Port events

- DSL lines up
- ANCP PORT-UP sent
- ANCP PORT-DOWN sent
- ANCP event packets sent

IPTV

Standards	<ul style="list-style-type: none">• RFC2236-IGMPv2• RFC3376-IGMPv3• RFC2710-MLDv1• RFC3810-MLDv2
Protocol options	<div>Subscriber access protocols<ul style="list-style-type: none">• Static IP• DHCP• PPPoE</div> <div>Subscriber IPTV protocol<ul style="list-style-type: none">• IGMPv1• IGMPv2• IGMPv3• MLDv1• MLDv2</div>
Configuration parameters	<div>IGMP/MLD<ul style="list-style-type: none">• IGMP version• Router alert• Send general query response• Send group-specific query response• Send unsolicited response• Report frequency• Send immediate response• Join/leave multiplier</div> <div>IPTV<ul style="list-style-type: none">• Inter-STB start delay• STB leave-join delay• Channel list• Viewing profile• Join latency threshold• Leave latency threshold• Log failure timestamp</div> <div>Multicast group range<ul style="list-style-type: none">• IP type• IP address• Increment By• Count• First channel• Source filter mode• Source IP address• Source increment by• Source count</div>

IPTV

Configuration parameters

Channel list

- Multicast group
- First channel
- Last channel
- Increment by
- Initial viewed channel
- Initial increment by

Viewing profiles

- Zap behavior
- Zap direction
- Zap interval type
- Zap interval
- # of channel changes before view
- View duration

Statistics

Per channel

- Join failures
- Leave failures
- Delayed joins
- Join latency (min/avg/max)
- Leave latency (min/avg/max)
- Channel change Latency (min/avg/max)
- Channel gap (min/avg/max)
- Channel overlap (min/avg/max)
- Rx frames received
- Rx bytes received
- Rx frame rate
- Duplicate frames
- Late frames
- Reordered frames
- Dropped frames
- Total error rframes

Per subscriber

- VLAN ID
- Join failures
- Leave failures
- Delayed joins
- Join latency (min/avg/max)
- Leave latency (min/avg/max)
- Channel change latency (min/avg/max)
- Channel gap (min/avg/max)
- Channel overlap (min/avg/max)

IPTV

Statistics	<p>Per subscriber</p> <ul style="list-style-type: none">• Rx frames received• Rx bytes received• Rx frame rate• Duplicate frames• Late frames• Reordered frames• Dropped frames• Total error frames
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Authentication

Standards	<ul style="list-style-type: none">• 802.1X—IEEE Std 802.1X-2004 edition• 802.1X—IEEE Std 802.1X-2020 edition
Authentication protocols	<ul style="list-style-type: none">• 802.1x (dot1x)• MS machine authentication• Layer 2 NAC, Layer 3 NAC (EAPoUDP, LPIP, GWIP)
Authentication modes	<ul style="list-style-type: none">• Single-Host• Multi-Host Single-Auth• Multi-Host Multi-Auth
Authentication types	<ul style="list-style-type: none">• EAP-MD5, EAP-TLS, EAP-TTLS, PEAP, EAP-FAST• Automatic certificate generation using an external certificate authority• Ability to mix authentication types in a single test
Configuration options	<p>Protocol control parameters</p> <ul style="list-style-type: none">• Retries• Authentication period• Session timing• Time to hold after a failure• Time to wait for ID request after EAPOL start• Maximum successive EAPOL start messages• EAP TLS fragment size <p>Supplicant parameters</p> <ul style="list-style-type: none">• Source MAC address• Source IP address• Username• Password• VLAN ID• Authentication type <p>NAC parameters</p> <ul style="list-style-type: none">• Application state catalogs• Application postures• Application posture sequences

Authentication

Configuration options	<div>EAPoUDP parameters<ul style="list-style-type: none">• Client rate control• Renew timer• Timeout• Cookie size• Port number• Traffic triggers, including ARP, GARP, DHCP and Web Traffic</div>
Statistics	<div>Test control<ul style="list-style-type: none">• Maximum authentication sessions• Setup delay• Establish delay• Tear-down delay• Test mode• Session hold time• Random hold time• Test duration</div> <div>Session<ul style="list-style-type: none">• Number of attempts• Success• EAP failures• EAP timeouts• Min, Max, and Avg. latency (time to successfully authenticate)• Statistics categorized based on authentication type (MD5, TLS, PEAP)</div> <div>EAPOL frame<ul style="list-style-type: none">• EAPOL frames received• EAPOL frames transmitted• EAPOL start frames transmitted• EAPOL logoff frames transmitted• EAP response/ID frames transmitted• EAP response frames transmitted• EAP response/ID frames received• EAP response frames received• EAP request/ID frames received• EAP request frames received• Invalid EAPOL frames received• EAP length error frames received• EAP alert• EAP successes• EAP failures</div>

AMT

Standards	<ul style="list-style-type: none">• draft-ietf-mboned-auto-multicast-12.txt• RFC2236-IGMPv2• RFC3376-IGMPv3
Protocol options	Receiver protocols <ul style="list-style-type: none">• IGMPv1• IGMPv2• IGMPv3
Device role	<ul style="list-style-type: none">• AMT gateway• Multicast receiver

GRE tunnel bonding protocol

Standards	<ul style="list-style-type: none">• RFC 8157 — Huawei's GRE tunnel bonding protocol
Protocol options	<ul style="list-style-type: none">• GRE tunnel bonding protocol• DHCP client over LTE tunnel
Device role	<ul style="list-style-type: none">• Home gateway (DHCP subscriber is emulated on LTE tunnel)
TLVs	<ul style="list-style-type: none">• Link Type TLV• Custom TLV
Operations	<p>Notify operations</p> <ul style="list-style-type: none">• Diagnostics bonding tunnel start• Diagnostics DSL tunnel start• Diagnostics LTE tunnel start• End diagnostics• Switch to DSL tunnel• Overflow to LTE tunnel• DSL link failure• LTE link failure <p>Tear down from HG</p> <ul style="list-style-type: none">• Teardown message with user defined error code <p>Stop hello</p> <ul style="list-style-type: none">• Stop hello messages from being sent from HG <p>Resume hello</p> <ul style="list-style-type: none">• Resume hello messages to be sent from HG
Statistics	<p>Test control</p> <ul style="list-style-type: none">• DSL tunnel to Wait for LTE tunnel to come up• Key usage• Emulate L2 Switch MAC

GRE tunnel bonding protocol

Statistics

Session

- BondedGRE up
- BondedGRE down
- BondedGRE not started
- BondedGRE total
- DSL tunnel up
- LTE tunnel up
- Total tunnel up
- DSL tunnel down
- LTE tunnel down
- Total tunnel down

BondedGRE messages

- Setup message transmitted
- Accept message received
- Setup deny message received
- Tunnel hello transmitted
- Tunnel hello received
- Tunnel teardown transmitted
- Tunnel teardown received
- Tunnel notify transmitted
- Tunnel notify received
- Total GRE messages transmitted
- Total GRE messages received
- Tunnel verification messages received
- Switching to DSL tunnel messages transmitted
- Overflowing to LTE tunnel messages transmitted

Drill down statistics

- HAAP IP address
- HAAP IPv6 address
- Session ID
- RTT difference threshold (msecs)
- Bypass bandwidth check interval (seconds)
- Hello retry times
- Idle Timeout (seconds)
- RTT difference threshold compliance
- Idle hello Interval (seconds)
- No traffic monitored Interval (seconds)
- Active hello interval (seconds)
- Bonding key value
- Configured DSL upstream bandwidth (kbps)
- Configured DSL downstream bandwidth (kbps)
- Tunnel notify transmitted
- Tunnel notify received
- Setup message transmitted

- Accept message received
- Setup deny message received
- Tunnel hello transmitted
- Tunnel hello received
- Tunnel teardown transmitted
- Tunnel teardown received
- Tunnel verification messages received
- Switching to DSL tunnel messages transmitted
- Overflowing to LTE tunnel messages transmitted
- RTT (msecs)

vBRAS CP

Standards

- CMCC standard for vBRAS CUSP
- draft-ietf-nvo3-vxlan-gpe-12
- CMCC defined YANG modules to configure UP

Protocol options

CUSP messages

- Hello message
- Heartbeat message
- Hello, keep alive, dead timer
- Sync request message
- Sync begin message
- Sync data message
- Sync end message
- Update object message
- Update object ack message
- QoS message
- Resource report message
- Resource remove message
- Address allocation request/Ack message
- Address renew request/Ack message
- Address release request/Ack message

CUSP TLVs

- BRAS_ACCESS_IFSRV_INFO
- BRAS_USER_BASIC_INFO
- BRAS_USER_PPP_INFO
- BRAS_USER_IPV4_INFO
- BRAS_USER_IPV6_INFO
- BRAS_USER_AUTH_INFO
- BRAS_ROUTEV4_INFO
- BRAS_ROUTEV6_INFO
- BRAS_IPV4_STATIC_USER_INFO
- BRAS_USER_L2TP_LAC_INFO
- BRAS_USER_L2TP_LNS_INFO
- BRAS_USER_L2TP_LAC_TNL

- BRAS_USER_L2TP_LAC_TNL
- BRAS_USER_NAT_INFO
- BRAS_IPV6_STATIC_USER_INFO
- HELLO_INFO
- ERROR_INFO
- INTERFACE_INFO
- BOARD_INFO
- VRF_INFO
- ADDR_ALLOC_REQ
- ADDR_ALLOC_ACK
- ADDR_RENEW_REQ
- ADDR_RENEW_ACK
- ADDR_RELEASE_REQ
- ADDR_RELEASE_ACK
- USER_ACL_POLICY
- USER_POLICY_GROUP
- RULE_ACTION_PAIRS
- RULE_DESCRIPTION
- SERVICE_ACTION_DESCRIPTION
- QOS_ACTION_DESCRIPTION
- HQOS_RULE_ACTION_PAIRS
- HQOS_RULE_DESCRIPTION
- HQOS_ACTION_DESCRIPTION
- HQOS_CFG_PROFILE_LEVEL1
- HQOS_APPLY_PROFILE_LEVEL1
- HQOS_CFG_PROFILE_LEVEL2
- HQOS_APPLY_PROFILE_LEVEL2
- HQOS_CFG_PROFILE_LEVEL3
- WEB_PORTAL_PROFILE

VxLAN GPE

- VNI configuration

NETCONF

- Configure CUSP channel
 - Configure VxLAN channel
 - Configure BRAS sub-interface
 - Configure VLAN
-

vBRAS CP

Protocol options	<div>vBRAS CP<ul style="list-style-type: none">• CUSP as protocol interface• VxLAN as service interface• NETCONF as management interface• CUSP sessions with multiple UPs• On demand Updates with rate control• Carrier Grade NAT (CGN)• Error generation capability• CUSP session with hundreds of UPs• Supports PPPoX IPv4/v6/dual stack, DHCPv4/v6/dual stack, Static subscribers v4/v6/dual stack• Emulates L2TP LAC• On the fly action to stop sending continuous Update request or Update delete request messages.• Learned Info to show data plane information received in event messages from the UP.</div>
Statistics	<div><div>Protocol summary<ul style="list-style-type: none">• Sessions up• Sessions down• Sessions not started• Average setup rate• Average teardown rate</div><div>Per port CUSP CP<ul style="list-style-type: none">• Sessions up• Sessions down• Sessions not started• Sessions total• Session flap count• Hello Tx• Hello Rx• Hello Ack Tx• Hello Ack Rx• Heartbeat Tx• Heartbeat Rx• Resource report Rx• Resource Remove Rx• QoS config Tx• QoS config Delete Tx• Outstanding subscribers• Update request Tx• Update delete request Tx• Update response Rx• Update delete response Rx• Subscriber session up• Subscriber session failed• Sync request Tx</div></div>

- Sync request Rx
- Sync begin Tx
- Sync begin Rx
- Sync begin Ack Tx
- Sync begin Ack Rx
- Sync data Tx
- Sync data Rx
- Sync end Tx
- Sync end Rx
- Sync end Ack Tx
- Sync end Ack Rx
- Address alloc request Rx
- Address alloc Ack Tx
- Address renew request Rx
- Address renew Ack Tx
- Address release request Rx
- Address release Ack Tx
- Erroneous message Rx
- Total message Tx
- Total message Rx

Per Session CUSP CP

All the per port statistics except the following:

- Sessions up
- Sessions down
- Sessions not started
- Sessions total

Per Port VxLAN GPE

- Sessions up
- Sessions down
- Sessions not started
- Sessions total
- Bytes Tx
- Bytes Rx
- Packets Tx
- Packets Rx

Per session VxLAN GPE

- Status
- VNI
- Bytes Tx
- Bytes Rx
- Packets Tx
- Packets Rx

Learned Info

Per CUSP session

- UP Resource Information
 - CGN Information
 - Subscriber data base for PPPoE/DHCP/L2TP/Static subscribers
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Hardware Options

Visit www.keysight.com for more information on IxNetwork platform options.

Virtual Platform	<ul style="list-style-type: none">• IxNetwork Virtual Edition (VE)
Chassis	<ul style="list-style-type: none">• XGS12-HSL/SDL/SD Chassis• XGS2-HSL/SDL/SD Chassis
Fixed Chassis	<ul style="list-style-type: none">• AresONE-M 800GE QSFP-DD800• AresONE-M 800GE OSPF800• AresONE-M 800GE Dual Interface Model• AresONE-S 400G QSFP-DD• AresONE 400G QSFP-DD• AresONE 400G OSPF• AresONE 400G High Performance QSFP-DD 400/200/100/50GE• NOVUS ONE PLUS 3- and 5-Speed 10GE/5GE/2.5GE/1GE/100M
Appliances	<ul style="list-style-type: none">• NOVUS ONE 10GE/1GE/100M
Load Modules	<ul style="list-style-type: none">• K400 QSFP-DD 400/200/100/50GE• K400 CFP8 400GE• NOVUS High Density QSPF28 100/50/40/25/10GE• NOVUS High Density SFP28/QSPF28 100/50/25/10GE• NOVUS 3-Speed 10GE/1GE/100M• NOVUS 5-Speed 10GE/5GE/2.5GE/1GE/100M• Xcellon-Multis QSFP28 100/50/25GE• Xcellon-Multis CFP4 100GE• Xcellon-Multis CXP 100/40/10GE• Xcellon-Multis QSFP 40/10GE• Xcellon-Lava CFP 100/40GE• Xcellon-Flex QSFP/SFP+ 40/10GE

IxNetwork Technology Solutions

Visit www.keysight.com for more information on IxNetwork Technology Solutions

- IxNetwork Overview—L2/3 network infrastructure performance testing
 - IxNetwork Software Defined Networking (SDN) test solution
 - IxNetwork Routing and switching test solution
 - IxNetwork MPLS test solution
 - IxNetwork industrial Ethernet test solution
 - IxNetwork broadband and authentication test solution
 - IxNetwork data center Ethernet test solution
 - IxNetwork MACsec test solution
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Ordering Information

PPPoX and L2TPv2 emulation

930-2024

IxNetwork, Optional Software, PPPoX and L2TPv2 emulation; Recommend with 930-2027 Broadband Control Plane Tests; REQUIRES pre-existing 930-1999 Base License OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2038

IxNetwork, Optional Software, Radius Attributes for L2TP; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2047

IxNetwork, Optional Software, Dual-stack PPPoX emulation; REQUIRES 930-2024 PPP and L2TPv2 Emulation Software; REQUIRES pre-existing 930-1999 Base License OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2065

IxNetwork, Optional Software, Dual-stack PPPoX over L2TP emulation; REQUIRES 930-2024 PPP and L2TPv2 Emulation Software, 930-2047 Dual-stack PPPoX emulation; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2048

IxNetwork, Dual-stack PPPoX and PPPoL2TP Bundle; INCLUDES: 930-2024 PPP and L2TPv2 emulation, 930-2045 DHCPv4/v6 Server emulation, 930-2046 DHCPv4/v6 Client and Relay Agent emulation, 930-2047 Dual-stack PPPoX emulation, and 930-2065 Dual-stack PPPoX over L2TP emulation; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2058

IxNetwork, Broadband Bundle; INCLUDES: 930-2024 PPP/L2TP emulation, 930-2027 Control Plane Tests for PPP/L2TPv2, 802.1x, and NAC, 930-2037 ANCP Protocol emulation, 930-2045 DHCPv4/v6 Server emulation, 930-2046 DHCPv4/v6 Client and Relay Agent emulation, 930-2047 Dual-stack PPPoX emulation, 930-2065 Dual-stack PPPoX over L2TP emulation; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

DHCPv4 and DHCPv6 emulation

930-2045

IxNetwork, Optional Software, DHCPv4/v6 Server Emulation; REQUIRES pre-existing 930-1999 Base License OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2046

IxNetwork, Optional Software, DHCPv4/v6 Client and Relay Agent Emulation; Recommend with 930-2027 Broadband Control Plane test; REQUIRES pre-existing 930-1999 Base License OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2059

IxNetwork, Optional Software Bundle, DHCP Bundle; INCLUDES 930-2045 DHCPv4/v6 Server Emulation; 930-2046 DHCPv4/v6 Client and Relay Agent Emulation; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

ANCP

930-2037

IxNetwork, Optional Software, ANCP emulation; **REQUIRES** pre-existing 930-1999 Base License OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

IGMP/MLD

930-2067

IxNetwork, Optional Software, IGMP/MLD Emulation; **REQUIRES** pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2004

IxNetwork, Optional Software, Multicast Emulation, includes IGMPv1/v2/v3, MLDv1/v2, PIM-SM/SSMv4/v6, and Multicast VPN support; **REQUIRES** pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

IPTV

930-2407

IxNetwork, Optional Software, IPTV QuickTests; **REQUIRES** 930-2067 IGMP/MLD Emulation (or 930-2004 IxNetwork Multicast Emulation); **REQUIRES** pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2090

IxNetwork, Optional Software Bundle, IPTV Test Basic Bundle; **INCLUDES** 930-2407 IPTV QuickTests; 930-2067 IGMP/MLD Emulation; **REQUIRES** pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2091

IxNetwork, Optional Software Bundle, IPTV Test Advanced Bundle; **INCLUDES** 930-2407 IPTV QuickTests; 930-2067 IGMP/MLD Emulation; 930-2046 DHCPv4/v6 Client/Relay Agent Emulation 930-2024 PPP and L2TP Emulation; **REQUIRES** pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

Link aggregation

930-2035

IxNetwork, Optional Software, LACP IEEE 802.3ad Protocol Emulation; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2051

IxNetwork, Optional Software, Protocol emulation over IEEE 802.3ad (LACP); REQUIRES 930-2035 LACP IEEE 802.3ad Protocol Emulation; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

Session aware traffic

930-2079

IxNetwork, Optional Software, Session Aware: Traffic REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

EoGRE

930-2108

IxNetwork, Generic Routing Encapsulation (GRE) and Protocol over GRE Emulation; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

Bonded GRE HG

930-2131

IxNetwork, Optional Software, Bonded GRE HG (Home Gateway) Emulation; Enable DHCPv4 over Bonded GRE tunnel for testing Hybrid Access Gateway; REQUIRES: 930-2046 DHCPv4/v6 Client and Relay Agent Emulation AND 930-2108 Generic Routing Encapsulation (GRE) and Protocol emulation over GRE; REQUIRES: pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

Authentication emulation

930-2025

IxNetwork, Optional Software, 802.1x Emulation; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076); operates with Optional Software 930-2027 Generic Control Plane Tests

930-2026

IxNetwork, Optional Software, Layer 2/3 Cisco NAC emulation; Operates with Optional Software 930-2027 Control Plane Tests; REQUIRES pre-existing 930-1999 Base License OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2028

IxNetwork, Optional Software, Web Authentication Emulation; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

QuickTest

930-2027

IxNetwork, Optional Software, Control Plane Tests for PPPoX/L2TPv2, DHCPv4/v6, 802.1x, and NAC; REQUIRES either 930-2024 PPPoX and L2TPv2 emulation, OR 930-2046 DHCPv4/v6 Client and Relay Agent Emulation, OR 930-2025 802.1x emulation; REQUIRES: pre-existing 930-1999 Base License OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

930-2409

IxNetwork, Optional Software, Asymmetric Data Performance QuickTest; REQUIRES pre-existing 930-1999 IxNetwork Base license OR new purchase of either IxNetwork Base PLUS (930-2056) or IxNetwork Base PREMIUM (930-2076)

vBRAS emulation

930-2138

IXIA IxNetwork, Optional Software, Control and User Plane Separation Protocol (CUSP) Emulation; Enable testing CUSP protocol between Control Plane (CP) and User Plane (UP) of disaggregated Broadband Network Gateway (BNG); **REQUIRES:** 930-2103 VxLAN Emulation; **REQUIRES:** pre-existing of either 930-1999 IxNetwork Base license or IxNetwork Base PLUS (930-2056), OR new purchase of IxNetwork Base PREMIUM (930-2076); **Recommend with:** 930-2024 PPP and L2TPv2 emulation AND 930-2047 Dual-stack PPPoX emulation AND 930-2065 Dual-stack PPPoX over L2TP emulation, and/or 930-2045 DHCPv4/v6 Server emulation AND 930-2046 DHCPv4/v6 Client and Relay Agent emulation; and 930-2124 NETCONF Emulation

930-2520

IXIA IxNetwork, Optional Software bundle, BNG Control and User Plane Separation Bundle; Enable testing of Control Plane (CP) and User Plane (UP) Separation of disaggregated Broadband Network Gateway (BNG); **INCLUDES:** 930-2138 CUSP Emulation, 930-2103 VxLAN Emulation, 930-2024 PPP and L2TPv2 emulation, 930-2047 Dual-stack PPPoX emulation, 930-2065 Dual-stack PPPoX over L2TP emulation, 930-2045 DHCPv4/v6 Server emulation, 930-2046 DHCPv4/v6 Client and Relay Agent emulation; 930-2124 NETCONF Emulation; **REQUIRES:** pre-existing of either 930-1999 IxNetwork Base license or IxNetwork Base PLUS (930-2056), OR new purchase of IxNetwork Base PREMIUM (930-2076)

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