

RuSIM O-DU Testing Solution

Emulating the O-RU over the O-RAN Fronthaul

O-RAN Fronthaul Validation Made Simple

Keysight Technologies is a founding member and active contributor for O-RAN Alliance Work Group 4, primary editor of the O-RAN Alliance WG4 Fronthaul Conformance and Interoperability Test Specification.

For testing over the O-RAN fronthaul interface, Keysight has successfully deployed with multiple industry players the RuSIM, a 4G and 5G UE and O-RU emulator. RuSIM enables infrastructure vendors, chipset providers and mobile operators and integrators to easily run functional testing, conformance testing and performance testing of O-RAN Distributed Unit over the option 7.2x functional split fronthaul interface.

Fully scalable and virtualized, it runs on commercial-off-the-shelf servers without the need for L1 hardware accelerators or special purpose hardware, with a migration path towards Cloud.

RuSIM enables network verification by generating IP traffic load, simulating applications running on multiple concurrent devices operating real voice and data sessions. Full protocol stack assessment is possible for 5G NR (NSA/SA) over eCPRI. O-DU full-stack testing can be performed with an optional wrap-around testing configuration, using CuSIM, the Keysight's O-CU emulator. CoreSIM, the Keysight core emulator, makes O-DU+O-CU wrap-around testing possible.

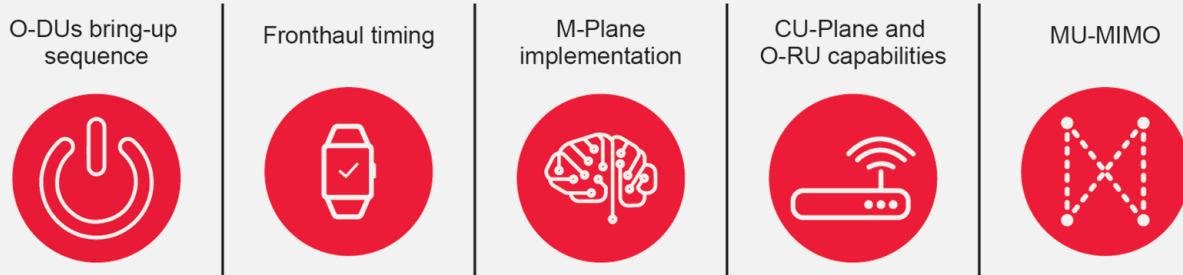
**5G**

Validate 5G RAN functionalities, conformance and performance over the O-RAN fronthaul interface

- Virtualized, migrating to Cloud
- Full protocol stack assessment
- Functional testing
- Performance and load testing
- Protocol conformance testing
- Compliance testing against interoperability specifications
- O-DU or O-DU-O-CU wrap-around testing options

O-DU Testing challenges

Despite the standard interface, O-DU testing presents several challenges.



- **O-DUs bring-up sequence**, due to loose O-RAN standard in this area
- **Front-haul timing**, given the tight requirements of O-RU, specifically for features like TDD, MIMO and multi-RU Carrier Aggregation
- **M-Plane implementation**, where the intentional specification flexibility creates significant interoperability issues (i.e. YANG Object Models have 6,000+ parameters, with less than 3% mandatory)
- **CU-Plane**, with O-DUs designed to work with very specific O-RU capabilities (i.e. only one O-RU category, or beamforming model sets)
- **MU-MIMO**, requiring close cooperation with O-DU vendor due to vendor specific operational aspects (e.g.: SRS-based + Beam weights) despite standardized communications across O-RAN interface.

Complete Protocol Implementation

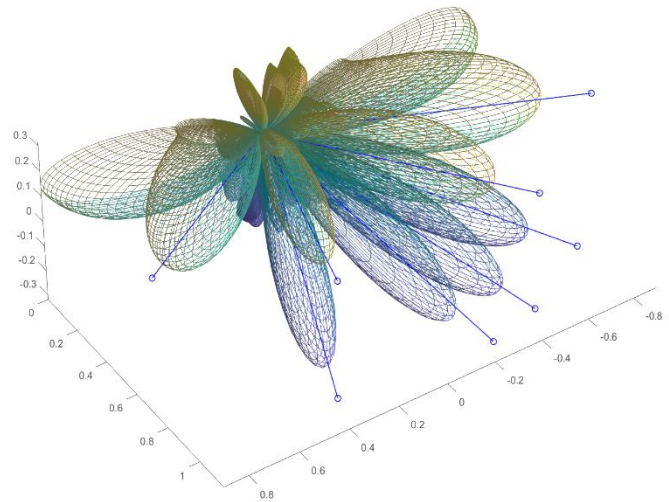
Keysight RuSIM implements the functional splits 7.2a and 7.2b over fronthaul interface.

It simulates the CUS and M-Plane interfaces defined by the specifications under O-RAN Alliance.

- **M-plane:** All YANG models are supported
- **S-plane:** Full PTP synchronization to a Master residing in the DU (LLS-C1) or elsewhere in the fronthaul network (LLS-C2 through LLS-C4) is supported.
- **C-plane and U-plane:** Support for multiple downlink and uplink endpoints and alternate numerologies, as well as static and weight-based dynamic beamforming and other advanced O-RU features.

MU-MIMO and Beamforming

MU-MIMO emulation enables functional and/or stress testing of the O-DU's proprietary scheduler, offering Customers a clear competitive advantage. Beamforming is a central element of 5G MU scheduling algorithms, however suitable MU-MIMO channel conditions are more difficult to recreate in laboratory. In order to test MU-MIMO functionality thoroughly, the O-DU scheduler must be stimulated with a Spatially-, frequency- and time-selective channel between O-RU and a sufficiently large population of UEs.



Keysight RuSIM provides a **joint emulation of O-RU, Spatial Channel and MU-MIMO UEs in a software-only solution**. RuSIM spatial channel emulation, operating in the subcarrier domain, associates U-plane spatial streams (which carry only IQ data) with their target UEs.

RuSIM MU-MIMO emulation has the following advantages over RF-based solutions:

- RuSIM has full visibility of beamforming weight vectors
- It Enables off-line analysis of performance of the O-DU's beamforming algorithm response to a given stimulus (e.g., SRS).
- It has no requirement for phase-coherent calibration of the (conducted or near-field) RF channel

5G SA/NSA and LTE O-DU Validation

RuSIM supports both NSA and SA configurations, with multiple wrap-around options to enable different testing needs. It can be used in combination with the Keysight Core Network Emulation (CoreSIM) to test O-DU O-CU combination, or together with Keysight O-CU emulation (CuSIM) to test the O-DU in isolation.

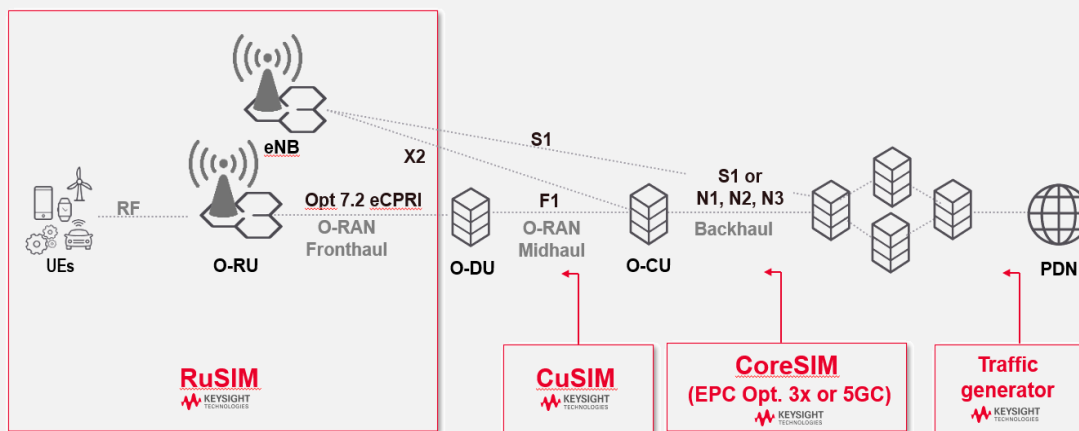


Figure 1. RuSIM testing topologies.

Easy and Intuitive User Interface

The RuSIM share the same user interface as UeSIM, enabling a seamless user experience.

RuSIM GUI provides an easy and intuitive way to manage system configuration and simulation parameters, customize device models and subscribers with different capabilities, create multiple subscribers or subscribers group scenarios, manage mobility for each subscriber or group of subscribers, edit and execute test scenarios.

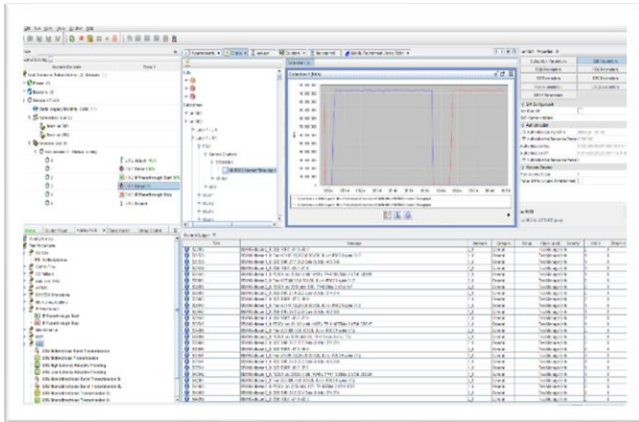


Figure 2. RuSIM GUI.



Figure 3. AMM map editor.

User has access to hundreds of comprehensive statistics in real-time during test execution with user-configurable views. All statistics are also available after the test for post-processing.

RuSIM comes together with a test automation framework, including a growing set of IOT test scenarios, providing an easy selection from the hundreds of profile configurations and automated configuration, allowing customer to save time and avoid errors.

Software Only Test Solution with optional Hardware

RuSIM is a SW only solution, running on commercial-off-the-shelf Intel™ servers ¹ without the need for L1 hardware accelerators or special purpose hardware, adapting to your infrastructure and easily scaling to follow your testing needs.

RuSIM can run on the UeSIM HW enabling a cost optimization approach, or optional Keysight hardware is available.

1. HW requirements available on demand.

Specifications

Protocol	Description
WG4 O-RAN Specifications	<ul style="list-style-type: none"> O-RAN Open Fronthaul Conformance Test Specification 2.00 and above. O-RAN Fronthaul Cooperative Transport Interface Transport Control Plane Specification 1.0 and above. O-RAN Fronthaul Interoperable Specification (IOT) 3.0 and above O-RAN Fronthaul Control, User and Plane Plane Specification 5.0 and above. O-RAN Management Plane Specification any version from v1.00 to 5.0 and above. O-RAN Management Plane -YANG Models 5.0 and above. O-RAN Cooperative Transport Plane Specification 1.0 – and above. O-RAN Cooperative Transport Transport Transport Plane YANG Models 1.0 and above.
3GPP Specifications	<ul style="list-style-type: none"> RuSIM is aligned with 3GPP Release 15 and 16
IETF Specifications	<ul style="list-style-type: none"> RFC 4253, The Secure Shell (SSH) Transport Layer Protocol, IETF, January 2006 RFC 4252, The Secure Shell (SSH) Authentication Protocol, IETF, January 2006 RFC 6242, Using the NETCONF Protocol over Secure Shell (SSH), IETF, June 2011 RFC 3339, Date and Time on the Internet: For Timestamps RFC 7950, The YANG 1.1 Data Modeling Language RFC 6241, Network Configuration Protocol (NETCONF) RFC 7895, YANG Module Library RFC 5277, NETCONF Event Notifications RFC 6470, NETCONF Base Notifications RFC 2132, DHCP Options and BOOTP Vendor Extension RFC 6241, Network Configuration Protocol (NETCONF) RFC 7895, YANG Module Library RFC 5277, NETCONF Event Notifications RFC 6470, NETCONF Base Notifications RFC 2132, DHCP Options and BOOTP Vendor Extension

Validate 5G Network Performance over the O-RAN Fronthaul Interface

Start validating your 5G network today: for interoperability and functional testing in terms of ultra-low latency, high reliability, extreme throughput and massive connectivity, you can rely on Keysight to provide highly scalable software solution.

- Full protocol stack assessment for 5G NR (NSA/SA modes) over eCPRI interface
- Functional testing layer by layer
- Protocol conformance testing
- Compliance testing against interoperability specifications
- Wrap-around O-DU testing option with CuSIM, Keysight's O-CU emulator
- Wrap-around O-DU+O-CU testing with CoreSIM, Keysight's Core emulator
- Performance and load testing
- Fully scalable virtualized solution
- Service quality validation with realistic subscriber and traffic modeling at high scale with LoadRAN
- Wireshark instant capture in Logs is supported for the fronthaul

Optional Hardware

Keysight **O-RAN Server** is a telecom testing equipment, endowed with several high-speed interfaces allowing fast connection towards O-DUs for O-RAN testing. This equipment can be used by Keysight RuSIM SW only, in case no commercial server is available.



Ordering Information

- **P8822S** - RuSIM over O-RAN Fronthaul
- **P88109A** - O-RAN Server

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications, or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

