TECHNICAL OVERVIEW

S8802A mmWave Base Station Fading Performance Toolset

Introduction

5G base station products support several access technologies, are flexible to deploy and reconfigure, and most importantly, can deliver a huge capacity to end users. However, the increasingly complex technology that enables these new capabilities, is more vulnerable for distortions. Typically, the performance challenges of 5G links and networks are related to beam management procedures and interoperability issues between user equipment (UE) and the network.

The key challenge of 5G arises from the above 24GHz millimeter-wave (mmWave) frequencies introduced in 5G new radio (NR). Millimeter wave propagation in the medium is different compared to traditional radio signal frequencies. Millimeter waves propagate in the same way as visible light and therefore obstacles block and scatter the signal instead of letting an attenuated signal travel through the medium (See Figure 1).

The industry has been lacking a fully automated turnkey solution for testing and optimizing 5G mmWave base station performance in realistic conditions. Keysight's S8802A mmWave Base Station Fading Performance Toolset solves this challenge by enabling you to reliably and cost effectively test your designs in a laboratory environment. By bringing the field conditions to the lab, the S8802A toolset allows you to assess the performance of your designs in real-world fading and interference RF conditions.

Validate and optimize your base station designs before launch with the S8802A toolset:

- Emulate up- and downlink FR2 MIMO channels Over-The-Air in real time

The toolset is extendable to:

- Measure SU/MU downlink RF beams with an embedded multi-port signal analyzer
- Test SU/MU uplink RF beams with an embedded multi-port signal generator
- Analyze and debug up- and downlink SU/MU 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 S8802A mmWave Base Station Fading Performance Toolset?

Keysight's S8802A mmWave Base Station Fading Performance Toolset provides a fully integrated and automated turnkey testing solution for optimizing, stress testing, and benchmarking mmWave base stations. Testing can be replayed in an automated 24/7 controlled laboratory environment with all testing tools.

S8802A mmWave Base Station Fading Performance Toolset enables users to overcome one of the biggest real-world testing challenges – repeatability. It provides an environment to stress test software stack and verify performance with mobile operator specific signaling. The ready-made and validated test case packages are based on 3GPP-defined conditions for fading testing of 5G.

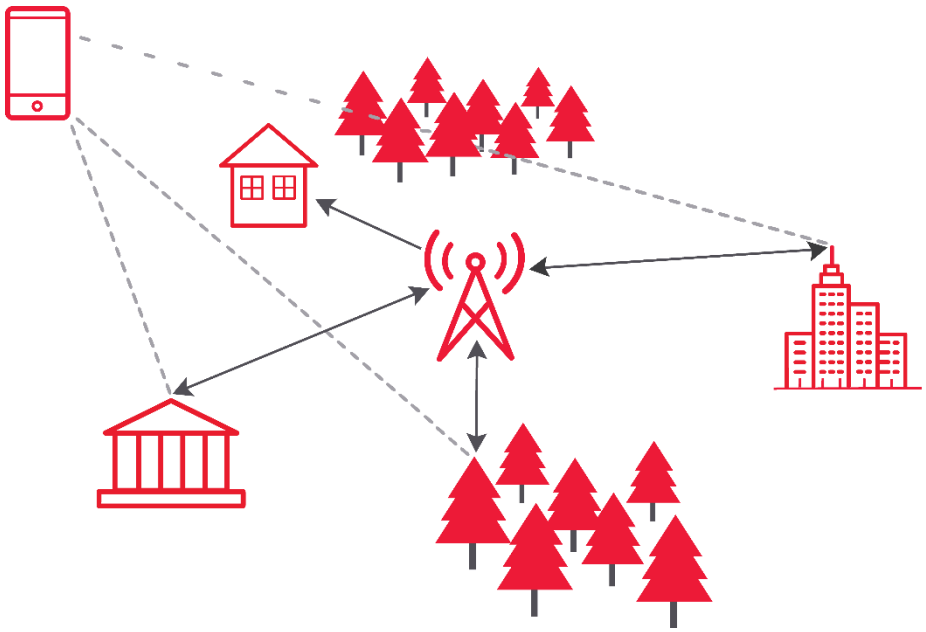

Figure 1. mmWave propagation in a real-world environment

Who benefits from using the S8802A toolset?

Network Equipment Manufacturers (NEMs) including ORAN radio unit manufacturers to

- Test and validate new 5G features and bug fixes
- Test, validate, and optimize base station performance in fading RF channel conditions

Mobile Network Operators (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 before launch and assure radio units' interoperability with the local network configuration

Related ecosystems (test houses and system integrators) to

- Verify new network radio units before launch and assure radio units' interoperability with the local network configuration
- Test, optimize, and benchmark base station manufacturers' product performance and interoperability
- Verify new network radio units before launch and assure the interoperability of radio units with the local network configuration

What does the S8802A toolset offer?

The toolset offers:

- Fully integrated turnkey solution for base station mmWave performance testing
- Bridging the gap between base station lab- and field testing
- Accelerated acceptance and validation testing of new features and releases for MNOs
- Tools for optimizing, stress testing, and benchmarking new products and releases
- Tools to evaluate base stations' mmWave KPIs
- Ready-made and validated test case packages for mmWave base station single- and multi-user testing
- 3GPP standard-defined testing conditions for mmWave fading testing
- Fully automated 24/7 testing solution to control RF channel fading conditions and UEs over multiple test runs without human interaction
- Automated KPI reports
- Advanced tools for custom test case creation including common geometric spatial channel modeling tools
- RF Field-to-Lab tool
- Common test automation, logging, and result analysis tools

5G O-RAN Network Elements - End-to-End Performance Verification

The S8802A mmWave 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 mmWave base stations.

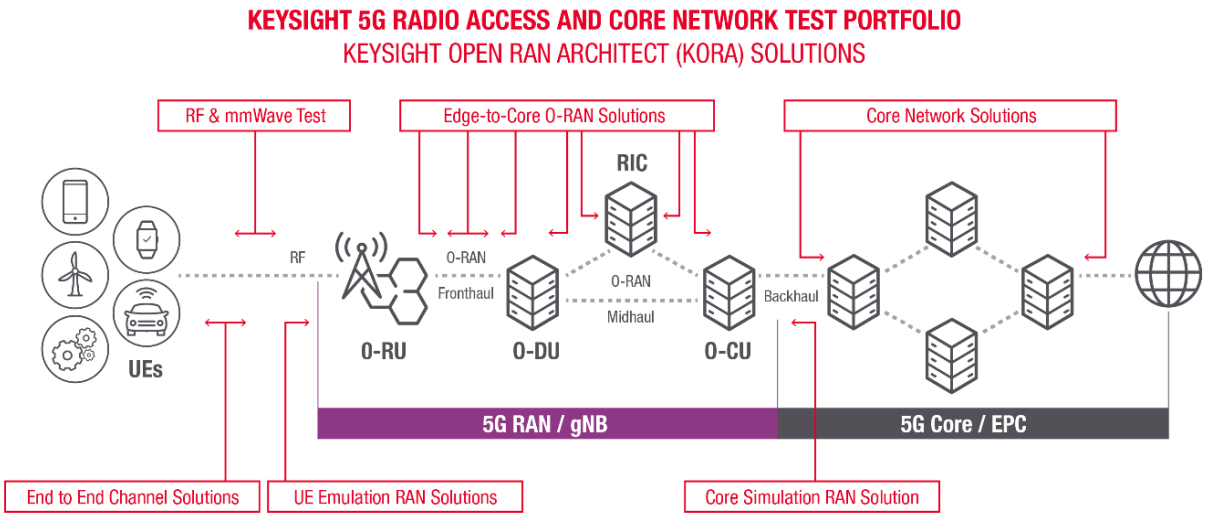

Figure 2. Keysight's 5G radio access and core network test portfolio

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 S8802A 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

Figure 3. S8802A hardware components

Keysight's S8802A mmWave Base Station Fading Performance Toolset supports different types of mmWave base station configurations. The S8802A toolset supports mmWave base station testing with:

- 5G FR2 24....44GHz bands
- All 5G NR Carrier BW and CA scenarios
- Up to 4 test UEs or 4 group of test UEs
- Up to two base station chambers (FR2 Handover)

Key Software Components

Performance Test Manager

The Performance Test Manager (PTM) enables fully automated end-to-end lab 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.

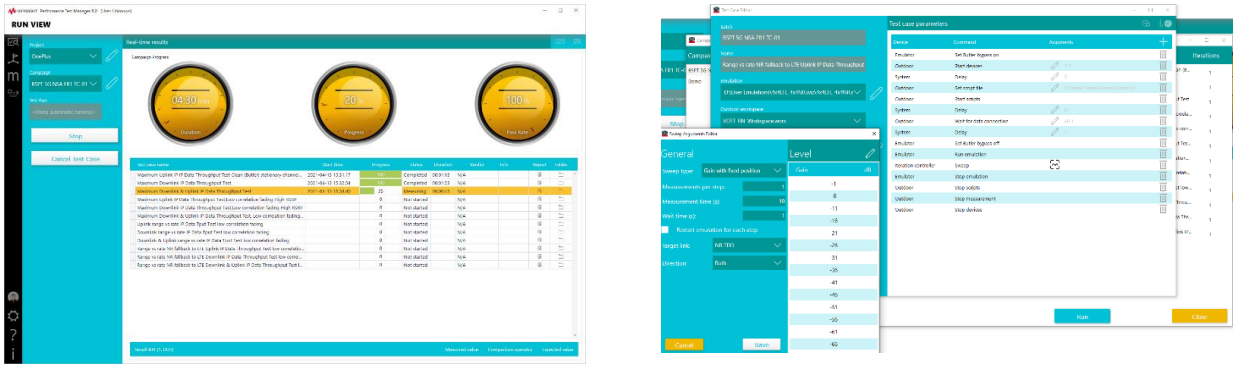

Figure 4. The user interface of Performance Test Manager

Ready-made and validated mmWave test cases and test scenarios

Ready-made and validated mmWave base station test case packages support single- and multi-cell base station testing with single and multiple UEs with different 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 FR2 mmWave test scenario packages offer pre-defined test scenario models for your own test case creation.

GCM Channel Studio

The optional GCM Channel Studio tool enables creating customer-specific channel models. Dynamic modelling capabilities include mobile speed, multipath profile, and range delay. The other parameters include interference and distant propagation path reflections to the device.

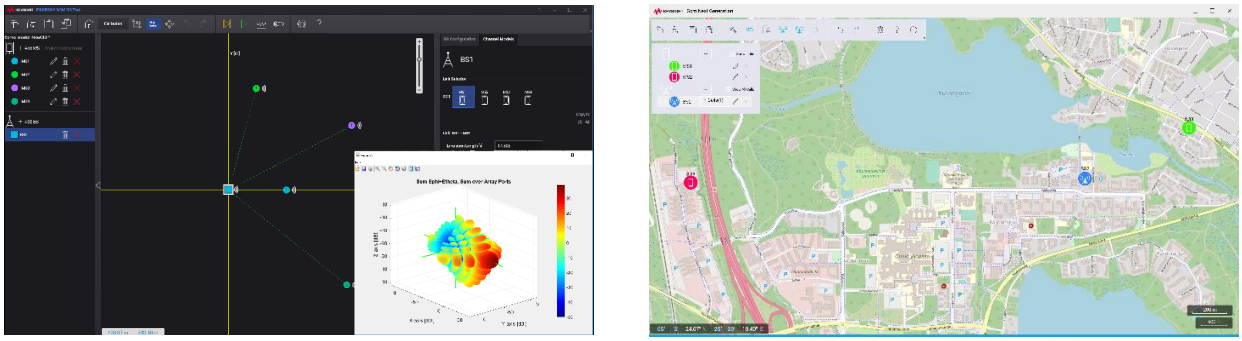

Figure 5. The user interface of GCM Channel Studio

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.

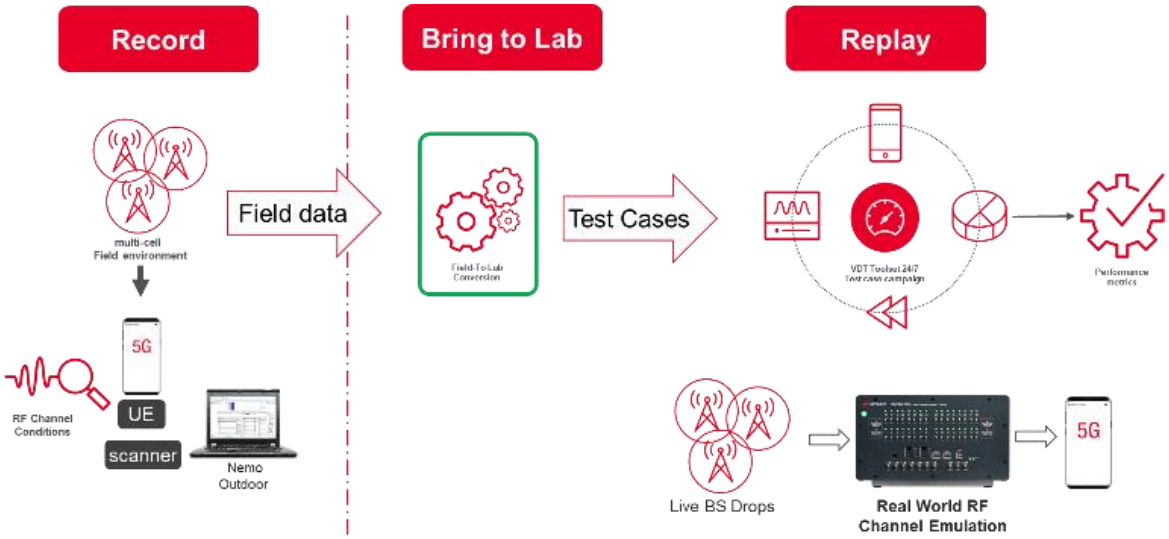

Figure 6. The RF Field-to-Lab tool brings field-measured RF conditions to the lab testing environment

Optional Keysight tools for deeper analysis and issue solving

When integrated with the S8802A 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 IQ-capture feature, you can measure IQ data from any PROPSIM RF port, with coherent multi-channel MIMO measurements supported. With the PROPSIM signal IQ-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.

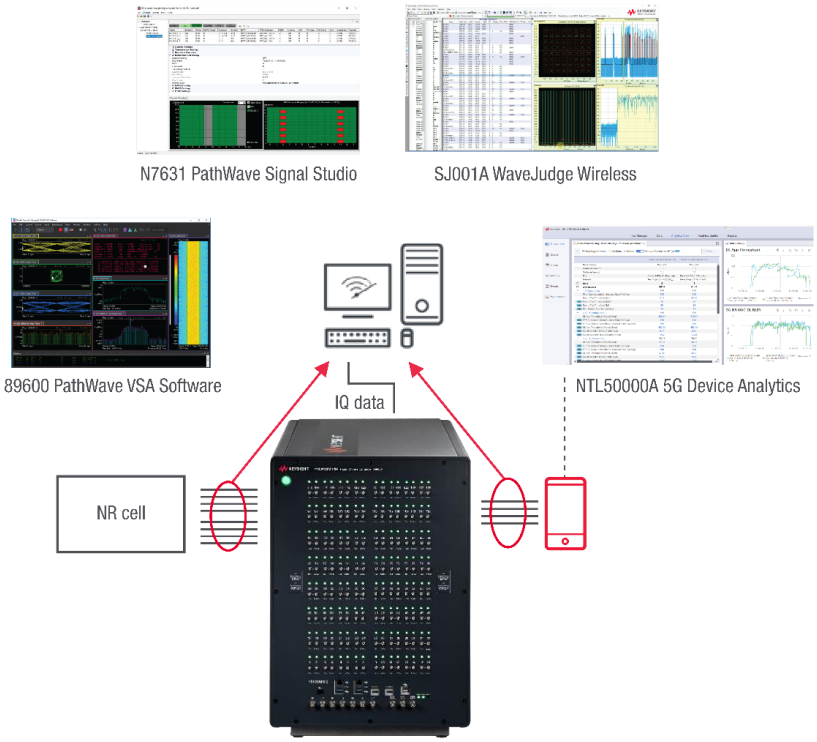

Figure 7. Optional Keysight tools for base station and UE issue solving and performance optimization.

Custom tests

With the S8802A mmWave 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 pre-defined set of data throughput test cases supporting 5G FR2 together with LTE for 5G non-standalone and standalone testing in mmWave frequency ranges. Base station performance can be verified across different configurations. Keysight's GCM Channel Studio tool enables you to create custom scenarios on top of the verified performance test cases.

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.

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 S8802A mmWave Base Station Fading Performance Toolset,
visit keysight.com/find/s8802a

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,
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