SOLUTION BRIEF

S8815A WLAN RF and Data Performance Toolset

Validate the performance of new Wi-Fi 7 features under uncompromised, real-world channel conditions

KEYSIGHT

Introduction

The latest industry standards for WLAN have enabled significant improvements in speed, reliability and quality of wireless connectivity on commercial WLAN products. While for consumers the upgrade from Wi-Fi 5 (802.11ac) to Wi-Fi 6 and 6E (802.11ax) is a fairly new thing, the next generation Wi-Fi 7 (802.11be) is already being developed for commercial use. Wi-Fi 6E added available capacity for crowded areas by extending frequency range with the new 6GHz band. Wi-Fi 7 promises notable improvements to Wi-Fi 6E, such as a wider channel bandwidth up to 320 MHz, higher order modulation (4096-QAM), multi-link operation, and automatic frequency coordination. The table below demonstrates the key differences between different Wi-Fi generations:

Wi-Fi generations

	Wi-Fi 4	Wi-Fi 5	Wi-Fi 6	Wi-Fi 6E	Wi-Fi 7 (Expected)
IEEE standard	802.11n	802.11ac	802.11ax	802.11ax	802.11be
The first revision of standard	2007	2013	2019	2021	2024
Max data rate	1.2 Gbps	3.5 Gbps	9.6 Gbps	9.6 Gbps	46 Gbps
Bands	2.4 GHz and 5 GHz	5 GHz	2.4 GHz and 5 GHz	6 GHz	2.4 / 5 / 6 / 7 GHz
Channel bandwidth	20,40 MHz	20,40,80,80+80, 160 MHz	20, 40, 80, 80+80, 160 MHz	20, 40, 80, 80+80, 160 MHz	20, 40, 80, 160, 320 MHz
Modulation	64-QAM	256-QAM	1024-QAM	1024-QAM	4096-QAM
MIMO	Up to 4x4 MIMO	Up to 4x4 MIMO, DL MU-MIMO	Up to 8x8 UL/DL MU-MIMO	Up to 8x8 UL/DL MU-MIMO	Up to 16x16 MU-MIMO

Source: IEEE, Wi-Fi Alliance

WLAN 802.11 standard is rapidly evolving, and new technologies are constantly deployed to reach higher data rates. To stay ahead of the competition, chipset and device manufacturers must be able to conduct quick testing in the R&D process. The S8815A WLAN RF and Data Performance Toolset provides industry-leading tools for testing WLAN products rapidly and reliably before market launch.

Wi-Fi testing challenges

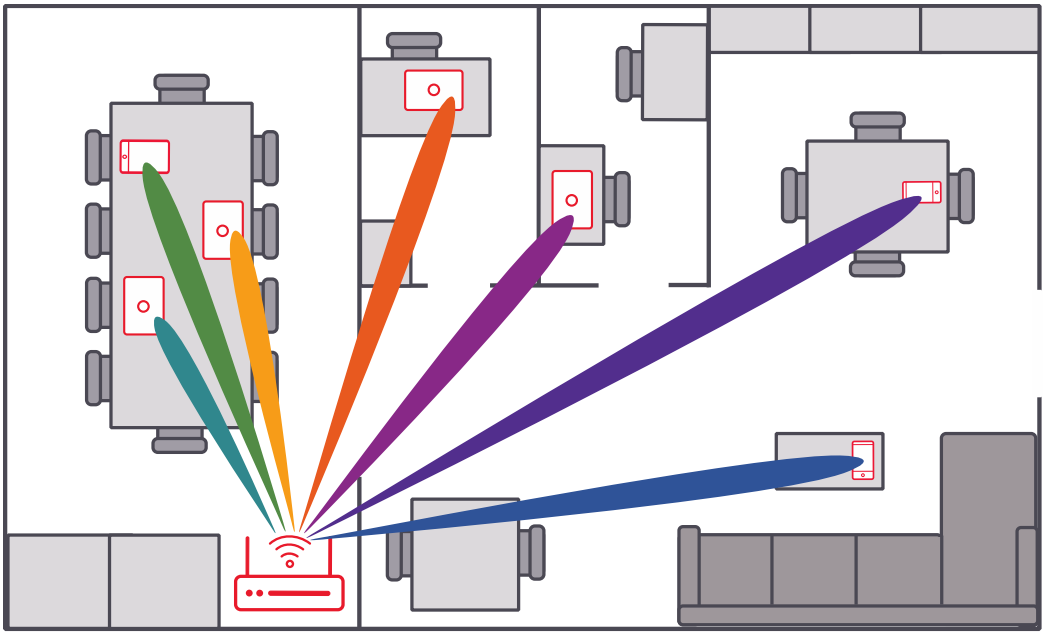

Figure 1. Wi-Fi 7 improves spectral efficiency with up to 16 spatial streams for Multi-User (MU) MIMO offering improved throughput for congested environments.

One of the objectives of Wi-Fi 7 is to deliver Extremely High-Throughput (EHT). Enabling low latency and wide bandwidth, EHT which will be essential for real-time apps and services. High throughput is achieved with wider channel bandwidths and a higher modulation scheme. These enhancements require a new level of RF performance from the equipment itself, and especially from the test instruments – the throughput must be verified in real-world conditions, and 4096 QAM modulation requires high EVM performance from the test instrument.

Wi-Fi 7 introduces the capability to allocate more than one resource units to a single user. This Multilink Operation (MLO) increases throughput by using several physical links in parallel. In addition, MLO devices with two or more radios can simultaneously transmit and receive on different links, allowing shorter delay with higher throughput. Multilink operation enables more effective utilization of the spectrum, and controlled and realistic real-world conditions are needed to verify multilink operation in practice.

Verification and debugging of the new physical layer (PHY) features, such as multilink operation, require a realistic signal snapshot with visibility into the real stack. Finding issues effectively requires simultaneous signal capture from both client's and access point's sides in a real-world test scenario. Without the right tools and a repeatable environment, debugging can be very time consuming and it may be impossible to find out where the message is corrupted during the transmission.

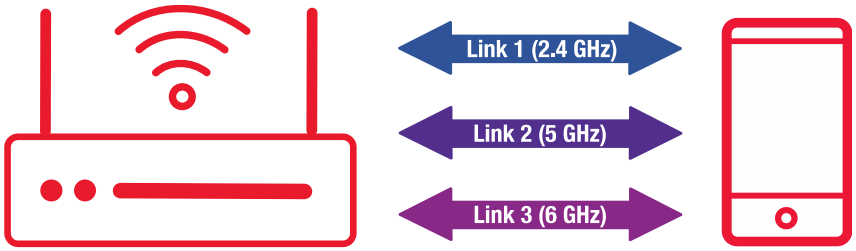

Figure 2. Additional unlicensed spectrum and a new MAC layer features introduced in Wi-Fi 7 enable MLO operation offering multiple links between a client and an access point.

S8815A WLAN RF and Data Performance Toolset

The S8815A WLAN RF and Data Performance Toolset enables chipset and device manufacturers as well as test labs to validate the interoperability and performance of the new WLAN features and products under uncompromised and complex real-world 3D propagation channel conditions.

Test automation of the S8815A WLAN RF and Data Performance Toolset enables 24/7 end-to-end interoperability and data performance testing between real access points and real devices. It supports testing multiple access points and devices to mimic real-world RF mobility and interference impairment conditions.

The S8815A toolset is extendable to perform RF MIMO measurements of Wi-Fi access points and Wi-Fi devices with an embedded signal analyzer and signal generation capabilities using Keysight's PathWave VSA High Throughput WLAN Modulation Analysis and PathWave Signal Generation for WLAN 802.11 measurement software.

When integrated with the S8815A toolset, Keysight WaveJudge Wireless Analyzer allows design and verification engineers to gain visibility into protocol and physical layer interaction in wireless transmissions. You can pinpoint PHY and protocol layer issues by importing and decoding PROPSIM IQ captures for troubleshooting and analysis.

Who benefits from using the S8815A toolset?

The Wi-Fi 7 standard enables the industry to push high speed data with very low latencies across the devices used in homes, offices, and public spaces. Some even claim that Wi-Fi 7 is the missing piece to what is called the *Metaverse* - an interaction in the digital world enabling advanced IoT applications, state-of-the-art medical applications, and gaming, to name a few. As a result, it is not just the traditional Wi-Fi chipset and access point manufacturers that need to verify their designs.

With the S8815A toolset, the manufacturers of virtual reality headsets and other new age consumer electronic devices can verify end user experience in a realistic and repeatable test environment. The automotive industry can ensure that in-car entertainment and software updates work seamlessly. Network operators and mobile device vendors can ensure effective offloading of traffic from a cellular network to Wi-Fi whenever available. The S8815A toolset enables controlled end-to-end testing of access points and devices in realistic user scenarios with a simultaneous access to RF MIMO measurements and signaling.

What does the S8815A toolset offer?

The toolset offers:

- Future-proof solution for Wi-Fi 6E and 7 performance testing
- Industry-leading channel emulation solution with the highest RF precision and the highest emulation capacity in the world
- Channel Studio WLAN channel modeling tool (IEEE models)

The toolset is extendable to:

- Channel Studio 3D Geometric Channel Modeling (Channel Studio GCM) tool for easy data throughput test case creation with MIMO and beamforming
- Visibility to 802.11be stack from PHY to upper layers with the WaveJudge wireless analysis tool
- MIMO TX and RX in-band RF MIMO measurements of Wi-Fi access points and devices
- End-to-end interoperability and data performance testing between real access points and real devices
- 24/7 testing for validating new product releases and verifying the performance of design implementation of new features prior to delivery and deployments

Hardware Components

PROPSIM F64 Channel Emulator

PROPSIM FS16 Channel Emulator

Test System PC F9000A

Figure 3. S8815A hardware components

Keysight's S8815A WLAN RF and Data Performance Toolset is built around the scalable PROPSIM platform. The benchtop model PROPSIM FS16 supports link level testing, and for more complex setups the industry leading PROPSIM F64 offers a scalable platform with up to 64 ports in a single chassis.

The PROPSIM channel emulation solution offers up to:

- MIMO and MU-MIMO topologies 2x2, 4x4, 8x8, 16x16
- Superior EVM up to < -50dB
- 802.11be up to 4096 QAM supported
- RF range 0.45 - 7.25GHz
- Signal BWs 160/320MHz up to 1600MHz aggregated

Figure 4. Lab setup example (F64-64ch): One 16x16 with bi-directional 160MHz links

Figure 5. Lab setup example (FS16-16ch): Single-link operation using multiple resource units (RU) for single user is introduced in 802.11be. Setup to test 4x4 bi-directional 320MHz links

Data Throughput Testing

The S8815A WLAN RF and Data Performance Toolset supports end-to-end interoperability and data performance testing between real access points and real devices. In the example illustrated in Figure 6, a data server PC is connected to an access point, and a data throughput range vs. rate test is conducted using three different WLAN 802.11 channel models. The toolset enables detailed RF signal analysis from physical layer to higher layers with Keysight analysis software, simultaneously while testing data throughput performance.

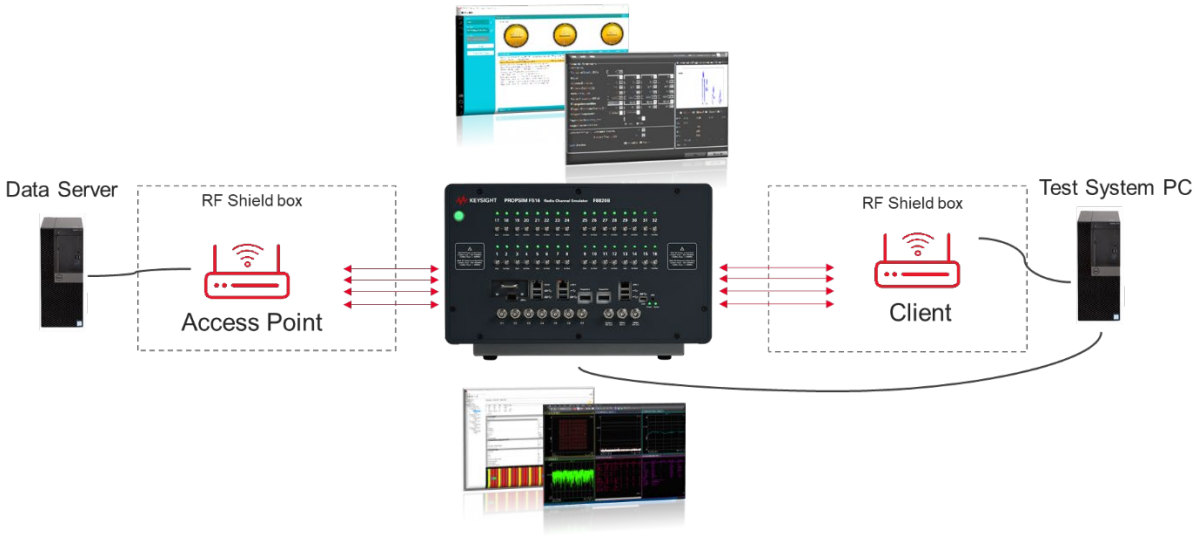

Figure 6. Performance test manager F934000A in the test system PC offers test campaign management, control of the emulator, and test applications.

In the range vs. rate test, application throughput is measured while power level drops until the connection is lost. The Butler channel model represents ideal channel conditions - B-NLOS models residual environment and C-LOS models a small office environment as defined in the IEEE Wi-Fi standard. The integrated WaveJudge wireless analyzer enables troubleshooting of physical layer and application layer issues.

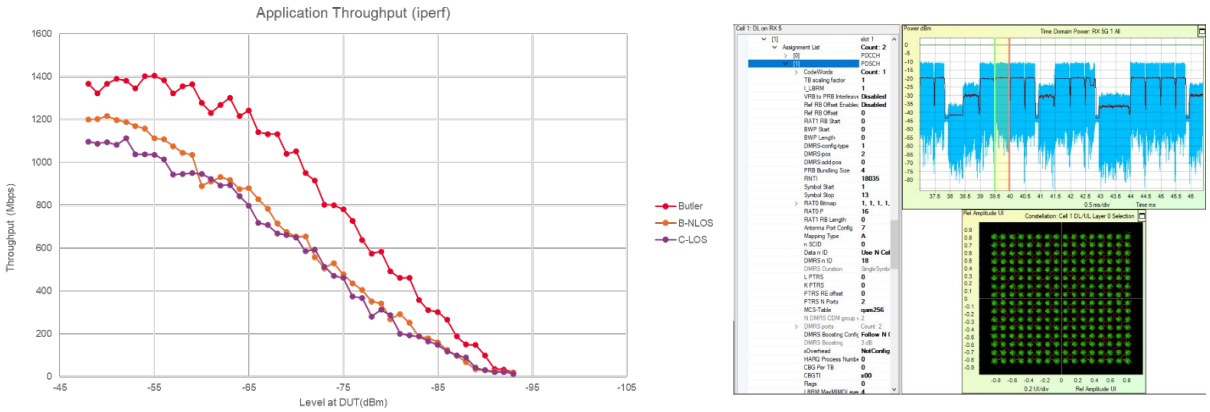

Figure 7. Application throughout measurement with a range vs. rate test and physical layer analysis with WaveJudge.

Key Software Components

Channel Studio WLAN Modeling Tool

The F9860300A Channel Studio WLAN Modeling Tool is a user-friendly application for generating standard 802.11n/ac/ax models. It supports MU-MIMO and different antenna configurations. The tool also provides models based on High Throughput Task Group documents (IEEE 802.11-03/940 & IEEE 802.11-09/0308).

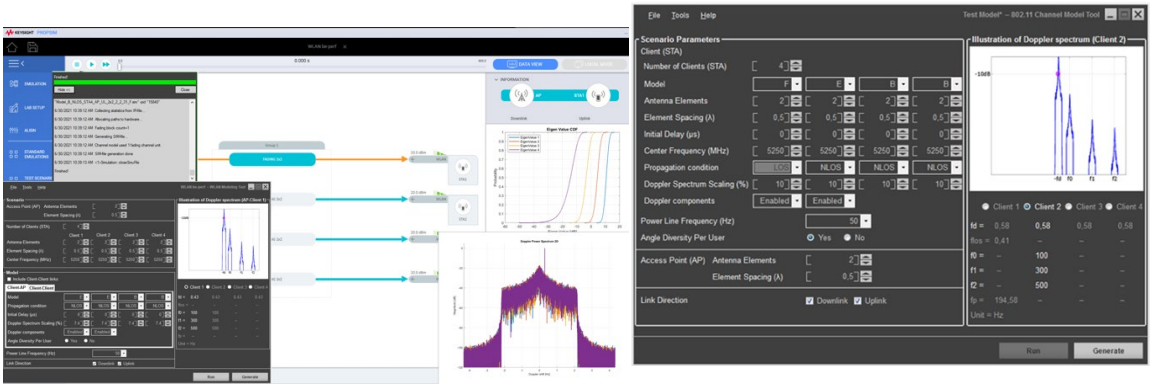

Figure 8. The user interface of Channel Studio WLAN Modeling Tool

Channel Studio Geometric Channel Modeling Tool

Extend your S8815A toolset with the state-of-the-art radio propagation channel modeling software F9860000A Channel Studio Geometric Channel Modeling tool. The tool offers device-to-device topologies for advanced Wi-Fi performance testing. It also supports importing 3D antenna models and includes Wi-Fi channel models enabling dynamic modeling of movement and beamforming.

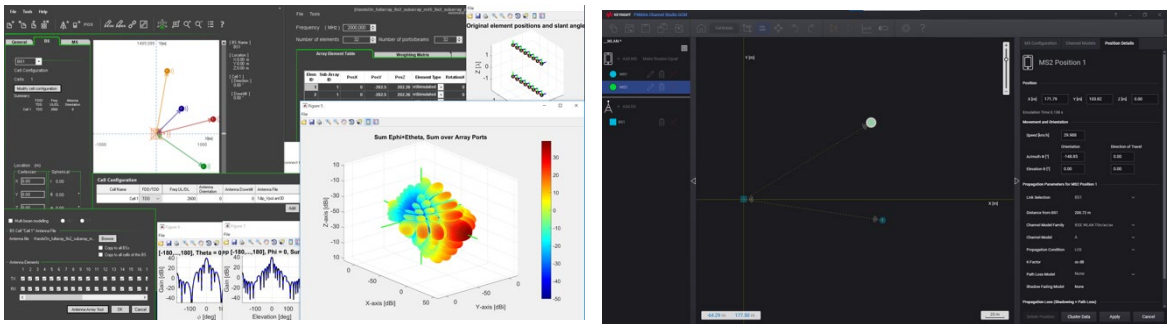

Figure 9. The user interface of Channel Studio Geometric Channel Modeling Tool

Performance Test Manager

The Performance Test Manager (PTM) F934000A enables fully automated end-to-end lab testing with real applications. PTM controls the device under test (DUT) and channel conditions created by PROPSIM during test runs and collects KPI data from the DUT. With ready-made or user-defined test scripts, you can create a variety of test cases. Moreover, PTM generates a textual report of each test case from the selected KPIs.

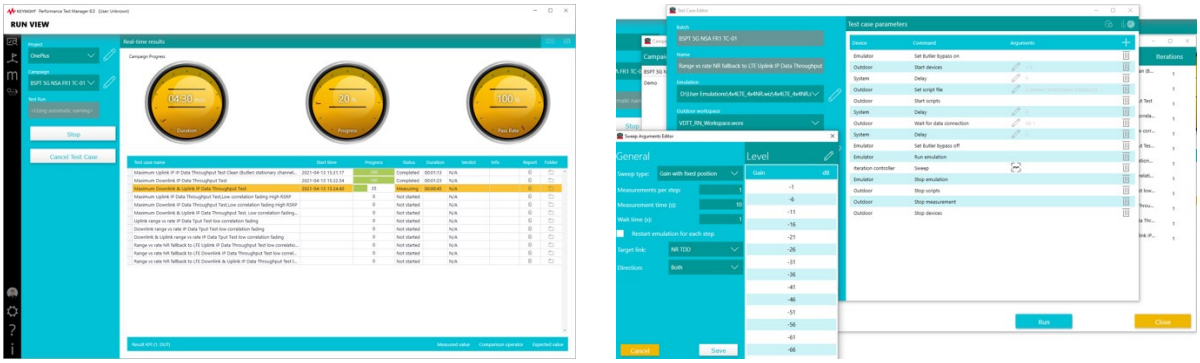

Figure 10. The user interface of Performance Test Manager

Extend the S8815A Toolset

Integrated with the S8815A toolset, Keysight WaveJudge Wireless Analyzer allows design and verification engineers to gain visibility into protocol and physical layer interaction in wireless transmissions. WaveJudge offers a powerful graphical user interface that simplifies the test setup and configuration.

Using the Keysight WaveJudge Wireless Analyzer, you can:

- Identify and analyze complex antenna schemes including MIMO and beamforming
- Compare expected vs. received frame structure and identify allocation issues
- Synchronize and reference signal errors
- Visually inspect scheduler performance
- Capture the attach process beginning with UL power
- Trace the bytes as they move through the MAC, RLC and PDCP layers

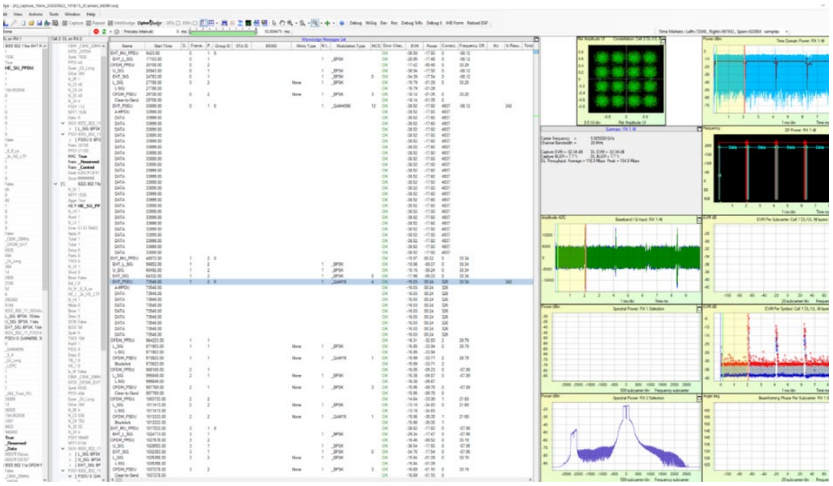

Figure 11. WaveJudge Software User Interface

With the PathWave VSA High Throughput WLAN Modulation Analysis software you can demodulate and evaluate error vector measurements of your IEEE 802.11n/ac/ax WLAN signals including advanced capabilities such as 8x8 MIMO. The software forms a vector signal analysis and visualizes signal quality with multiple domain traces in time, spectrum, and modulation based on PROPSIM measurements.

Figure 12. PathWave VSA Software User Interface

The PathWave Signal Generation software for WLAN 802.11 allows you to generate, export, download, and playback Wi-Fi 7 waveforms with the PROPSIM platform. PathWave Signal Studio enables flexible signal configuration with both single-carrier and multi-carrier support.

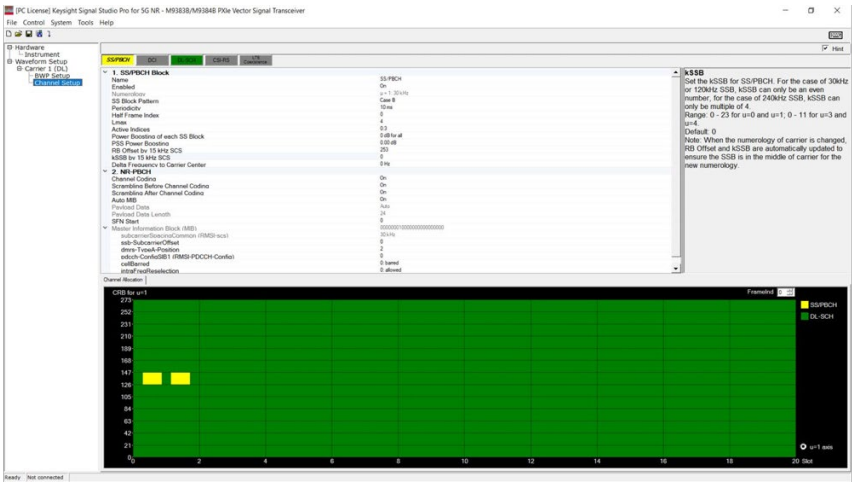

Figure 13. PathWave Signal Studio Software User Interface

Keysight Wireless Solutions

Keysight's wireless end-to-end design and test solutions enable the mobile industry to accelerate wireless 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 and IEEE standards, enabling the ecosystem to quickly and accurately validate wireless technologies. You can test chipsets, devices, base stations, and networks, as well as emulate subscriber behavior scenarios.

- For more information about Keysight's S8815A WLAN Data and RF Performance Toolset, visit http://www.keysight.com/find/S8815A
- For more information about Keysight's WaveJudge Wireless Analyzer software visit https://www.keysight.com/zz/en/product/SJ001A/wavejudge-5000.html
- For more information about Keysight's PathWave VSA High Throughput WLAN Modulation Analysis, visit www.keysight.com/us/en/product/89601BHXC
- For more information about Keysight's PathWave Signal Generation software for WLAN 802.11, visit www.keysight.com/us/en/product/N7617EMBC
- For information about Keysight's Wi-Fi access point test platform, visit www.keysight.com/us/en/products/network-test/network-test-hardware/wavetest-6

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