

# 5G

SOLUTION BRIEF

## PROPSIM FS16 5G Channel Emulation Solution

End-to-end real-world performance testing for wireless devices and base stations in the lab

The latest advancements in commercial wireless technologies address high-density environments like trains, stadiums, and airports. They require 3D spatial beamforming, multi-user massive multiple-input multiple-output (MU-MIMO), and more advanced spectrum utilization to increase wireless RF propagation channel effectiveness between devices and base stations.

With 5G devices, the data speed experienced by the user is highly dependent on the performance of the device in harsh mobile environments. Keysight's family of 5G channel emulators are widely used by the industry to benchmark and validate devices and base stations end-to-end real-world performance in the lab environment.



### 5G Challenge – How to be first and best in the market

The best 5G devices deliver superior end-user experience with ultra-high data transfer speeds in real-world 5G networks everywhere.

Quick testing process with high test coverage is fundamental to keep pace with evolving 5G technology.

PROPSIM FS16 is a versatile and validated 5G end-to-end channel emulation solution that enables developers to focus on device optimization and validation instead of test tools development.



## Test under Complex 5G RF Channel Conditions in Lab

Once you have validated your 5G device data rates and stability under ideal, clean RF propagation channel conditions, the next step is to optimize and validate the device performance in real-world conditions. It is important to test in faded and subject to interference channel conditions with multiple cells, users, and radio access technologies (RATs), as depicted in Figure 1. They include the following:

- multipath fading and spatial diversity
- antenna patterns and polarizations
- frequency Doppler and dynamic channel delay
- propagation delay offsets
- noise and interference from other users and cells

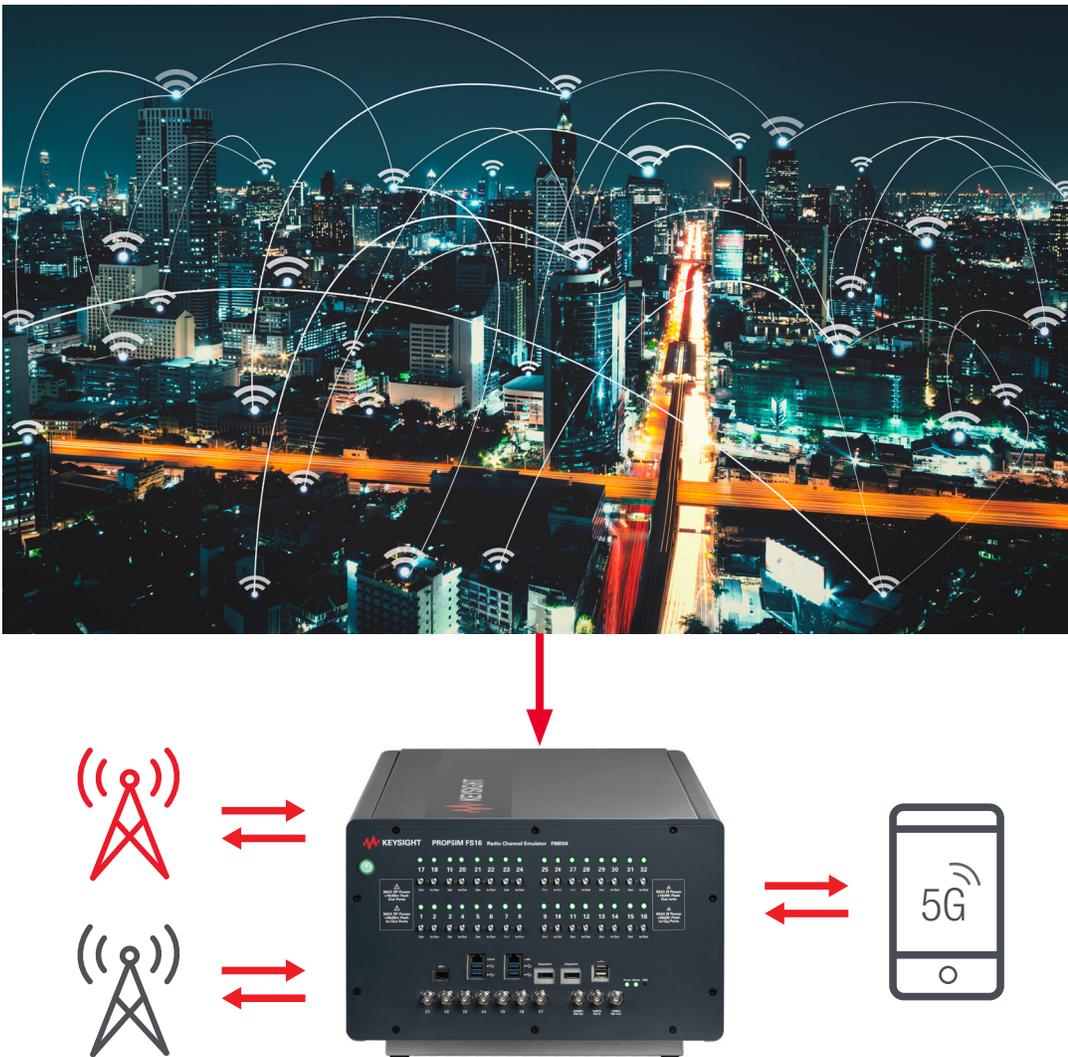


Figure 1. Real-world RF channel emulation process in the laboratory

## PROPSIM FS16 Overview

The PROPSIM FS16 (F8820A) is the latest 5G performance test solution in a series of innovative technology from Keysight to accelerate 5G development and commercialization. The PROPSIM FS16 RF Channel Emulator enables you to verify real-world performance of 5G New Radio (NR) devices and base stations that support ultra-wide bandwidths in the millimeter-wave (mmWave) spectrum, beamforming technology, and multiple-antenna configurations — such as MIMO and massive MIMO.

PROPSIM FS16 extends Keysight's family of 5G channel emulators widely used in the industry today. This solution helps device makers and network equipment manufacturers (NEMs) to benchmark and validate devices and base stations. It complements Keysight's PROPSIM F64 (F8800A) Channel Emulation Solution that leading NEMs use to address high-fading capacity needs.



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PROPSIM FS16 takes end-to-end RF performance testing to new heights by providing the highest dynamic range and 10 times better error vector magnitude (EVM) linearity performance than other RF channel emulators

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## Easily Integrate Complex 5G Radio Channel Emulation into Mobile Device Test Systems

PROPSIM FS16 supports all 5G NR frequency bands and bandwidths specified by the 3rd Generation Partnership Project (3GPP). The extremely high RF dynamic range and linearity performance of PROPSIM FS16 positions it to perform 256/1k QAM testing and makes integration easy in practical laboratory setups using RF cable connectivity or over-the-air (OTA) testing.



Figure 2. Verifying interoperability with real devices and base stations in the lab

PROPSIM FS16 creates a real-world mobile environment in the lab with live base stations and mobile devices, enabling end-to-end testing against real network infrastructure and services.

The solution seamlessly integrates with Keysight's 5G network emulation solutions to address industry requirements beyond 3GPP 5G NR standards conformance testing.



Figure 3. FS16 integrates seamlessly with wireless test systems to test device performance

The solution supports full-stack end-to-end testing of commercial wireless radios in the lab under uncompromised, coherent, and real-world 3D propagation channels.

PROPSIM FS16 offers up to 256 digital fading channels in a single, compact unit. This platform enables 8x8 bidirectional or 16x16 unidirectional fading in conducted or OTA test environments for multicell and multi-RAT mobility handover testing.

# Scalable Solutions for Chipset and Device Performance Testing

PROPSIM FS16's compact size, scalability, and unidirectional fading features enable a smooth integration with all wireless test systems. It offers realistic and repeatable end-to-end performance testing in the laboratory.

Configurations range from two channels for a cost-effective solution for basic RF testing to high MIMO capacity setups (Figures 4, 5, 6, and 7).

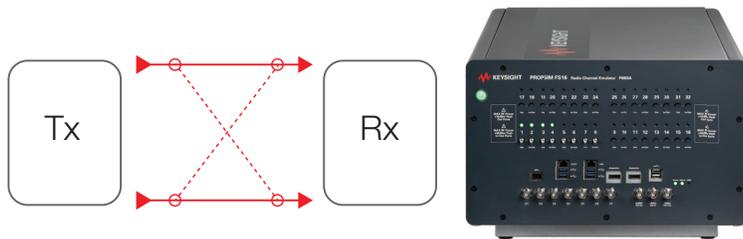


Figure 4. PROPSIM FS16 2-channel configuration offers 2x2 MIMO unidirectional fading for entry-level configurations



Figure 5. Scalability enables 4-channel configurations for 4x4 MIMO or two times 2x2 MIMO to perform RF fading performance testing



Figure 6. A single setup with high MIMO capacity



Figure 7. Multiple PROPSIM FS16 units used in parallel for higher configurations allowing the flexible use of resources for multiple test stations

## MIMO OTA testing

OTA test methods fully characterize the effect of a device’s MIMO antenna design on user experience. Keysight, along with its global network of OTA solution partners, provides end-to-end OTA test capability to characterize and validate chipsets, devices, and network equipment at sub-6 GHz and mmWave frequencies. Leading system integrators, device makers, and NEMs, use Keysight’s OTA test solutions and expertise to develop solutions that meet the requirements set by industry bodies. These entities include standards organizations such as 3GPP, the Cellular Telecommunications Industry Association (CTIA), and the Communications Standards Association (CCSA), and major mobile network operators.

## 5G device FR1 MIMO OTA testing

PROPSIM FS16 supports reverberation and anechoic chambers — it offers optimal configurations for unidirectional sub-6 GHz 5G MIMO OTA test environments (Figure 8). Exceptional RF linearity performance positions PROPSIM FS16 to perform 256/1k QAM testing with repeatable results. For anechoic chamber-based MIMO OTA test systems, PROPSIM FS16 supports 8 and 16 dual-polarized probes to enable anechoic chamber-based MIMO OTA test systems. Such support facilitates the upgrade of existing LTE test environments to 5G.

Keysight’s UXM 5G and PROPSIM FS16 integrate seamlessly to give you industry-standard test scenarios for 5G and 4G device MIMO OTA testing. Keysight provides a fast turnaround on calibration services, interoperability testing, and upgrades verification to ensure reliable operation.



Figure 8. MIMO OTA sub-6 GHz test setup

## 5G NR mmWave OTA test solution

PROPSIM FS16 offers seamless integration with Keysight's 5G network emulation solution. Keysight OTA test solutions for devices and their sub-components are purpose-built to address a wide range of RF, demodulation, and functional performance test requirements across the development, acceptance, and manufacturing workflow for 5G NR design validation.

Real-world performance requires 5G mobile devices to operate seamlessly according to beam management procedures under fading and blocking conditions. Keysight's device multi-beam MIMO OTA end-to-end performance test setup offers key performance indicators under real-world channel conditions. The setup integrates Keysight's network and channel emulation solutions (Figure 9).



Figure 9. MIMO OTA mmWave testing

# PROPSIM 5G: Industry-Leading RF Channel Emulation Solutions

PROPSIM FS16 supports industry-leading PROPSIM Channel Modeling Software Tools to start testing your work instantly. PROPSIM solutions enable you to create scenarios with industry-defined dynamic channel models such as 3GPP TR38.901. Keysight Channel Studio provides the realism and ability you need to create your own test scenarios with geometric channel models. The Field-to-Lab tool lets you replay measured radio conditions in a lab environment instead of using standard models (Figure 10).

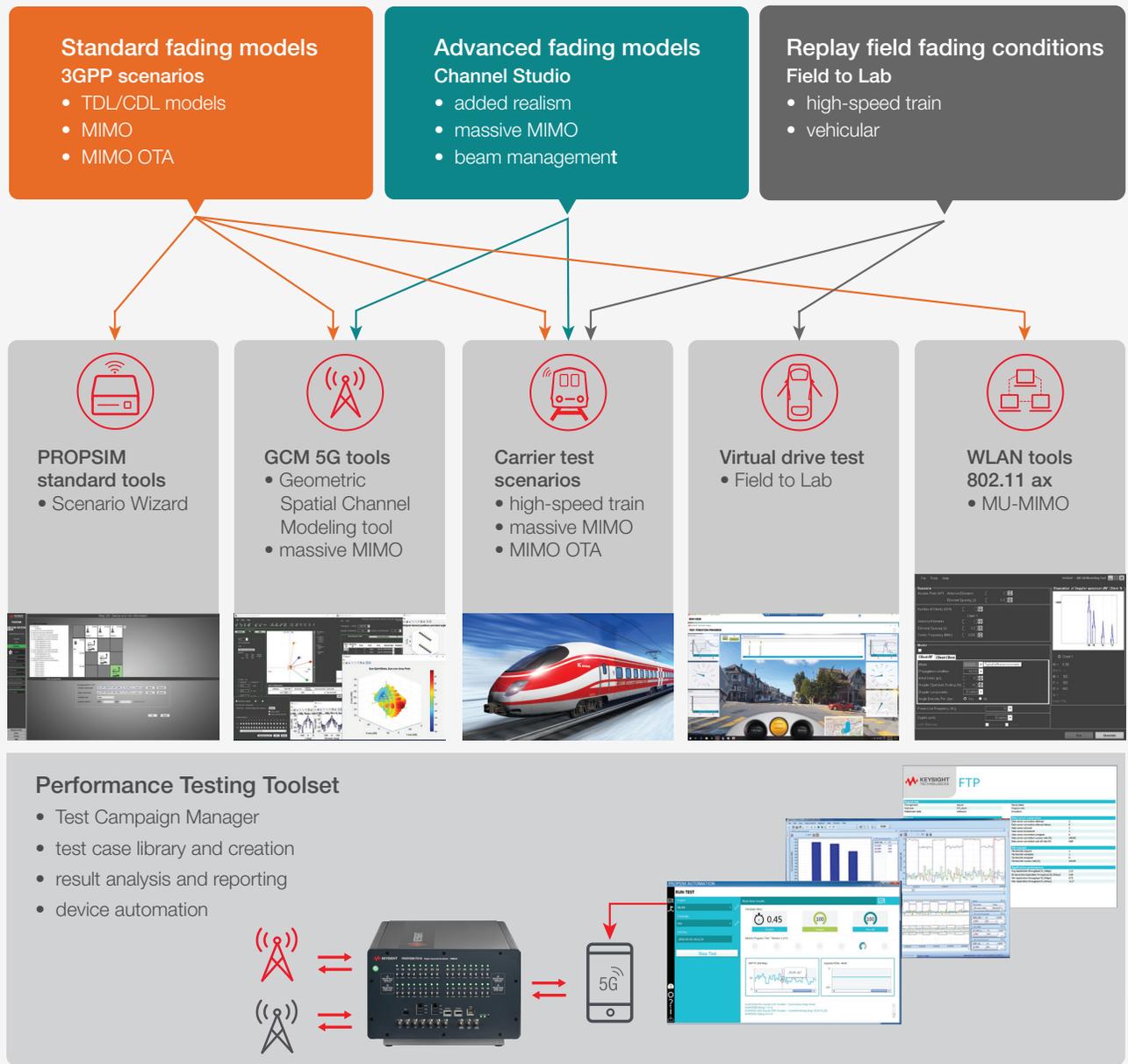


Figure 10. Keysight Channel Emulation tools span industry-defined and advanced channel models while enabling efficient testing 24/7



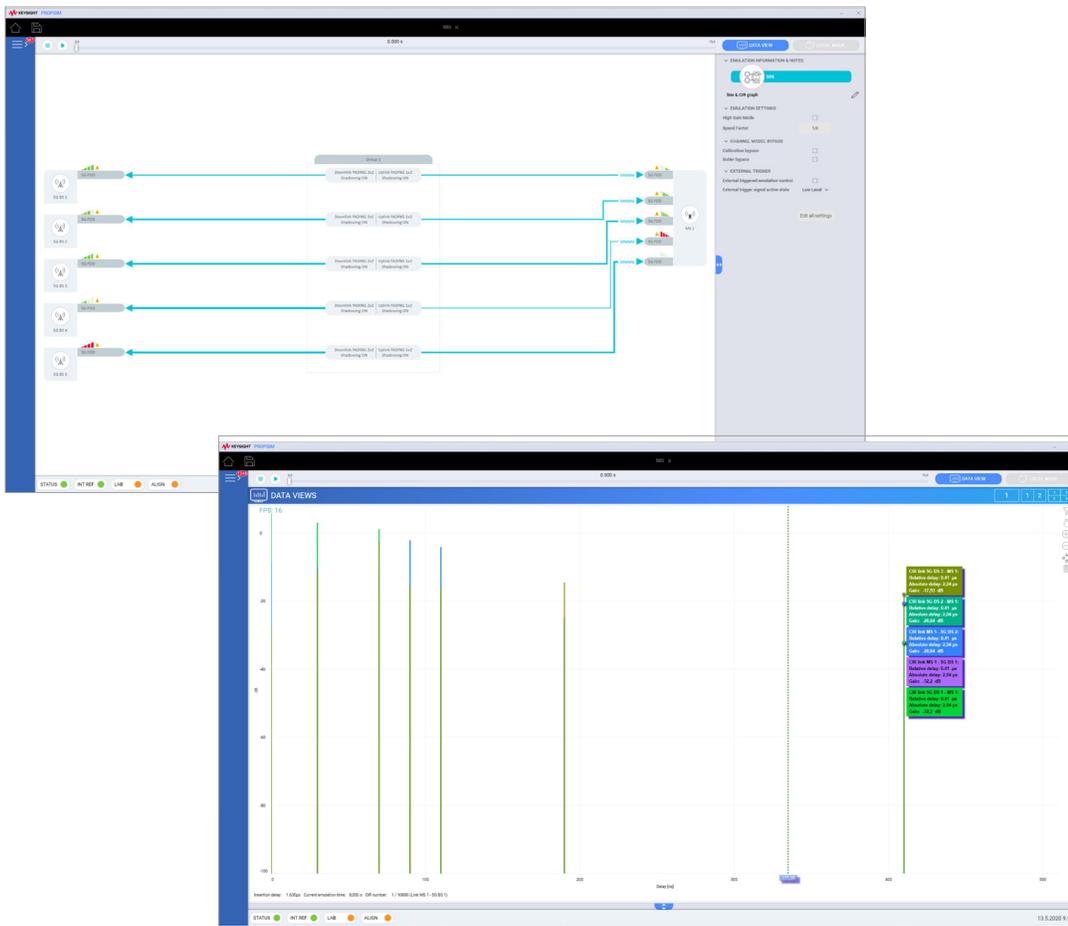
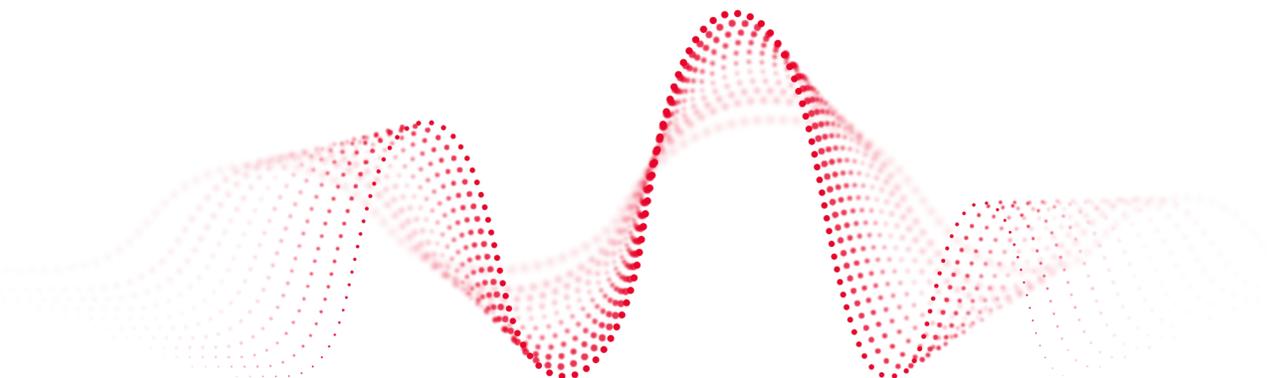


Figure 12. Running View enables you to see the created emulations and control and modify the emulation process easily



# Simplify Complex Testing without Sacrificing Modeling Accuracy

## PROPSIM Geometric Channel Modeling tool

PROPSIM's Geometric Channel Modeling (GCM) tool enables you to create multi-link test scenarios for wireless testing easily.

User-defined 3D spatial scenarios and dynamic modeling of movement for 5G NR frequency range 1 (FR1) and frequency range 2 (FR2), and Long Term Evolution-Advanced (LTE-A) testing use the following models from 3GPP TR38.901/TR36.873:

- urban micro (UMi), urban macro (UMa), outdoor to indoor (O2I), and indoor to outdoor (I2O)
- clustered delay line (CDL) and tapped delay line (TDL)
- WINNER
- spatial channel model extension (SCME)

GCM software (Figure 13) also supports ray-tracing data import and 3D antenna parameter inclusion into the channel model.

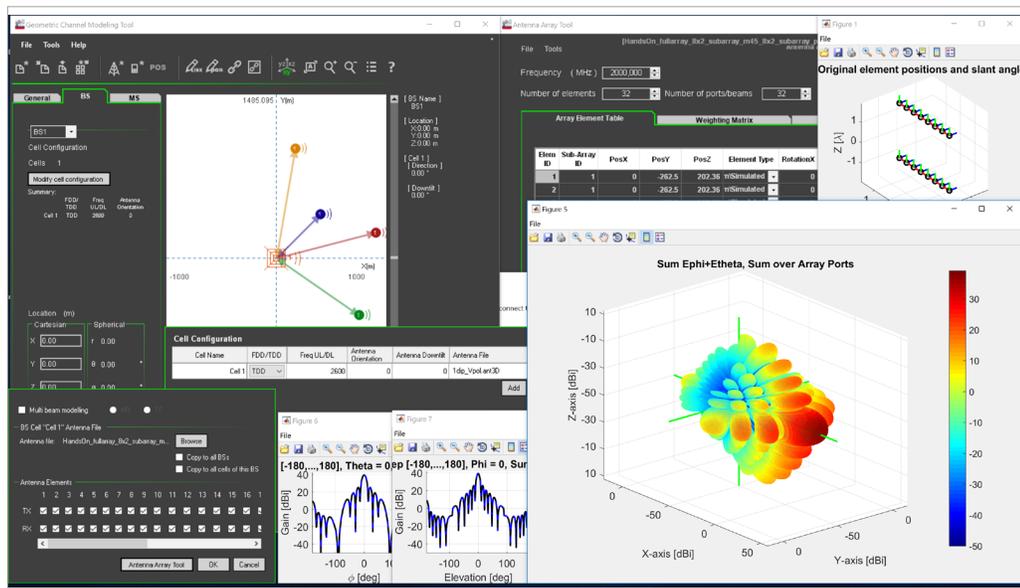


Figure 13. PROPSIM GCM software

For example, GCM enables testing of all radios in a connected car. It offers 3GPP-defined channel models to test vehicle-to-everything (V2X) safety applications as well as onboard Wi-Fi and cellular connections. The software also supports device-to-device, V2X topologies, and 3GPP channel models for automotive testing.

Continuously updated, this future-proof platform is ready for 3GPP 5G NR non-terrestrial networks (NTN) Release 17 study item. The platform is ideal for asymmetric satellite link modeling. Optional aerospace functionality enhances the link characteristics to match the challenging conditions of satellite link testing.

## WLAN 802.11ax end-to-end performance testing

Performance validation of advanced features, as introduced in the 802.11ax standard, implies realistic test scenarios and propagation conditions. Keysight's PROPSIM FS16 Channel Emulation Solution offers superior EVM performance when conducting tests using a 1024-QAM modulation scheme. You can easily verify system performance in dense deployments that leverage beamforming technology and MU-MIMO in both the up- and downlink.

PROPSIM FS16 supports client and access points with a signal bandwidth of up to 320 MHz in all available unlicensed bands. PROPSIM WLAN tool offers an easy way to create different test topologies by providing standard-specified channel models. Today's advanced use cases, such as drones flying with high speed, require tools beyond standards. With PROPSIM's GCM tool, you can create more advanced 3D spatial scenarios that include beamforming and dynamic movement (Figure 14).

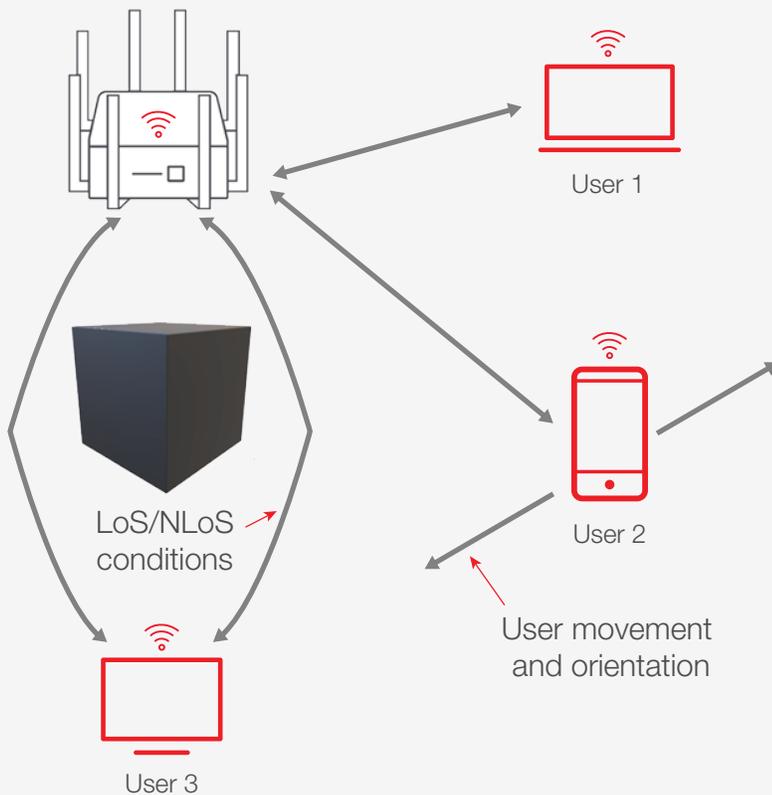
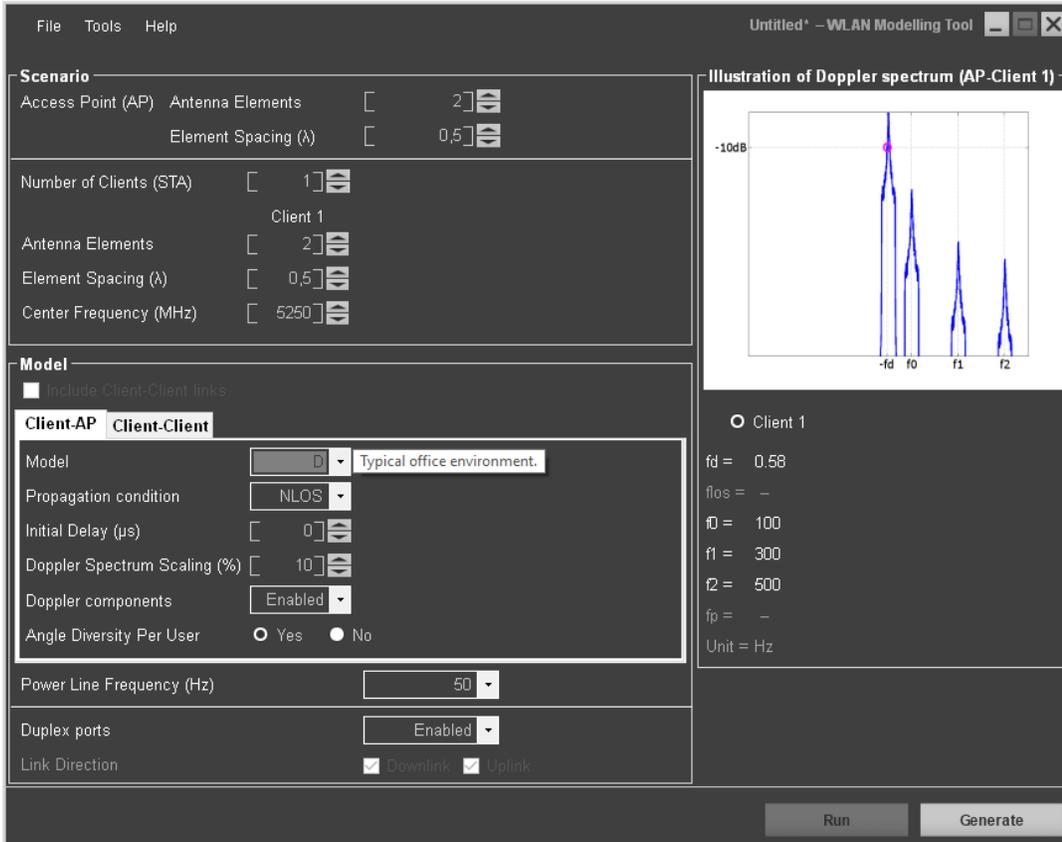


Figure 14. Wi-Fi beamforming and MIMO testing

## Introduction to WLAN modeling tool

The WLAN modeling tool enables you to define test scenario parameters for standard 802.11ax models. It supports MU-MIMO configurations allowing multiple clients with different antenna configurations (Figure 15).



The screenshot displays the 'WLAN Modelling Tool' interface. The window title is 'Untitled\* - WLAN Modelling Tool'. The interface is divided into several sections:

- Scenario:** Contains input fields for 'Access Point (AP)' parameters: 'Antenna Elements' (set to 2) and 'Element Spacing ( $\lambda$ )' (set to 0,5). Below this, 'Number of Clients (STA)' is set to 1. Under 'Client 1', 'Antenna Elements' is 2, 'Element Spacing ( $\lambda$ )' is 0,5, and 'Center Frequency (MHz)' is 5250.
- Model:** Includes a checkbox for 'Include Client-Client links'. It has two tabs: 'Client-AP' (selected) and 'Client-Client'. Under 'Client-AP', 'Model' is 'Typical office environment.', 'Propagation condition' is 'NLOS', 'Initial Delay ( $\mu$ s)' is 0, 'Doppler Spectrum Scaling (%)' is 10, 'Doppler components' is 'Enabled', and 'Angle Diversity Per User' has radio buttons for 'Yes' and 'No'. Below the tabs, 'Power Line Frequency (Hz)' is 50, 'Duplex ports' is 'Enabled', and 'Link Direction' has checked boxes for 'Downlink' and 'Uplink'.
- Illustration of Doppler spectrum (AP-Client 1):** A plot showing a central peak at  $f_0$  and side lobes at  $-f_d$ ,  $f_1$ , and  $f_2$ . The y-axis is labeled '-10dB'. Below the plot, 'Client 1' is selected, and parameters are listed:  $f_d = 0.58$ ,  $f_{los} = -$ ,  $f_0 = 100$ ,  $f_1 = 300$ ,  $f_2 = 500$ ,  $f_p = -$ , and 'Unit = Hz'.

At the bottom right, there are 'Run' and 'Generate' buttons.

Figure 15. WLAN tool

## Virtual drive testing — RF field to lab

Keysight's Virtual Drive Testing (VDT) solution enables you to easily bridge the gap between lab and field testing by bringing realistic air-interface conditions in the lab, accelerating the validation of wireless devices and network equipment (Figure 16). The VDT toolset offers repeatable and realistic lab-based tests to verify multiple designs or revisions of a single design cost-effectively and quickly. You can create test scenarios based on any cellular radio technology and apply a wide range of multi-link configurations.

Replicate real-world radio channel conditions with the RF Field to Lab tool:

- supports real user equipment measurements
  - select field logs – no additional user input required
  - replay any cellular technology from GSM to NR
- optimize with RF Field to Lab Studio
  - set technology and frequency for each available lab link/cell
  - generate emulation as recorded or remove sections like in your favorite video editor
- create a test scenario for data or voice with device automation
  - includes a template to create File Transfer Protocol (FTP) data throughput test case
  - includes a template to create voice call performance and quality (MOS score)

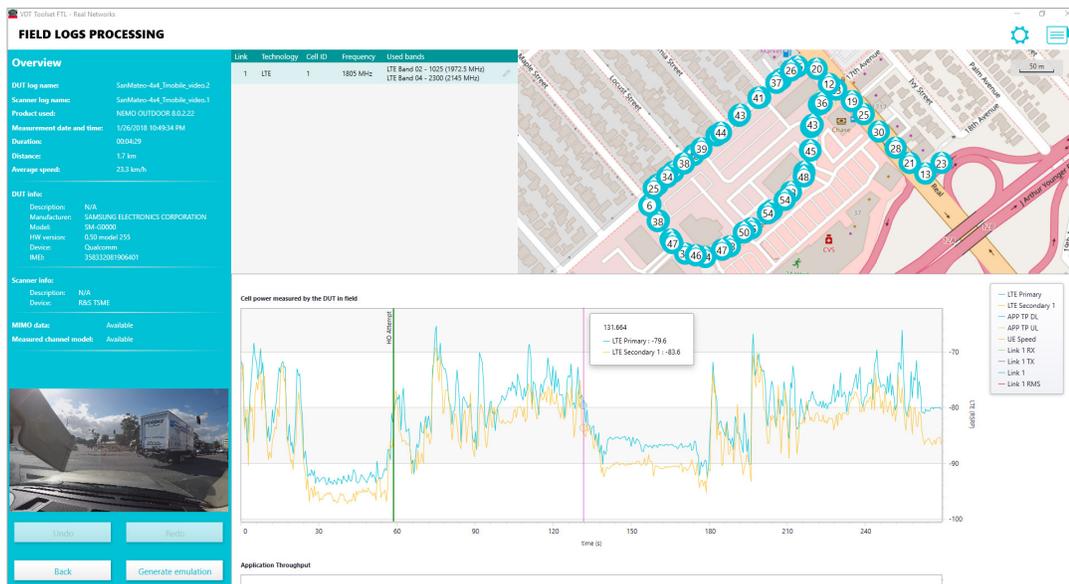


Figure 16. Field-to-lab tool importing field-measured conditions into the lab

## Performance Testing Toolset

Keysight's Performance Testing Toolset accelerates lab testing by offering 24/7 execution of test scenarios with device control and logging capabilities. You can execute ready-made test cases or create custom performance and interoperability test cases for 5G/Wi-Fi devices and live base stations in the lab. The Performance Testing Toolset supports multi-UE control, testing, trace logging, and test application logging. The toolset supports automatic device under test benchmarking analysis and reporting as well pass/fail report creation. You can control the toolset with your own proprietary higher-level test automation framework and peripherals in the test setup.

Automate your lab testing for efficient use of time and equipment (Figure 17):

- Performance Test Manager software: oversees test scenarios, including an overview of the test campaign progress and results.
- Device automation: enables 24/7 test execution with real devices.
- Test applications: stress test devices like end users with FTP, Internet Performance Working Group (IPERF), Web, WhatsApp, and other applications.
- Results analysis and reporting: high-level pass/fail reports at the test campaign level, storing each test into your database for benchmarking analysis. Log files for each test run enable detailed information for debugging.

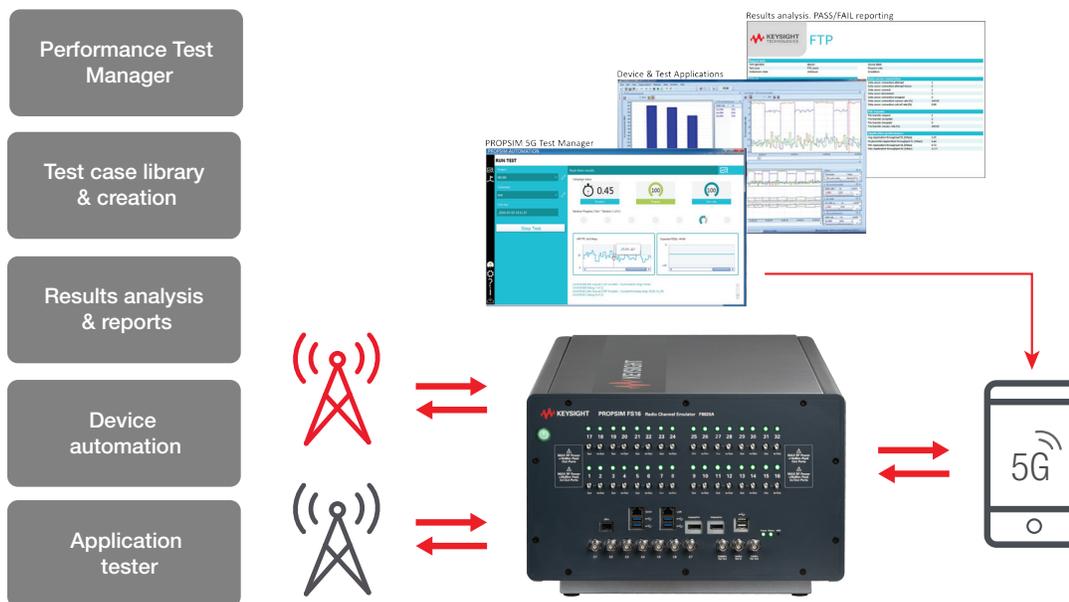


Figure 17. Performance testing tools

## PROPSIM FS16 Channel Emulation Solution

PROPSIM FS16 is a compact, scalable solution enabling the emulation of the real-world air interface with all its imperfections. You can create a stress test environment that will test actual applications under a broad range of conditions.

FS16 integrates seamlessly with wireless test systems and offers realistic and repeatable end-to-end performance testing in the laboratory:

- modular RF emulator - single unit from 2 TRx + 2 Tx up to 16 TRx + 16 Tx
- EVM < -50 dB
- efficient for uni- and bidirectional fading testing
- supports all 5G NR bands and bandwidths with seamless RF range from 3 to 6,000 MHz
- testing in the lab with real infrastructure

Emulate impairments of complex 3D real-world radio channel conditions:

- dynamic multipath propagation
- range path loss and blocking effects
- Doppler from mobility
- noise and synchronous programmable interference (virtual cells and users)

You can operate the PROPSIM FS16 channel emulator with a remote control or by using the GUI. Remote access requires the Keysight Test Automation on PathWave (TAP) plugin or standard commands for programmable instruments (SCPI).

Keysight's software tools enable you to create custom test scenarios and automate tests easily to meet aggressive 5G development schedules.



## Keysight 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](http://www.keysight.com/find/5G).

- For more information about Keysight's PROPSIM FS16, visit [www.keysight.com/find/PROPSIM](http://www.keysight.com/find/PROPSIM)
- For more information about Keysight's PathWave, visit [www.keysight.com/find/pathwave](http://www.keysight.com/find/pathwave)
- For more information on the M1740A mmWave transceiver, visit [www.keysight.com/find/m1740a](http://www.keysight.com/find/m1740a)
- For more information on the E7770A Common Interface Unit, visit [www.keysight.com/find/e7770a](http://www.keysight.com/find/e7770a)

Keysight's 5G Network Emulation Solutions leverage the Keysight E7515B UXM 5G Wireless Test Platform. To learn more, please visit [www.keysight.com/find/NES](http://www.keysight.com/find/NES).

The 5G solutions include the following:

- 5G Protocol R&D Toolset  
[www.keysight.com/find/5g-protocol](http://www.keysight.com/find/5g-protocol)
- 5G Protocol Conformance Toolset  
[www.keysight.com/find/5g-protocol-conformance](http://www.keysight.com/find/5g-protocol-conformance)
- 5G RF/RRM DVT & Conformance Toolset  
[www.keysight.com/find/5g-rf-conformance](http://www.keysight.com/find/5g-rf-conformance)

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