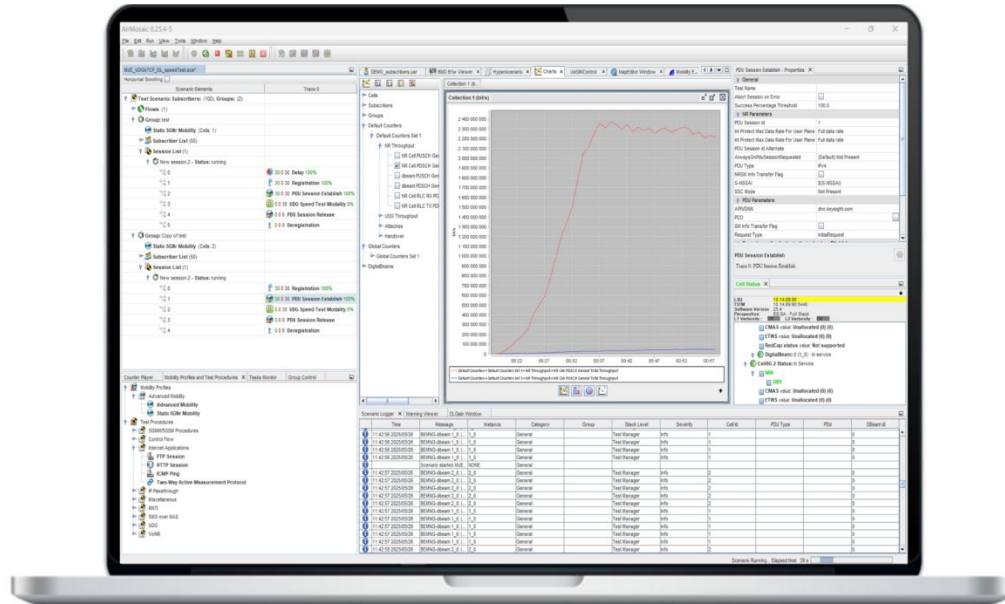


P8822S RuSIM RAN Testing Toolset

UE / O-RU emulation over the O-RAN Fronthaul



Testing of RAN and Open RAN Networks

The **Radio Access Network (RAN)** is a vital component of mobile telecommunications systems, connecting individual devices to the broader network through radio connections. In the context of 5G, modern RAN technologies have significantly evolved to support higher speeds, lower latency, and greater capacity. Key features of modern RAN include:

- Massive MIMO (Multiple Input Multiple Output, mMIMO)
- Beamforming
- Network Slicing

Open RAN (O-RAN) is an approach to building RANs using open and interoperable interfaces, allowing components from different vendors to work together providing following flexibility for the network providers and operators.

Artificial Intelligence (AI) and **Machine Learning (ML)** play a crucial role in modern RAN. AI enhances optimization of network performance, efficiency and adaptability. AI analyzes real-time data for better resource allocation, reduces latency, and enables predictive maintenance to prevent issues. This results in smarter, more reliable networks ready for future advancements like 6G.

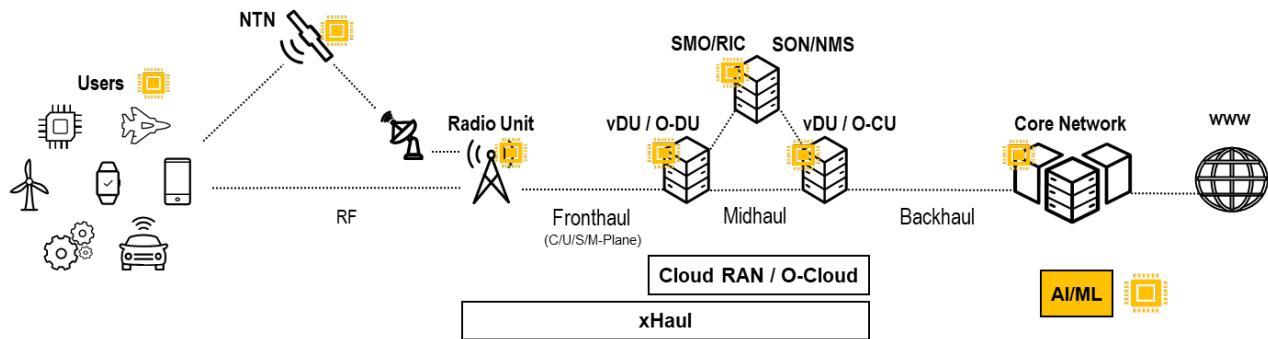


Figure 1. RAN and O-RAN architecture for terrestrial and non-terrestrial networks

Testing Challenges in RAN Testing Workflow

Testing Radio Access Network (RAN) and Open RAN (O-RAN) components involves several complex challenges. For RAN, ensuring seamless integration and performance across various network elements is critical. O-RAN introduces additional hurdles with its multivendor, disaggregated architecture, requiring rigorous conformance and interoperability testing to ensure different vendors' components work together effectively. The disaggregation of gNB components necessitates testing each part in isolation and in integrated scenarios, adding to the complexity.

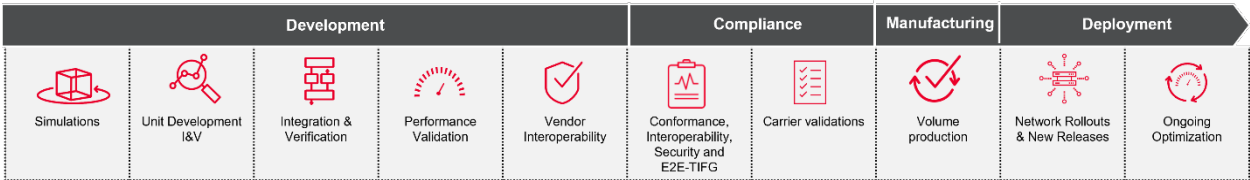


Figure 2. Example of RAN component development workflow

Development phase



Development phase includes various steps where each of them introduces their own challenges. Some of the key challenges which are shared across the steps:

- How to validate the implementation of O-RAN elements new features at early stage, before actual UE availability, including forefront technologies like MU-MIMO and NTN.
- How to optimize O-DU scheduling algorithms, specifically for MU-MIMO co-scheduled devices.
- How to validate O-RAN performances in realistic and demanding end to end scenarios, under traffic load of thousands of devices.
- How to test and validate O-DU/O-CU interoperability in isolation and in integrated environments.
- How to generate continuous workloads to develop, train and optimize AI-RAN models.

Compliance phase



In compliance phase components needs to be validated to meet the set specifications. For this type of testing, automation is crucial to be able to run the tests according to set requirements.

- How to verify DU/CU compliance with O-RAN interfaces and specifications.
- How to ensure interoperability gaps between vendors, specifically within the O-RAN ecosystem.
- How to ensure system meeting set carrier expectations.
- How to characterize and optimize energy efficiency of O-RAN solutions.
- How to assess and improve O-RAN response to increasing security threats, as security becomes increasingly important due to network decomposition

Deployment phase



At deployment phase testing is continuous process where new networks are rolled out, new network releases are being validated, and performance is continuously optimized.

- How to seamlessly integrate into continuous CD/CI/CT workflows for regression.
- How to replicate in the lab complex issues coming from the field.
- How to assess network optimizations before deployment.

P8822S RuSIM RAN Testing Over Fronthaul Toolset

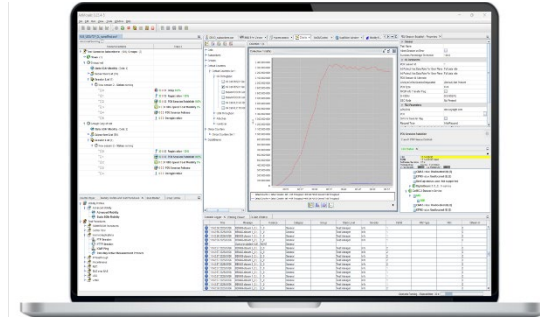


Figure 3. P8822S RuSIM RAN testing toolset

P8822S RuSIM RAN Testing Toolset is a 4G and 5G User Equipment (UE) and O-RAN Radio Unit (O-RU) emulator that enables infrastructure vendors, chipset providers, and mobile operators to easily perform functional, conformance, and performance testing of O-RAN Distributed Units (O-DUs) over fronthaul functional split option 7.2x. Fully scalable and virtualized, the solution runs on commercial-off-the-shelf servers without the need for layer-1 hardware accelerators or special-purpose hardware and offers a migration path to the Cloud.

Key features

- Support for key 3GPP technologies
 - 4G and 5G in NSA and SA modes, FR1 & FR2 frequency bands
 - Massive MIMO with beamforming up to 64T64R
- Support automated O-RAN compliance Test Cases
 - O-RAN WG4 O-DU Conformance Test Cases
 - O-RAN WG5 Interoperability Test Cases
 - O-RAN E-Plane– O-DU/O-CU Test Cases
 - O-RAN Security Test Cases
 - O-RAN TIFG-E2E Test Cases
- Full protocol stack assessment from L1 to L7 covering functional testing – layer by layer
- Scalable up to thousands of UEs and 10+ CCs with simulation of real application data and generation of network traffic load.
- Support for O-DU+O-CU wrap-around testing with core emulation option (CoreSIM).
- Full stack O-DU testing by using CuSIM, Keysight's O-RAN Central Unit (O-CU) emulator.
- Service quality validation with subscriber modeling, and multi-play voice, video, and data traffic generation: eMBMS, VoNR, ViNR.
- Advanced mobility scenarios, fading and cross-cell interference simulation.
- Automation and Integration into CI/CD/CT Workflows
- Data generation for AI/ML, AI/ML Benchmarking, RAN Workloads for AI and RAN

Who benefits from using this solution?

- Network Equipment Manufacturers (NEM's)
- Open RAN component providers (O-DU, O-CU)
- Mobile Network Operators (MNO's) and Solution Integrators
- O-RAN Open Test and Integration Centres (OTIC) Labs

Solution components

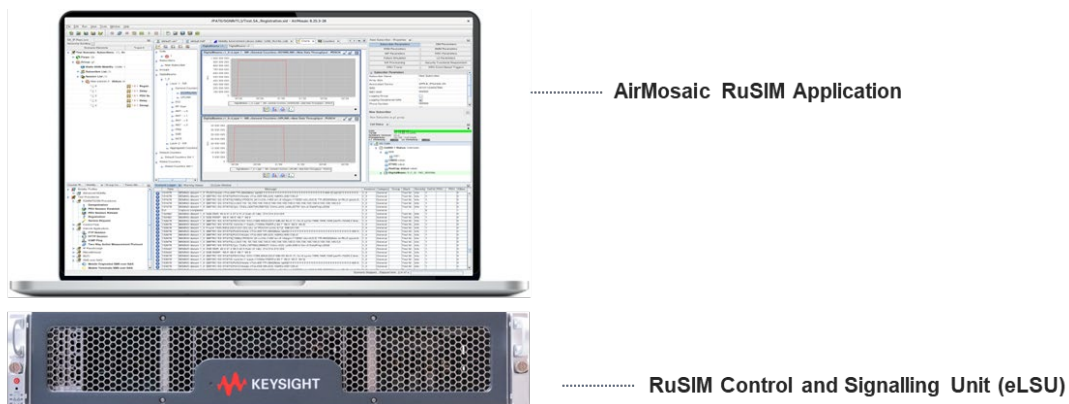


Figure 4. P8822S RuSIM RAN testing toolset components

AirMosaic RuSIM application

- Main user interface to control RuSIM system.
- Test system configuration and scenario creation
- Real-time test execution, result analysis and reporting

Ethernet Line Server Unit (eLSU)

- eLSU runs the RuSIM full stack protocol signaling and control functions of the solution
- It can host both UeSIM and RuSIM (but not simultaneously)
- System can be scaled up by clustering multiple eLSU units.

Note: RuSIM can also run on Commercial-Off-the-Shelf (COTS) servers

Automation, Analytics and Reporting with Atlas Test Management Center (Atlas-TMC)

- Atlas TMC provides the automation, analytics and reporting interface with pre-defined test case scenarios.
- O-RAN compliance test scenarios enable user to perform test cases according to O-RAN Alliance and 3GPP specifications.

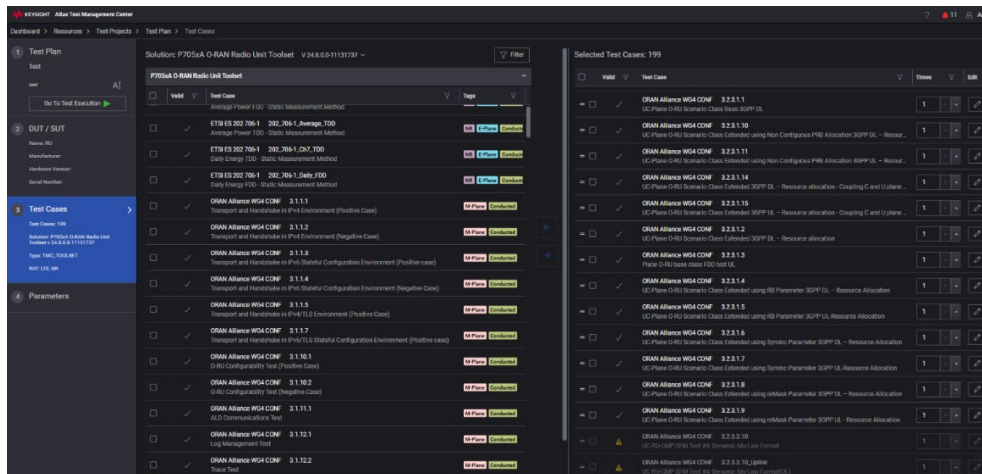


Figure 5. Atlas test management center

Key Use Case Examples

RuSIM provides test solution spanning from early 3GPP feature validation to E2E network performance testing. Below the key use cases highlighted:

- O-RAN Compliance Testing covering interoperability, conformance, performance and security
- 3GPP and O-RAN Release Validation
- mMIMO and beamforming
- AI-RAN workload generation, KPI validation and training data generation.
- Energy Efficiency Testing

O-RAN compliance testing

RuSIM enables interoperability testing between multi-vendor CU and DU over the F1 interface. It verifies successful connection establishment and ensures compliance with O-RAN specifications.

Integrated with Keysight's O-RAN Compliance Test Case Portfolio, RuSIM provides comprehensive coverage of test scenarios defined by the O-RAN Alliance. The following automated compliance test cases are supported:

- O-RAN WG4 O-DU Conformance Test Cases
- O-RAN WG5 Interoperability Test Cases
- O-RAN Security Test Cases
- O-RAN TIFG-E2E Test Cases

O-RAN Compliance test case execution, analytics and reporting is centralized to Keysight Atlas Test Management Center (TMC).

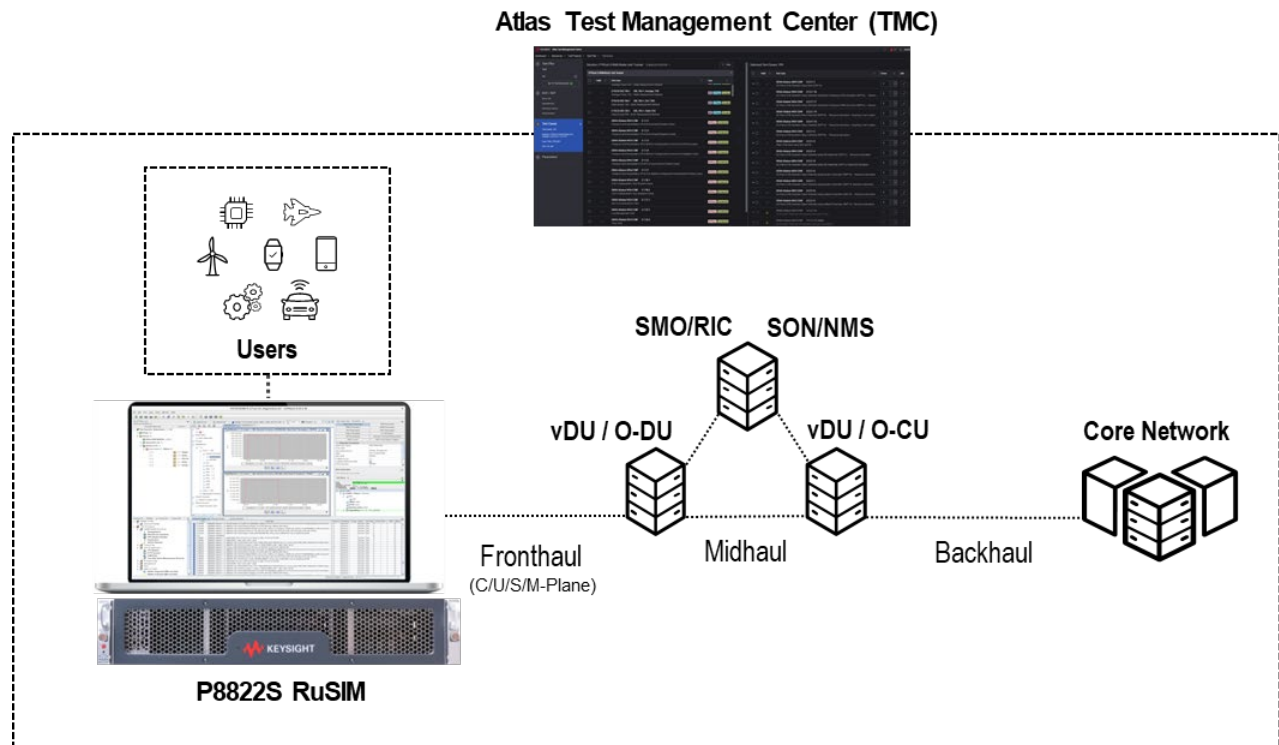


Figure 6. Keysight Atlas Test Management Center (TMC) orchestrates the O-RAN Compliance Tests

Read more about Keysight Open RAN compliance test cases:

<https://www.keysight.com/zz/en/assets/3125-1162/brochures/Keysight-Open-RAN-Automated-Compliance-Test-Cases.pdf>

3GPP and O-RAN feature development and verification

3GPP and O-RAN release validation can be divided into pre-release validation—when the release has not yet been published—and frozen release validation. The main challenge for pre-release validation is the absence of available UEs to test new 3GPP, O-RAN features, and similar challenges persist for post-release testing.

The RuSIM solution provides the latest 3GPP and O-RAN features to emulate both UE and RU, enabling validation of RAN functionality and performance even before the specification is frozen (pre-release).

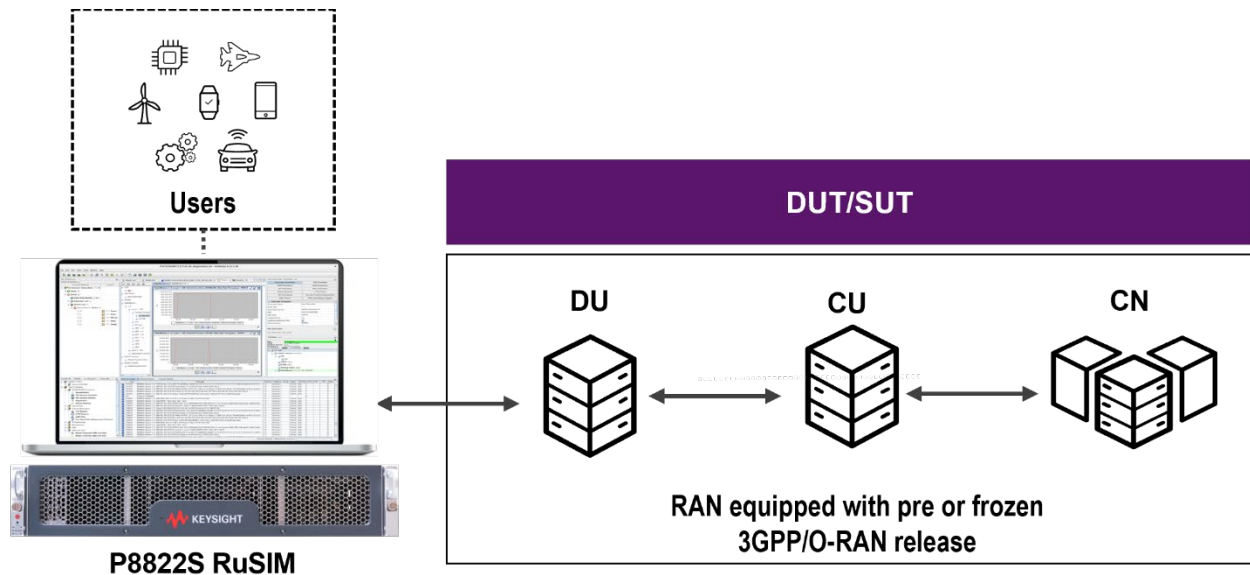


Figure 7. RuSIM solution for 3GPP, O-RAN development and verification

Massive MIMO (mMIMO) and beamforming

RuSIM enables functional and stress testing of the O-DU's proprietary scheduler via a simultaneous emulation of O-RU, spatial channel and mMIMO UEs in a software solution running on Commercial Off the Shelf (COTS) servers. Beamforming is a central element of 5G mMIMO scheduling algorithms, and the RuSIM can emulate mMIMO channel conditions that have been very difficult to recreate in laboratory environments.

RuSIM solution includes:

- Full visibility of beamforming weight vectors
- Enable offline analysis of the performance of the O-DU's beamforming algorithm response to a given stimulus (e.g. SRS)
- No requirement for phase-coherent calibration of the RF channel (conducted or near-field)

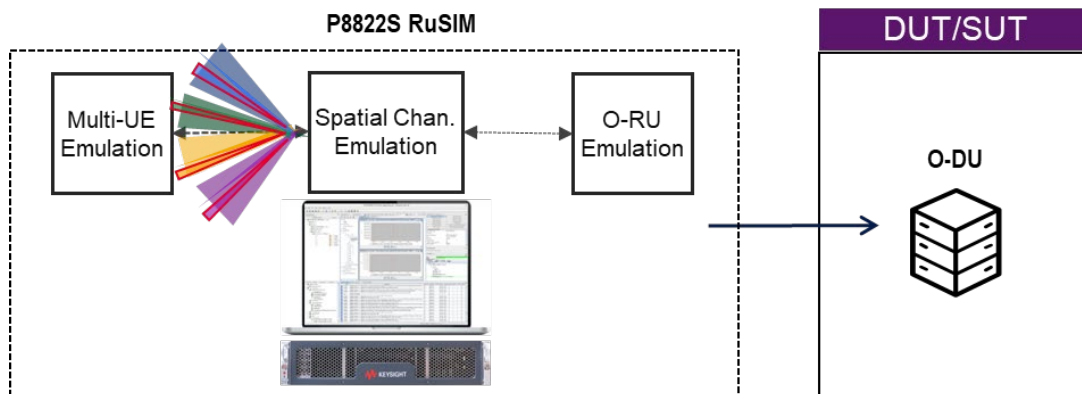


Figure 8. RuSIM solution for mMIMO and beamforming

Testing AI empowered RAN (AI-RAN)

Keysight provides wrap-around solution for RAN workload generation, performance evaluation and training data creation for AI-RAN system:

- RAN Workload generation for AI-RAN use cases
- Training data creation.
- KPI Benchmarking of AI/ML models.

Figure 9 illustrates test configuration for AI-and-RAN use case RAN and AI shares the cloud cluster. RuSIM generates RAN workloads, CoreSIM emulates core network and Atlas TMC handles the test automation, results reporting and analytics.

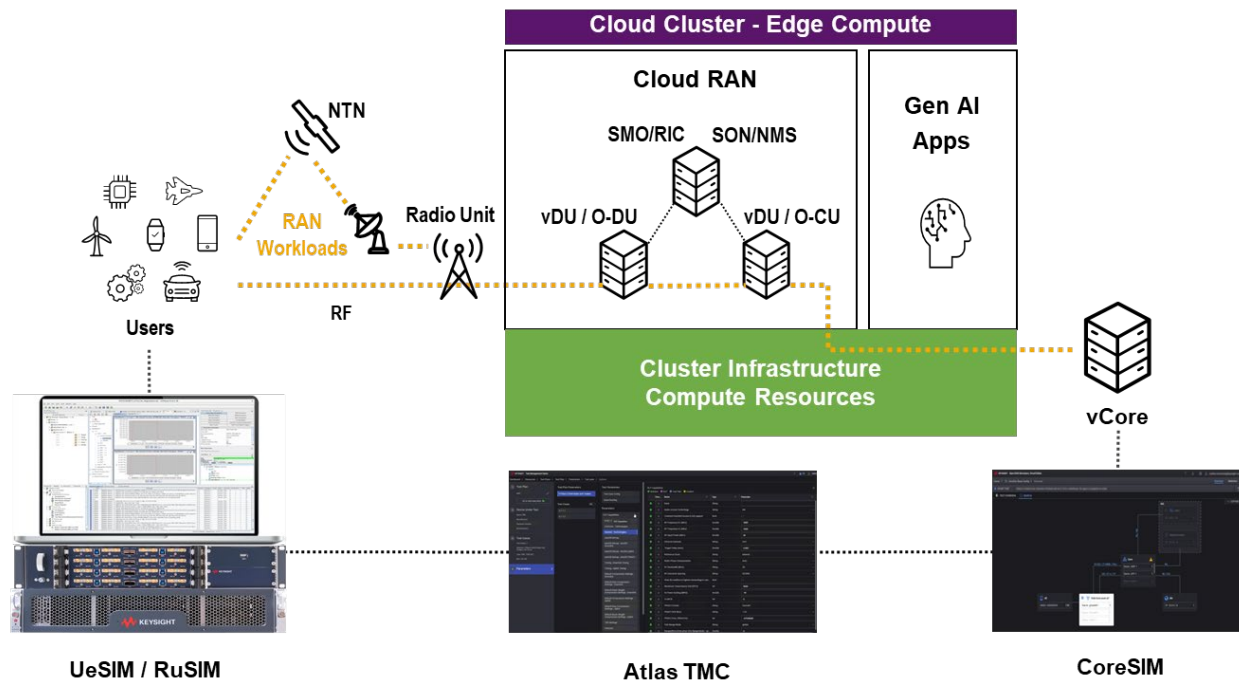


Figure 9. Wrap-around test solution to generate RAN workloads for AI-and-RAN use case

Ensuring energy efficiency

The combination of P8822S RuSIM and Atlas Test Management Center (TMC) enables a broad range of testing capabilities, including the assessment of energy efficiency across different network components:

- Measure power consumption of cloudified O-DU/O-CU.
 - Name space level
 - Pod Level
 - Container Level
- Perform tests according to ETSI standards with different traffic profiles.

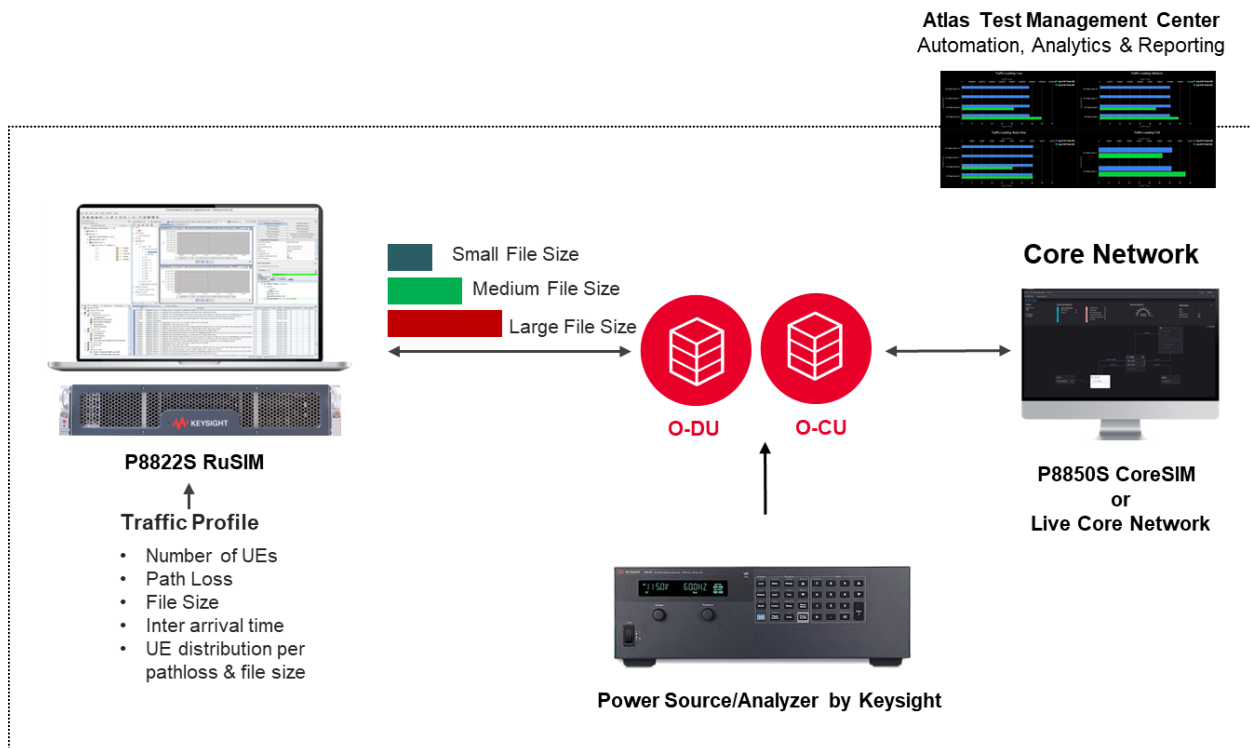


Figure 10. O-DU and O-CU energy efficiency test configuration

Flexible Licensing Options

Keysight offers a wide range of license types and terms for fit into your testing needs, allowing cost effective use of assets.

License type	Description
Node Locked	License may be used on one specific PC/instrument
Floating	Networked instruments/computers can access a license from a server one at a time
Floating single site	License server is based within 1 mile radius from the instrument/computer

License Terms	Description
Perpetual	Perpetual licenses can be used indefinitely
Subscription based	Temporary licenses can be used for a limited duration of 6, 12, 24, or 36months

Further Resources

- [P8822S RuSIM RAN Testing Toolset](#)
- [Radio Access and Core Network Test](#)
- [Keysight and Intel Create Automated 5G mMIMO vRAN Test Framework](#)
- [Open RAN Handbook 2nd Edition | Keysight and Vodafone](#)

Related Solutions

- [P8800S UeSIM RAN Testing Toolset | Keysight](#)
- [U5040BSCB Open RAN Studio for O-RU Testing and Validation](#)
- [P8850S CoreSIM – Core Simulation RAN Solutions](#)
- [P8827S CuSIM – O-DU Midhaul Solutions](#)
- [P8826S DuSIM – O-CU Midhaul Solutions](#)
- [P8828S RICtest — RAN Intelligent Controller Test Solutions](#)
- [SJ001A WaveJudge Wireless Analyzer Toolset](#)

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