LoadCore™ - 4G/5G Core Network Test Solution

Simulation of multiple nodes and interfaces from end-to-end to node isolation for complete core network validation

5G deployments will enable enhanced mobile broadband services with higher data rates, increased capacity, and lower latencies. New business opportunities and increased revenue sources can be found with Network Slicing, Mobile Edge Computing and Private 5G via massive and critical IoT services in sectors like automotive, manufacturing, energy, and utilities.

But to ensure the carrier-grade quality required to carry this amount of wireless traffic, service providers need to characterize and continuously validate their 5G Core (5GC) network in the lab and pre-production deployments. This requires extensive testing of 5G SA (Standalone) elements in the Core network.

Challenges include:

- Implementing virtualization technologies and cloud-optimized network functions
- Validating emerging architectures and standards: handling simultaneous protocol requests for tunneling-, session-, or HTTP2-based signaling

Pre-deployment validation using real-world subscriber simulation

Keysight's 5G LoadCore™ test solution addresses critical validation requirements for improved reliability and performance of 5G emerging architectures. With comprehensive performance testing of all nodes and interfaces, this powerful yet easy-to-use solution helps network operators deliver higher-performing services, greater scale, and lower-latency communications.

Using real-world subscriber modeling, testers do not need to be protocol experts to develop realistic test scenarios. From a single application, perform capacity tests, detail a device’s throughput, measure voice and video quality, and model a wide variety of mobility scenarios.

With 5G development and adoption progressing rapidly, *cloud native* is central to the 5GC architecture. With its microservice architecture and options to be deployed either as a virtual machine (VM) or Container, LoadCore is fully aligned to this new paradigm.

KEYSIGHT

Highlights

- Test the 4G/5G Core Network by simulating multiple nodes and interfaces, from end-to-end to node isolation.
- Simulate UE behavior in multiple 4G/5G use cases: network slicing, multi-access edge computing (MEC) low latency and offloading, video optimization.
- Scale up to millions of subscribers with high data throughput, using stateful application traffic mixes that can interact with real servers and peers.
- Perform service quality validation with subscriber modeling, multiplay traffic, and quality of experience (QoE) measurements.
- Ease of use and intuitive definition of advanced call models and traffic patterns via Control & User Planes Primary and Secondary test objectives
- Validate complex scenarios for service-based architecture (SBA)
- Control test traffic mix and intensity using network objectives to independently manage control and user planes.
- Deploy either as VM or containers on private, hybrid or public clouds. High flexibility in terms of supported platform, hypervisor and orchestration.
- Available through AWS Marketplace either as BYOL (Bring Your Own License) or PAYG (Pay As You Go).
- Full automation via REST API and Python allows users to create regressions for continuous validation of product quality.
- Predefined test suites for 3GPP 5G Security Assurance Specification (SCAS) conformance validation.
- Fuzzing testing capability on SBI interfaces.

5G Core Network Validation

LoadCore is a comprehensive solution for the complete validation of the 5G Core Network. From end-to-end to node isolation, LoadCore simultaneously simulates multiple nodes and interfaces, allowing the recreation of entire networks in lab environment by using a topology-based user interface (web UI).

The entire core is simulated, with each node independently deployed. User equipment (UE) actions (Registration/PDU Session Establishment/Modification, Handovers, etc.) are simulated across all 5G core nodes and interfaces, offering a complete end-to-end view. 4G, 5G NSA (non-standalone) and 4G/5G iRAT procedures can also be simulated for complete validation across multiple domains.

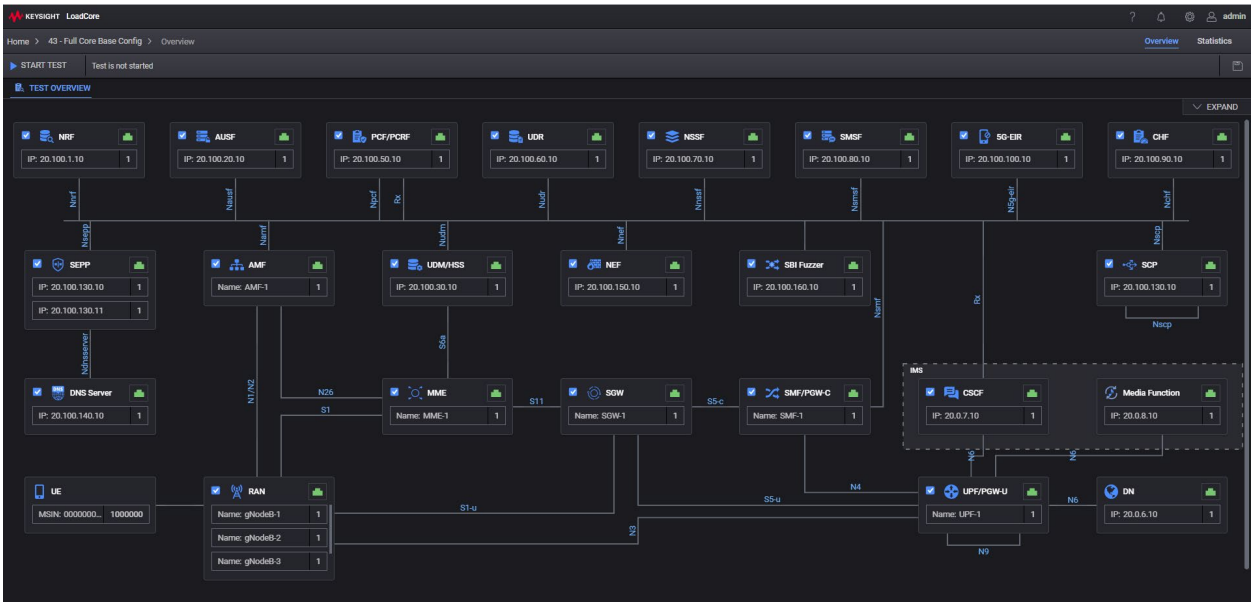

Figure 1. Entire 4G/5G Core simulation

NGRAN simulation — entire core is under test

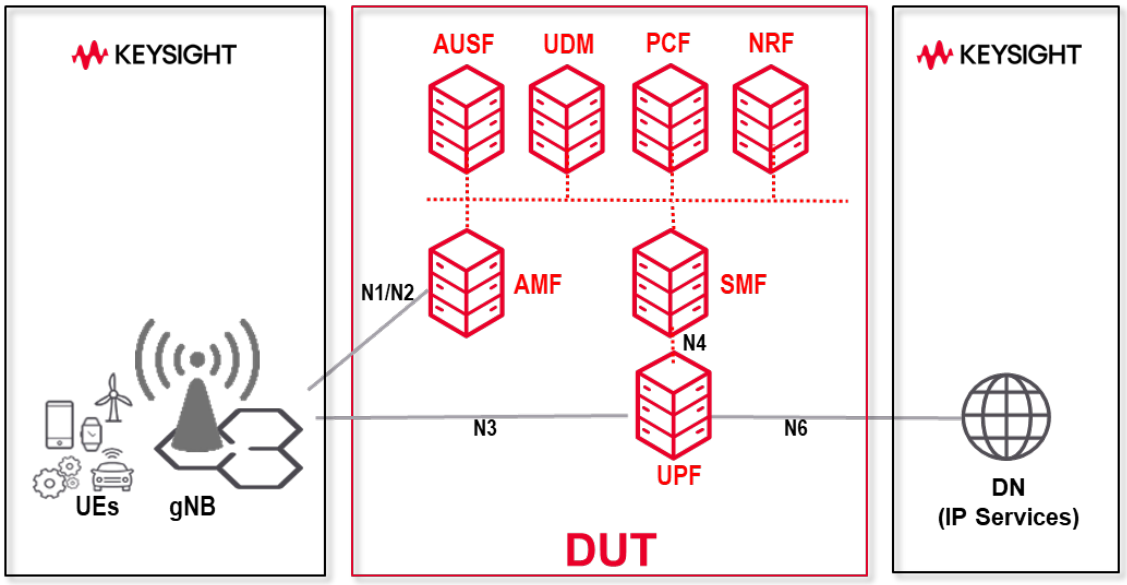

Figure 2. UE/gNB (NGRAN) simulation via coordinated N1/N2/N3

NGRAN and core simulation — node(s) isolation topology

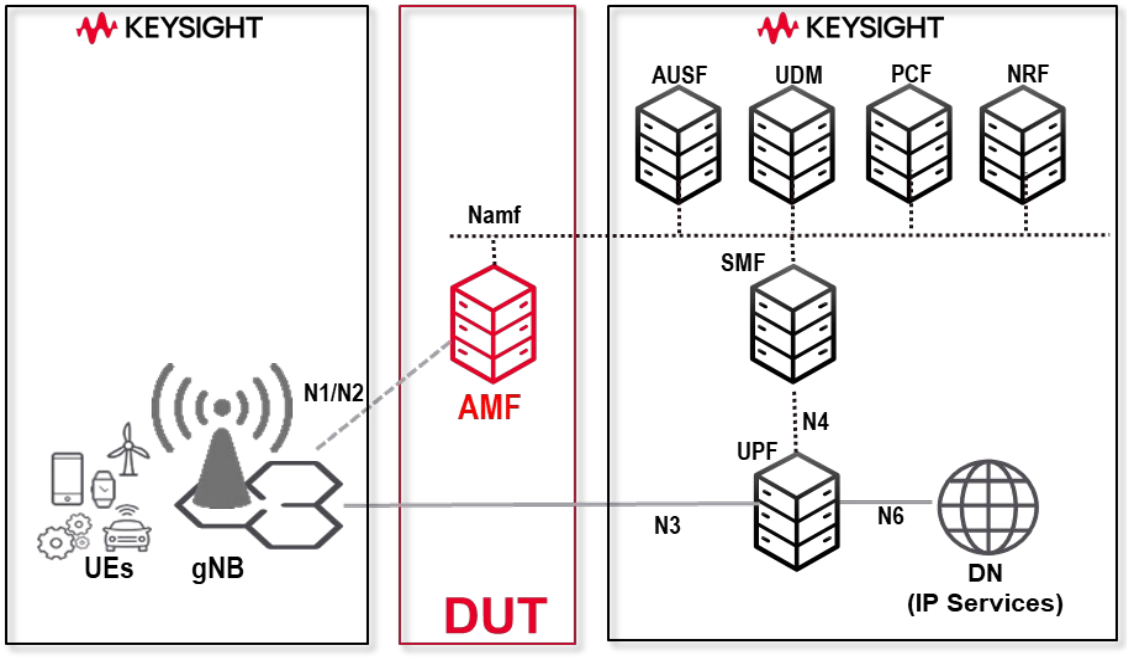

Figure 3. Node(s) Isolation Topologies Examples (AMF isolation)

SBA Node(s) isolation topology

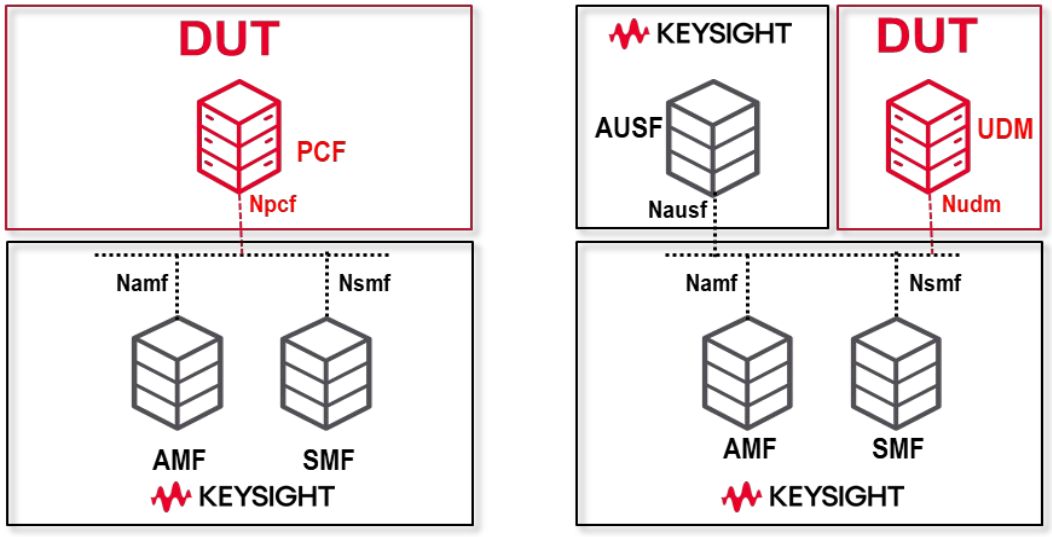

Figure 4. Node(s) Isolation PCF or UDM isolations

Product Capabilities

Control plane features

- Simulate millions of sessions across multiple coordinated interfaces; perform UE Register/Deregister/Authentication/Session Establishment and Release
- Ability to simulate or place under test any of the 5G nodes and associated interfaces: gNB, AMF, SMF, UPF, AUSF, UDM, UDR, PCF, NSSF, CHF, NRF, SMSF, CHF, 5G-EIR, SCP, NEF, AF, IMS Core, DN
- Ability to simulate or place under test any of the 4G nodes and associated interfaces: eNB, MME, SGW, PGW, PCRF, HSS
- Topology-driven UI: start by defining your test topology by selecting your device(s) under test
- Validate PDU Sessions establishment, uplink and downlink flows, deletion and modification of the sessions
- Option to configure single or multiple PDU sessions per UE, with single or multiple DNNs
- Perform isolation testing for SBA nodes: AUSF, UDM, PCF, NRF, NSSF, CHF, SMSF, 5G-EIR
- N3IWF testing in isolation, simulating UE/AP over NWu interface and AMF/UPF (Untrusted WiFi Offload)
- Perform isolation testing for UPF, including Intermediary or PDU Session Anchor UPFs exposing N9 interface
- Perform network function (NF) Register/Deregister/Discovery vs simulated or real NRF
- Ability to simulate coordinated HTTP/2.0 (SBI) and Diameter (4G) flows for validating combo boxes such as PCF/PCRF or HSS/AUSF

- Support for Roaming scenario testing, exposing N32 interface; home routed topology with N16 and N9 interfaces exposed.
- 4G Public Warning System (ETWS) supported.
- 5G Location Service support for Rel 16 and Rel 17 E-CID Measurement quantities
- Ability to perform Control Plane Impairment at IE or Message level on all protocols (SCTP, PFCP, HTTP2). Define negative behavior and reconfigure default state machine by having multiple UE groups with different behaviors
- IPsec support for N2,N3 interfaces and 5G Untrusted WiFi control plane traffic
- IP Endpoint simulation (Client/Server) on N6/SGi interfaces.
- Support for SBI (Service Based Interfaces) Fuzzing on http/2 json payload.
- Support for 3GPP versions Rel15/Sept2019, Rel16/Sept2020 and Rel17/Dec2022

User plane features

- A modular system design allows LoadCore to scale with your infrastructure while real-time QoE metrics let you drill down to quickly identify network degradations and isolate breaking points.
- Configure each UE group with a distinct objective consisting of single or multiple flows with the ability to specify overall throughput and distribution per flow.
- Support for triple play fully stateful traffic (data, voice, video), able to terminate connections on simulated or real servers.
- Validate network performance by assessing packet loss, One Way Delay (OWD), Delay Variation Jitter (DVJ), Mean Opinion Score (MOS)
- High performance capability for VoNR and Video OTT sessions.
- Full support for IMS Core simulation, exposing P-CSCF (coordinated Gm and Rx) and Media Function. Support for SIP over TLS
- Support for VoLTE/VoNR over 3GPP IPSec, including Rel17 authentication.
- Highly customizable SIP and SDP headers via dynamic variables
- Support for VoLTE / VoNR and EPS Fallback scenarios
- VoNR – IPME/MSRP support
- Support for multiple QUIC versions: v50, v43, v46 + IETF drafts 34 (& 27 & 29) + IETF Version 1 (RFC 9000)
- Emergency/E911 VoNR & VoLTE calls on UE/RAN simulation.
- Packet capture (pcap) replay capability
- Validate QoS enforcement at UPF level by leveraging inbuilt per-UE detection mechanism.
- Exercise UPF traffic selection & steering, QoS marking via configurable SNI for TLS traffic (HTTPS) and Video over QUIC
- Validate complex call models using various test objectives: Throughput, Concurrent Connections, Connection rate
- Ability to visualize Per-UE statistics (Control and User Plane) allowing QoE analysis for assessing services at UE and PDU session level.
- Ability to achieve close to line rate throughput on various Network Interfaces (10/25/40/100 GE) with both UDP and TCP traffic (DPDK=on)

Web UI and REST API browser

- LoadCore presents a web-based UI for controlling the test execution, allowing parameter configuration, and checking the statistics. Complemented by REST API Browser (see below), it allows users to conduct the entire testing process directly from a web browser in a client-free, Windows-free environment.
- Through the REST API Browser, users can create and modify LoadCore configuration parameters and add/modify/delete components to build or adjust a test configuration just from a web browser. REST API Browser can be also used for automation, allowing users to easily identify embedded methods and internal parameters names by navigating, in a simple and intuitive way, the object structure of the test configurations.

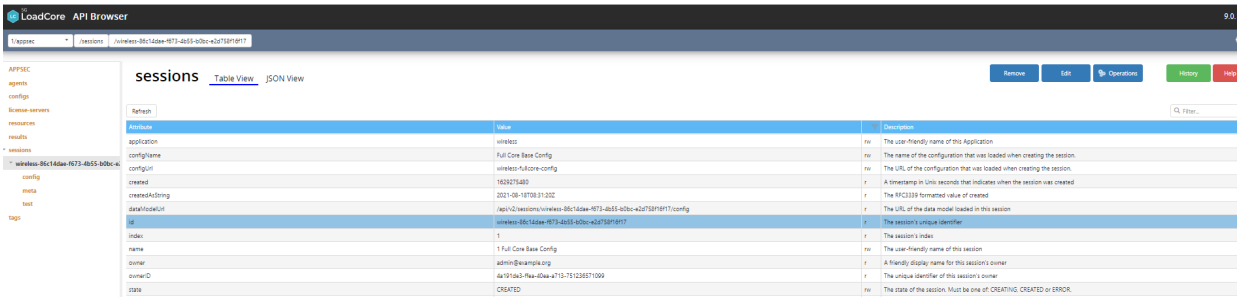

Figure 5. REST API browser interface

Statistics

Users have access to hundreds of comprehensive statistics in real-time, during text execution with user-configurable views, or the data can be sent to an upstream server. All statistics are also available after the test completed, in CSV format for post-processing.

Figure 6. Statistics general overview dashboard

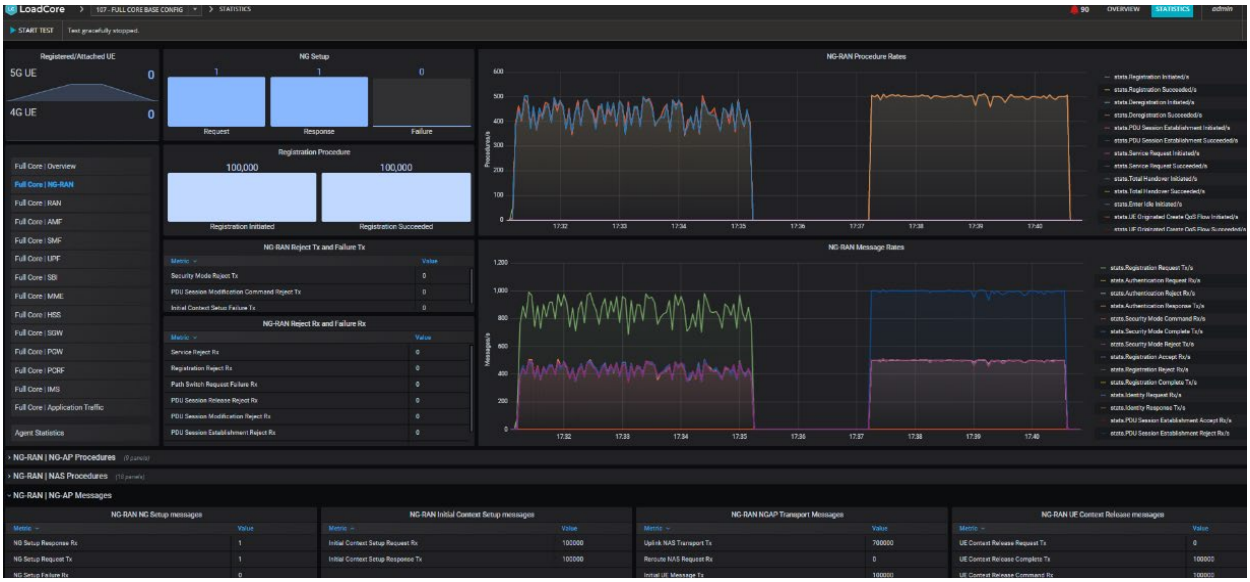

Figure 7. Statistics NG-RAN dashboard

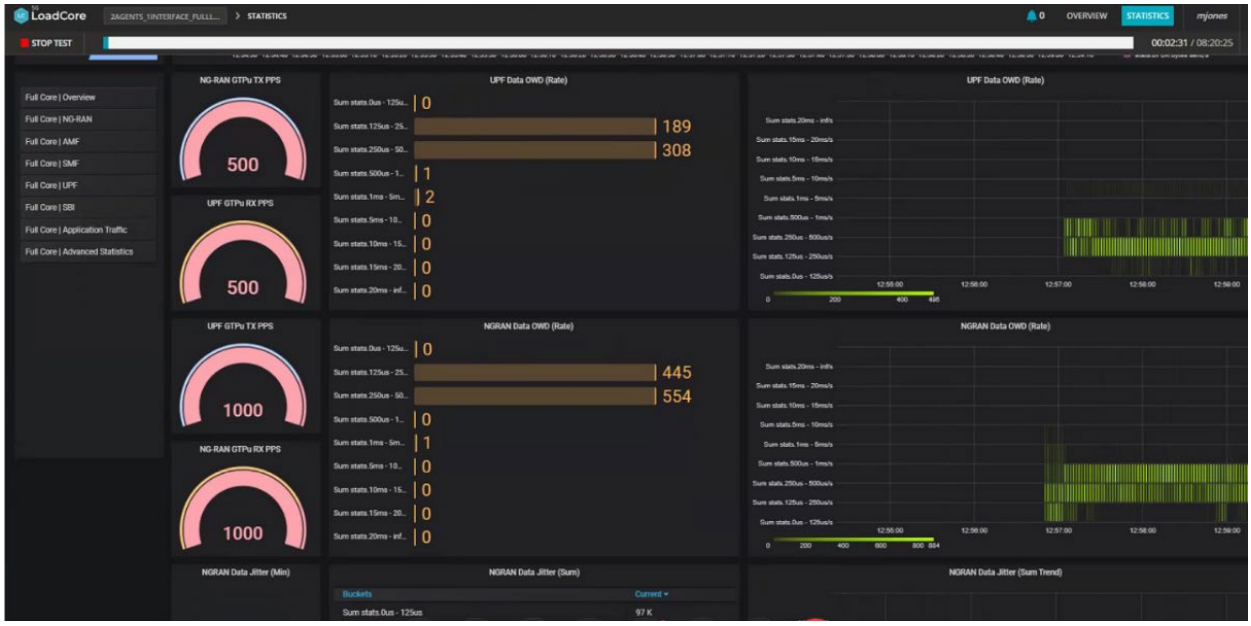

Figure 8. User Plane statistics dashboard – One Way Delay

Figure 9. User Plane statistics dashboard – Delay Variation Jitter

Per-UE stats (Control & User Plane) and Network Slicing statistics (N1/N2) provide in-depth capability of analyzing traffic results with enhanced granularity. Filtering per-IMSI and drill-down on TCP statistics per traffic objective are available to help narrow down issues.

5G Security SCAS test support

- LoadCore offers support for 3GPP 5G Security Assurance Specification (SCAS) using OpenTap automation platform. Tests are pre-defined according to the standard specification and offered as test library for each NF.
- Includes Pass / Fail criteria for each test, offering a complete picture for SCAS spec compliance.
- Support for AMF (TS 33.512), UDM (TS 33.514), SMF (TS 33.515), NRF (TS 33.518), UPF (TS 33.513) test suites.

Keysight Open RAN simulators cloud edition

LoadCore runs on top of the Keysight Open RAN Simulators infrastructure, a cloud-native platform which allows multiple Keysight products to run in parallel (LoadCore, CuSIM, DuSIM and CoreSIM). This test solution provides seamless integration on the same infrastructure as the Device Under Test (DUT), sharing the same look-and-feel and functionalities across all products. The Keysight Open RAN Simulators platform can accommodate any type of cloud – public or private – via the deployment of containers or complete Virtual Machines (VMs).

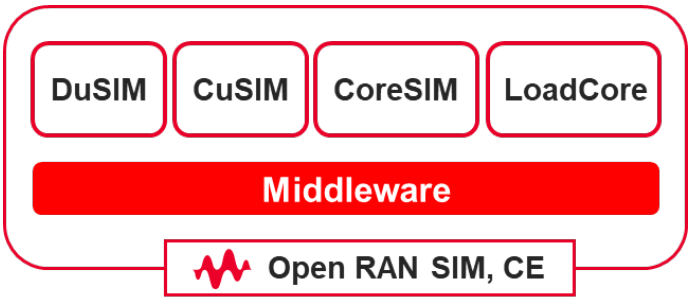

Figure 10. Keysight Open RAM Simulators Cloud Edition

One user interface for the different O-RAN and core testing needs

The Keysight Open RAN Simulators user interface is common across the different products of the Keysight O-RAN testing portfolio, both virtual and hardware-based, enabling end-to-end testing from a single common user interface.

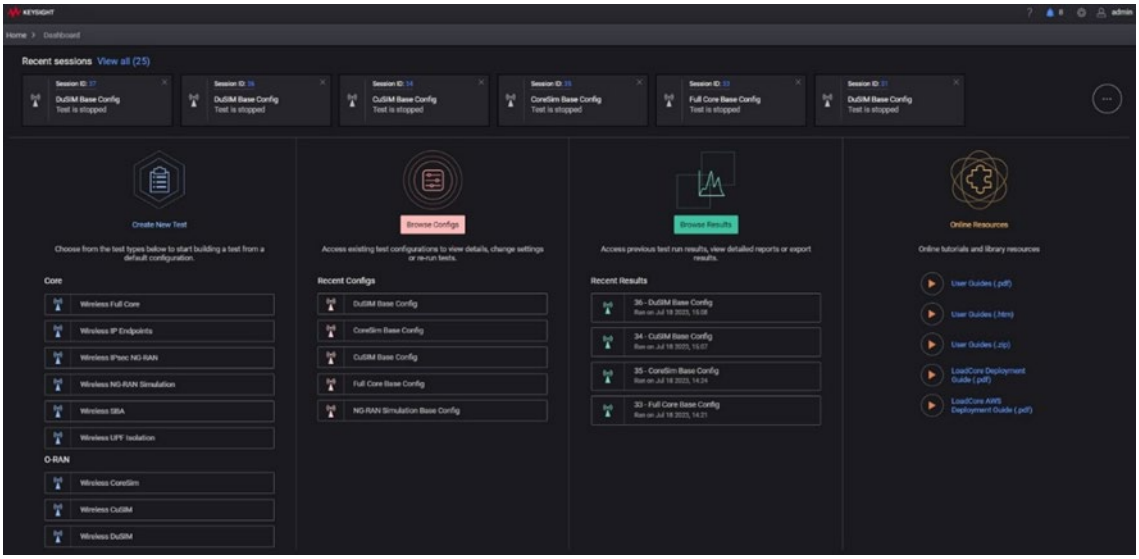

Figure 11. Keysight Open RAM Simulators user interface

LoadCore components are software-based and optimized for stateful protocol emulation in virtual environments, adapting to your infrastructure and easily scaling to follow your testing needs.

Specialized Keysight hardware is available on demand.

Model	Description
P88109H 	**ORAN Server, runs Ubuntu OS** • 56c Xeon 6238R processor • 128 GB RAM (3200MHz) • 2 x HDD: 4TB + 2TB • 2 x Power Supply
Network Interface Cards	**Network Interface Cards** • 4 x 10GbE X710 T4 • 2 x 100GBE-SFP MCX516A-CCAT • 2 x 10BGE-SFP Intel 520 • 2 x 25 GBE Intel XXV710 • 2 x 10GBE-SFP Intel 520
Size and weight	• **Size:** 43.7 cm width (19” rack mounted) 8.89 cm height (2U rack mounted) 45 cm depth • **Weight:** 14 Kg.

Supported platforms

AliCloud	AWS	AWS EKS	Azure	Container agent	Google Anthos/GDCE	KVM	OpenShift	OpenStack	VMware ESX
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Supported drivers

vmxnet3, mlx4_core, mlx5_core, ixgbe, ixgbevf, i40, i40e, i40evf, iavf, ena, virtio, ice

KEYSIGHT

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.