TECHNICAL OVERVIEW

S8801A MIMO Base Station Fading Performance Toolset

Introduction

5G promises a huge data throughput capacity to end users. However, compared to 4G networks, optimizing, parametrizing, and issue solving of 5G networks is more complex. To deliver on the promises of 5G, traditional and new Open RAN (O-RAN) Network Equipment Manufacturers (NEMs) and Mobile Network Operators (MNOs) need advanced tools to validate and optimize the real-world performance of their 5G designs.

As 5G optimization is starting, both NEMs and MNOs are working hard to optimize 5G network performance. To ensure a high-quality user experience, 5G capable base stations must perform smoothly under real-world RF fading channel conditions. Therefore, the existing NEMs and new O-RAN challengers need tools for quick interoperability and performance validation with real user equipment (UE). MNOs, on the other hand, need to validate the optimal operation of their network in a multivendor field environment.

The industry has been lacking a fully automated turn-key solution for testing and optimizing 5G and LTE network equipment performance under realistic fading, interference, and mobility conditions prior to product and feature launches. Keysight's S8801A MIMO Base Station Fading Performance Toolset solves this challenge by enabling you to reliably and cost effectively test your designs starting from RF performance validation to tests with real UEs under real-world conditions in a laboratory.

Validate and optimize your base station designs prior to market launch with the S8801A toolset:

- Emulate up- and downlink FR1 MIMO channels in real time

The toolset is extendable to:

- Measure SU/MU-MIMO downlink RF beams with an embedded multi-port signal analyzer
- Test SU/MU-MIMO uplink RF beams with an embedded multi-port signal generator
- Analyze and debug up- and downlink SU/MU-MIMO L1/L3 signaling with an integrated RF sniffer
- Test key performance indicators, such as multi-user data throughput, in an instant

KEYSIGHT TECHNOLOGIES

What is the S8801A MIMO Base Station Fading Performance Toolset?

Keysight's S8801A MIMO Base Station Fading Performance Toolset provides a fully integrated and automated turn-key testing solution for 5G FR1 base stations' MIMO TX (transmit) and RX (receive) RF measurements and full protocol stack interoperability, as well as data throughput performance verification and optimization with real UEs.

The toolset supports single- and multi-user UL/DL (uplink/downlink) data performance testing and MIMO technologies, such as PMI feedback, Uplink Sounding Reference Signal (SRS), and open loop testing. It enables NEMs and MNOs to test and optimize network equipment functionality against ready- and custom-made test cases as well as field measurement -based test scenarios in a laboratory environment.

The S8801A MIMO Base Station Fading Performance Toolset is a part of Keysight's comprehensive portfolio of base station testing solutions.

Figure 1. The S8801A toolset brings the real-world channel conditions to the lab

Who benefits from using the S8801A toolset?

- NEMs including O-RAN radio unit manufacturers to
  - test and validate new 5G features and fix bugs before field deployment
  - test, validate, and optimize base station performance in real-world and 3GPP-specified fading RF channel conditions
- MNOs to
  - validate and optimize NEMs' base station functionality and performance parameters in fading RF channel conditions
  - benchmark base station manufacturers' product performance
  - verify new network radio units prior to market launch and assure radio units' interoperability with the local network configuration

- Related ecosystems (test houses and system integrators) to
  - test, optimize and benchmark base station manufacturers' product performance and interoperability
  - verify new network radio units prior to market launch and assure radio units' interoperability with the local network configuration

What does the S8801A toolset offer?

The solution offers:

- A fully integrated framework comprising a 5G FR1 MIMO base station, a channel emulation solution, real UEs, and full test automation
- Test scenarios based on 3GPP TR38.901 static and mobile fading conditions for Line of Sight, Non-Line of Sight, and blocking channel models
- Ready-made and verified test case packages
- GCM Channel Studio tools for custom test case creation (optional)
- RF Field-to-Lab tool that brings real-world RF conditions to the testing workflow in a laboratory environment (optional)
- Single- and multi-UE testing with real 5G multimode reference devices and test automation (optional)
- The possibility to test SU/MU-MIMO downlink RF beams with an embedded Keysight PathWave 89600 multi-port vector signal analyzer (optional)
- The possibility to test SU/MU-MIMO uplink RF beams with an embedded Keysight PathWave Signal Studio multi-port vector signal generator (optional)
- The possibility to analyze and debug up- and downlink SU/MU-MIMO L1/L3 signaling with an embedded Keysight SJ001A WaveJudge Wireless Analyzer Toolset (optional)
- The possibility to replay testing in an automated 24/7 controlled laboratory environment with all advanced testing and debugging tools, including channel parametrization

5G O-RAN network elements - end-to-end performance verification

The S8801A MIMO Base Station Fading Performance Toolset is a part of Keysight's end-to-end O-RAN architect wireless network testing portfolio (see Figure 2), providing fading performance testing tools for MIMO base stations.

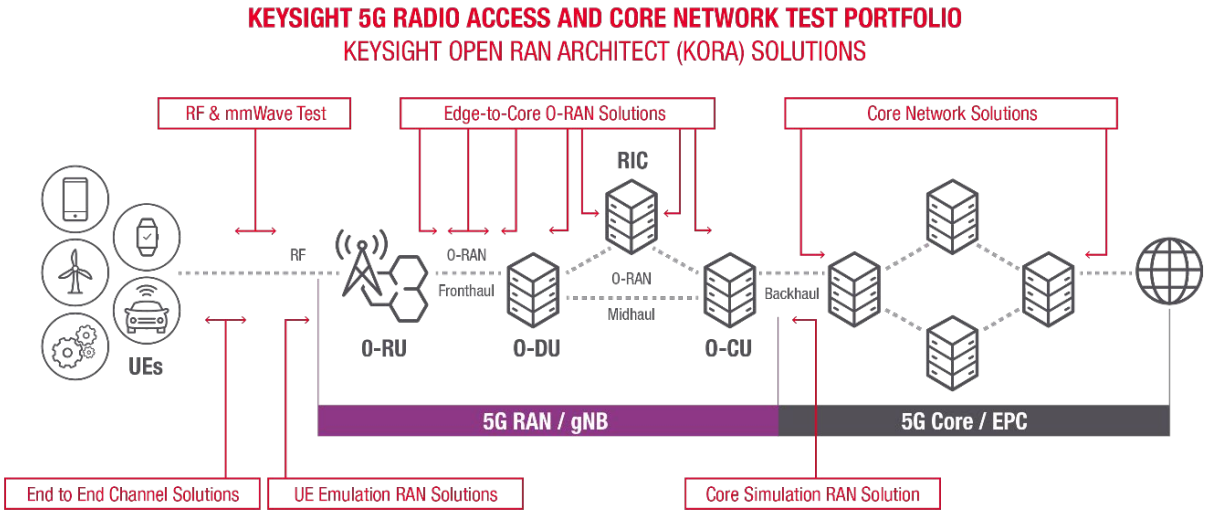

Figure 2. Keysight's 5G radio access and core network test portfolio

Keysight's O-RAN Architect offers integrated solutions that accelerate development, integration, and deployment of O-RAN compliant equipment. The suites are tailored for the supply chain workflow. You can uniquely access a common set of solutions to simplify the sharing of results across the workflow from pre-silicon to cloud deployments.

The S8801A toolset is a part of NEMs', MNOs' and Open Test and Integration Centers' (OTIC) testing suites that validate real-world data throughput, mobility performance, and interoperability.

Hardware Components

The S8801A MIMO Base Station Fading Performance Toolset is a fully integrated solution comprising the following hardware components:

- F8820A PROPSIM FS16 or F8800A PROPSIM F64 channel emulator
- Test System PC F9000A
- Optional hardware components:
  - Reference 5G user equipment
  - RF shield enclosure for UEs
  - Audio accessory kit
  - RF cables and power attenuators

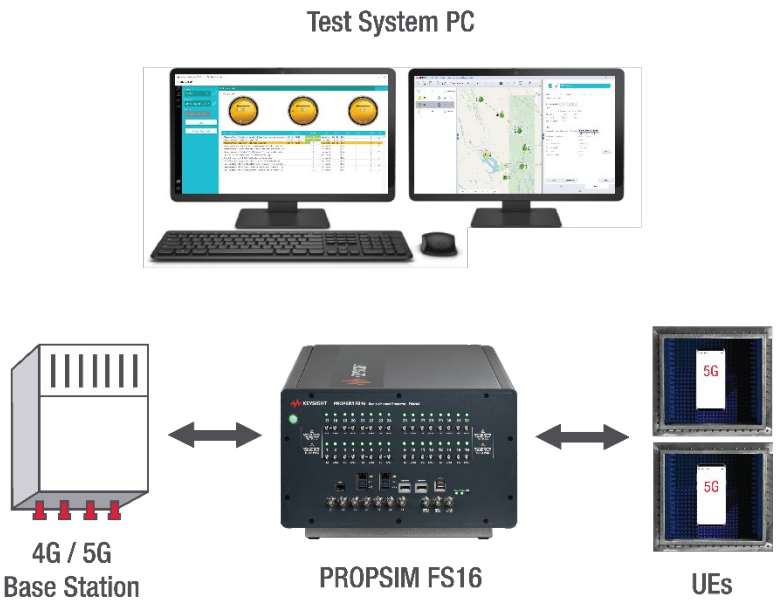

Figure 3. The S8801A toolset integrates a MIMO base station, real UEs, and a channel emulation solution together with fully automated 24/7 testing.

Key Software Components

Performance Test Manager

The optional F9340A Performance Test Manager (PTM) enables fully automated end-to-end laboratory testing with real applications. PTM controls UEs and channel conditions created by PROPSIM during test runs and collects KPI data from UEs. With ready-made or user-defined test scripts, you can create a variety of test cases. PTM also generates test cases based on the information measured in the field with the Field-to-Lab feature. Moreover, PTM generates a textual report of each test case from the selected KPIs.

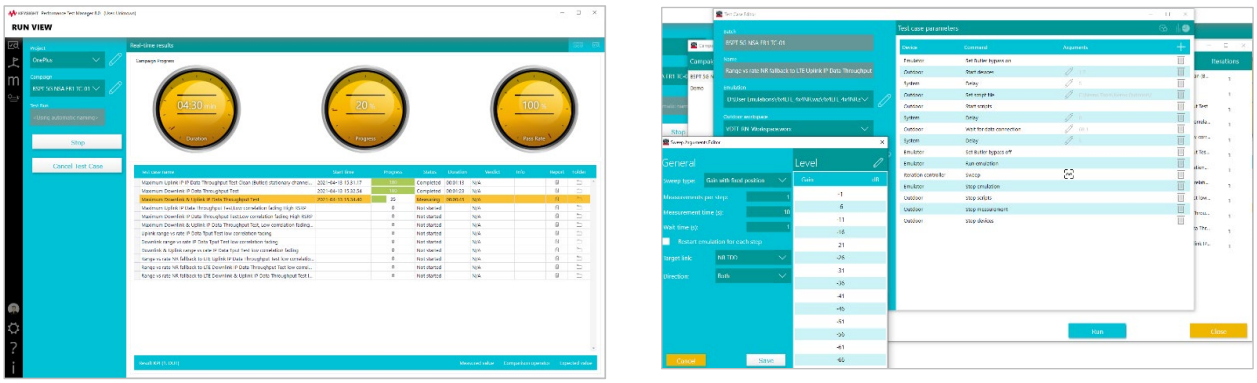

Figure 4. The user interface of F9340A Performance Test Manager

Ready-made verified multimode MIMO test cases and test scenarios

Ready-made and verified FR1 multimode MIMO base station test case packages support Multi-RAT single and multi-cell base station testing with single and multiple UEs with different SISO and MIMO configurations in static and mobile fading channel conditions. Test cases are testing peak and average data throughput and link performance for uplink, downlink and simultaneous up- and downlink in Line of Site (LOS) and Non-Line of Site (NLOS) conditions (3GPP TR 38.901). The following test cases are supported for single- and multi-UE testing:

- Urban Micro (UMi) and Urban Macro (UMa) outdoor street canyon
- UMi stationary and dynamic/moving performance test cases
- Single and multi-UE maximum data throughput test cases
- Sector angular coverage and performance test cases
- Near-Far / link range performance test cases

The 5G NR FR1 multimode MIMO test scenario packages offer pre-defined test scenario models for your own test case creation.

GCM Channel Studio

The optional F9860A GCM Channel Studio tool for custom-made channel model creation with Antenna Array Tool options, enables creating customer-specific channel models. Dynamic modelling capabilities include mobile speed, multipath profile, range delay, and base station antenna correlation. The other parameters include interference and distant propagation path reflections to the device.

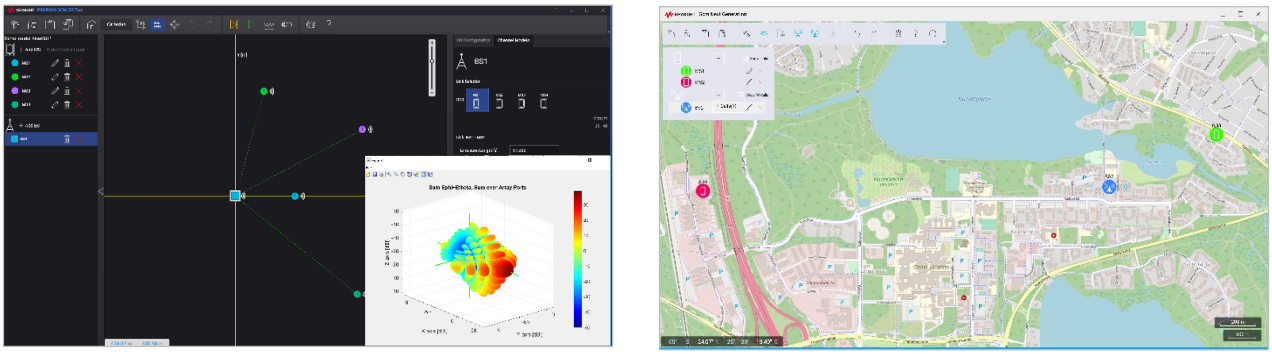

Figure 5. The user interface of F9860A GCM Channel Studio

RF Field-to-Lab Channel Studio

The optional RF Field-to-Lab Channel Studio tool brings field-measured RF conditions to the laboratory testing environment. With the RF Field-to-Lab tool, you can easily bridge the gap between laboratory and field testing under realistic air-interface conditions through seamless real-world representation of the environment. The RF Field-to-Lab tool offers a repeatable and realistic lab-based test method that enables you to cost-effectively and quickly verify multiple designs or multiple revisions of a single design. You can also build a library of RF Field-to-Lab test cases containing data measured in various locations around the world.

The RF Field-to-Lab tool imports radio channel parameters (e.g., Cell ID, RSRP, SNR, and MIMO correlation) from the measurement files to create a channel model for the channel emulator. It delivers a reliable replication of recorded field conditions without the need for additional modeling or user input.

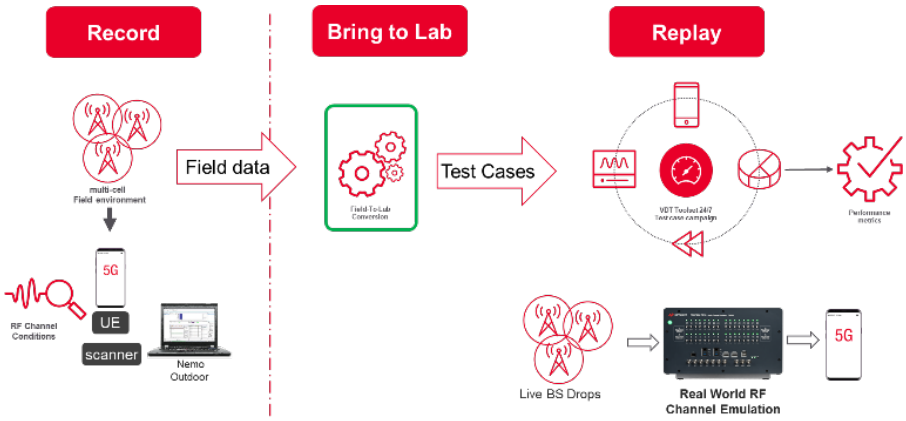

Figure 6. The F9340A100 RF Field-to-Lab tool brings field-measured RF conditions to the lab testing environment

Optional Keysight tools for deeper analysis and issue solving

When integrated with the S8801A toolset, the following optional tools provide you with more data for deeper analysis for issue solving and performance optimization.

The NTL50000A 5G Device Analytics tool is an in-depth troubleshooting, benchmarking, and analytics software for analyzing 5G chipset and device trace logs in a laboratory.

With the PROPSIM signal capture feature, you can measure IQ data from any PROPSIM RF port, with coherent multi-channel MIMO measurements supported.

With the PROPSIM signal playback and streaming feature, you can play RF waveform(s) created with optional Keysight PathWave Signal Studio software.

The 89600 PathWave VSA software solution performs a vector signal analysis and visualizes signal quality with multiple domain traces in time, spectrum, and modulation based on PROPSIM-captured uplink and downlink IQ data files.

The N7631 PathWave Signal Studio solution enables you to generate, export, download, and playback 3GPP 5G NR (New Radio) waveforms with the PROPSIM platform. PathWave Signal Studio enables flexible signal configuration with both single-carrier and multi-carrier support.

The SJ001A WaveJudge Wireless Analyzer Toolset allows design and verification engineers to gain visibility into protocol and physical layer interaction in wireless transmissions. The toolset also combines a powerful over-the-air communications analysis, real-time protocol decoding, and a PHY analysis. It is an essential tool for troubleshooting 5G network performance issues between devices and base stations in development and deployment using PROPSIM-captured uplink and downlink IQ data files.

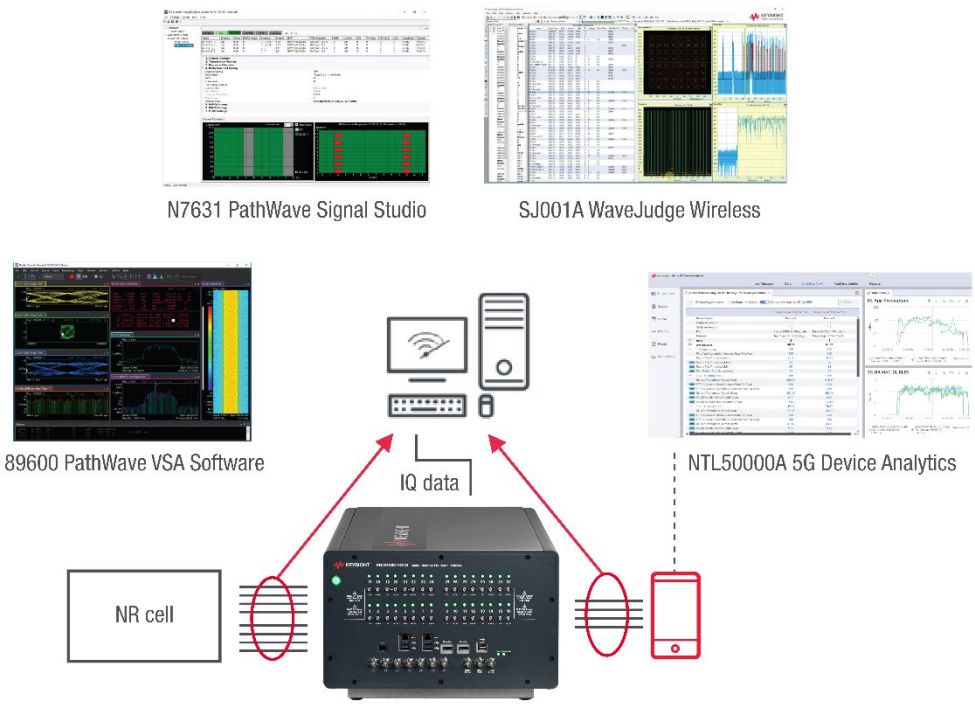

Figure 7. Optional Keysight tools for base station and UE issue solving and performance optimization.

Custom tests

With the S8801A MIMO Base Station Fading Performance Toolset, you can verify base station data performance under static and mobile test conditions, as well as validate device maximum data throughput performance under TDL-x and CDL-x channel models defined in the 3GPP 38.901 standard. The toolset supports a predefined set of data throughput test cases supporting NR FR1 together with LTE for NR standalone and non-standalone testing in sub-7 GHz frequency ranges. Base station performance can be verified across different MIMO configurations. Keysight's GCM Channel Studio tool enables you to create custom scenarios on top of the verified performance test cases. With the GCM Channel Studio tool, you can create different MIMO antenna arrays and device antenna beam patterns.

Validated 5G reference UEs for testing

Keysight provides a wide variety of 5G reference devices for base station performance testing. The list of support devices is growing rapidly as new user devices are launched. The supported devices are equipped with latest chipsets, such as Qualcomm X50/X55/X60 and Samsung Exynos 5100/5123. The 5G reference devices for sub-7GHz testing are delivered with the RF cabled option.

Keysight's 5G Solutions

Keysight's 5G end-to-end design and test solutions enable the mobile industry to accelerate 5G product design development from the physical layer to the application layer and across the entire workflow from simulation, design, and verification to manufacturing, deployment, and optimization.

Keysight offers common software and hardware platforms compliant to the latest 3GPP standards enabling the ecosystem to quickly and accurately validate 5G. You can test chipsets, devices, base stations, and networks, as well as emulate subscriber behavior scenarios. Additional information about Keysight's 5G solutions is available at www.keysight.com/find/5G.

- For more information about PROPSIM Base Station Fading Performance Testing, visit keysight.com/find/basestationtesting
- For more information about the S8801A MIMO Base Station Fading Performance Toolset, visit keysight.com/find/s8801a
- For more information about Keysight KORA solutions, visit keysight.com/products/network-test/radio-access-core-network-test
- For more information about PROPSIM Channel Emulation Solutions, visit www.keysight.com/find/propsim
- For more information about PROPSIM F64 RF Channel Emulator, visit www.keysight.com/find/propsimf64

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

KEYSIGHT TECHNOLOGIES

This information is subject to change without notice. © Keysight Technologies, 2021, Published in USA, November 29, 2021, 3121-1465.EN