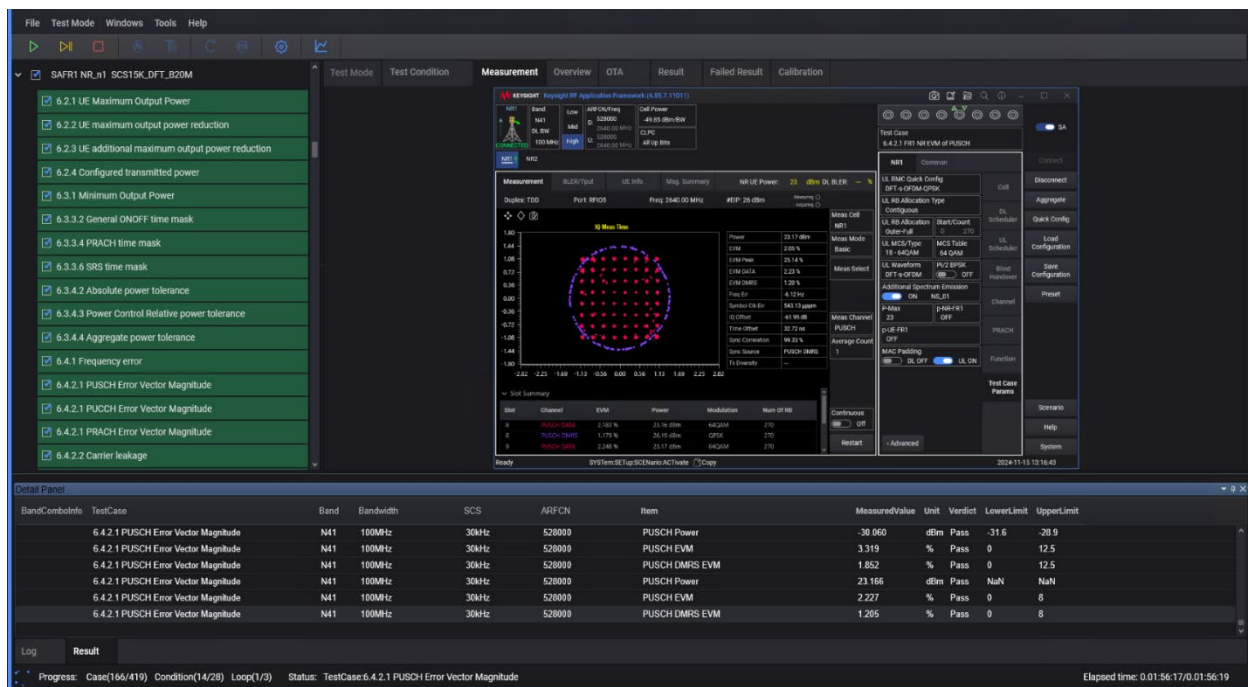


S8702A RF Automation Toolset

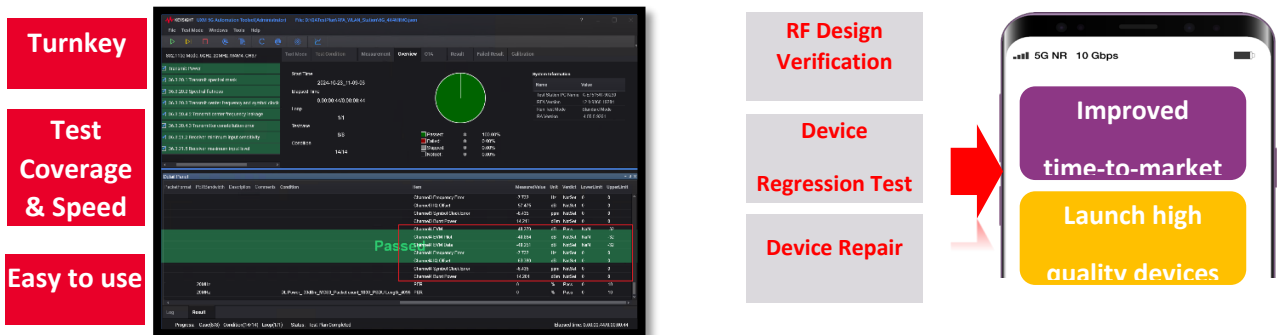
Benchmark Automation Toolset to Verify Device Performance

Keysight's RF Automation Toolset leverages the UXM 5G Wireless Test Platforms to provide users with a comprehensive range of tests to quickly verify the Transmitter (Tx) and Receiver (Rx) performance of 5G New Radio (NR) and 4G LTE devices in accordance with the 3GPP specifications as well as WLAN devices in accordance with IEEE specifications. The toolset forms part of Keysight's suite of 5G network emulation solutions and offers a flexible and easy-to-use software environment.



Accelerating RF Transmitter and Receiver Tests for Cellular Devices

Testing cellular devices today requires deep knowledge of the radio access technologies such as LTE, 5G NR, NB-IOT as well as the related 3GPP test specifications. The complexity of testing is compounded by the addition of other technologies such as Wireless LAN (WLAN) and improvements such as Non-Terrestrial Networks (NTN). A versatile RF design verification test solution adapts to evolving cellular and WLAN standards, scales to address sub-7 GHz and mmWave frequencies, and provides optimized testing times to quickly verify a device's RF performance and identify design issues.



Keysight's RF Automation (RFA) Toolset is a comprehensive RF design verification solution that supports Transmitter and Receiver tests for 5G NR, 4G LTE, NB-IOT, NB-NTN radio access technologies based on the latest 3GPP 38.521 (5G NR, C-V2X) / 36.521-1(4G LTE) / 36.521-4 (NB-IOT) test specifications respectively. RFA also supports Transmitter and Receiver tests for WLAN based on 802.11a/b/g/n/ac/ax/be. The toolset relies on the Keysight E7515B, E7515W or E7515P UXM 5G Wireless Test Platforms and uses its built-in RF Application (RA) or Test Application (TA) Framework software environment. Keysight's E7770A Common Interface Unit, M1740A or M1749A mmWave Transceivers, and test chamber extend the test range to mmWave frequencies.

RFA highlights

- Cost-effective tests with comprehensive coverage
 - Test case coverage of 5G NR, LTE, RedCap, NB-NTN, Wi-Fi, C-V2X, WLAN
 - Low-cost benchtop tool for design verification
- Intuitive and easy-to-use graphical interface
 - Real time results. Test reports in .xls, .csv and .pdf formats
 - RFA analytics for detailed result visualization and analysis
- Accelerated time-to-market
 - Dependable and repeatable with optimized test speeds for early detection of design issues

Based on the Test Application (TA) & RF Application (RA) Framework

Keysight's S8714A RF Application (RA) Framework & 5G S8711A Test Application (TA) allow both, touch-based and remote control of the UXM 5G network emulator. The RFA Toolset uses this underlying RA or TA Framework to control the UXM 5G Network Emulator (NE) and provide a suite of fully automated Transmitter and Receiver tests that are based on the 3GPP TS 38.521 (5G NR) / 36.521 (4G LTE) test specifications.

A number of operation modes support a wide range of tests. These range from non-signaling for UE Calibration to full signaling tests, providing a comprehensive set of features for engineers designing RF components and devices. The framework supports 4G LTE as well as both 5G deployment modes, Non-Standalone (NSA) and Standalone (SA). RFA full signaling test mode enables users to perform RF measurements while a call is in progress.



Figure 1. Screen capture illustrating collection on Keysight's 5G RF Application Framework

RF Automation Toolset – Key Features

Keysight's RF Automation Toolset extends the capabilities of the 5G Test Application and 5G RF Application by providing:

- An intuitive and easy-to-use graphical user interface for creating, configuring and running test campaigns.
- A suite of fully automated RF Transmitter and Receiver tests, based on the 3GPP TS 38.521 / 36.521 for 5G NR(FR1 & FR2) and 4G LTE respectively.
- Comprehensive coverage to verify performance for WLAN (Wi-Fi) devices from 802.11 through to 802.11be (Wi-Fi 7)
- Support for connected and Over-the-Air (OTA) tests
- Optimized test execution times, enabling quick inspection of the RF performance of devices.
- A report generator in different formats to summarize the results of test campaigns.
- Support for both 4G LTE and 5G (Non stand alone and Standalone modes) in the same network emulator, providing a small footprint benchtop solution.
- Test cases for NB-NTN, RedCap and legacy NB-IOT devices.
- Interactive dashboard analytics to view and analyze the results and identify trends in testing.
- State-of-the art logging, visualization and debugging tools.
- Flexible licensing options and tools

Campaign Creation

The RF Automation Toolset user interface allows users to easily create test campaigns by simply adding one or more test modes (e.g. NSA FR1, NSA FR2, SA FR1). This is followed by selecting the target tests and specifying the key network parameters for each test mode, e.g. duplex mode, frequency band, channel bandwidth, high/mid/low band channels, and Sub-Carrier Spacing (SCS).

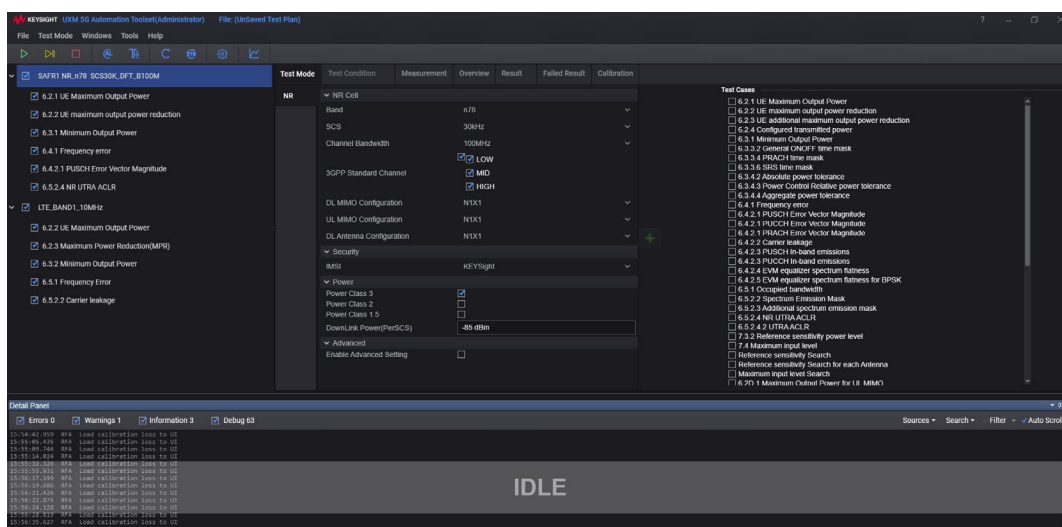
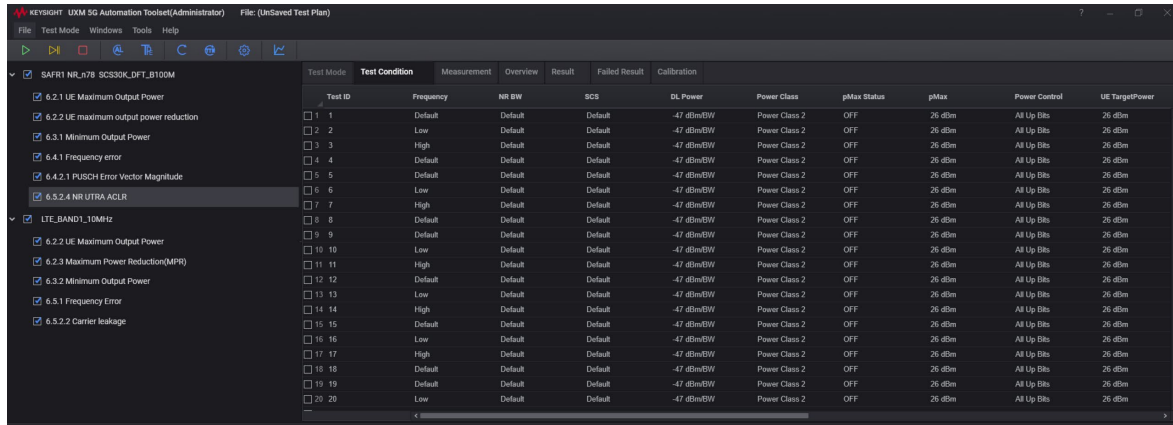


Figure 2. Campaign created by selecting available tests and configuring the Test Mode.

Test Configuration

Each test in the campaign may be executed over a range of test conditions specified by the user, resulting in a test generated for each individual test condition. Test conditions provide access to a range of test-specific parameters, including bandwidth, modulation scheme, power levels, and the limits/measurement values against which the pass/fail verdict is assessed. This provides users with the flexibility to focus campaigns on specific conditions requiring further debugging, in order to quickly complete the verification of a device's RF performance.

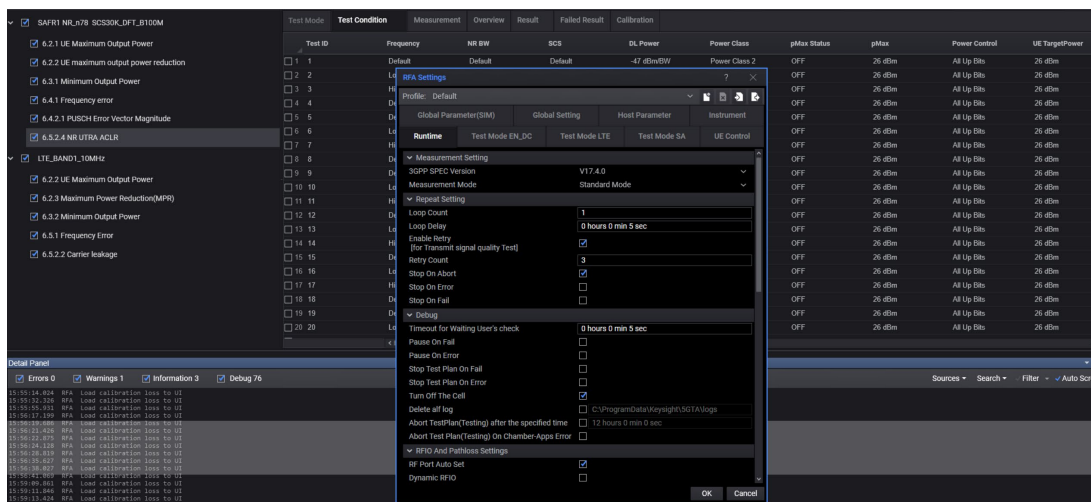


Test ID	Frequency	NR BW	SCS	DL Power	Power Class	pMax Status	pMax	Power Control	UE Target Power
1	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
2	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
3	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
4	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
5	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
6	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
7	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
8	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
9	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
10	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
11	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
12	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
13	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
14	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
15	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
16	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
17	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
18	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
19	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
20	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm

Figure 3. Screen capture illustrating a selection of the test conditions

Campaign Management

The RF Automation Toolset also supports a range of test campaign configuration options, including the ability to repeat tests, retry failed tests and stop/pause execution when errors are found.



Test ID	Frequency	NR BW	SCS	DL Power	Power Class	pMax Status	pMax	Power Control	UE Target Power
1	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
2	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
3	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
4	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
5	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
6	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
7	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
8	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
9	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
10	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
11	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
12	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
13	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
14	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
15	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
16	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
17	High	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
18	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
19	Default	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm
20	Low	Default	Default	-47 dBmBW	Power Class 2	OFF	26 dBm	All Up Bts	26 dBm

Figure 4. Screen capture illustrating test campaign configuration options

Dual SIM and Dual UE Testing

Most new mobile devices support the provisioning of both physical and embedded SIM in a single device thus increasing the need to ensure proper coexistence and functionality when both systems are active. It is important to ensure that the RF performance in such scenarios needs to be verified accurately, as per the specifications defined in the 3GPP standards. These test cases are available with S8702A RF Automation toolset, along with the UXM 5G.

Users can

- Verify DSDA (Dual SIM Dual Standby) performance for Dual SIM scenario.
- Run the test plan for two devices simultaneously using one UXM 5G.



Figure 5. Dual UE (left) and Dual SIM (right) testing with S8702A RF Automation toolset.

Result Analysis

The Result List area provides real-time information about the test campaign execution progress with relevant information about each individual test result, including a pass/fail verdict for each test based on the user-defined verdict conditions.

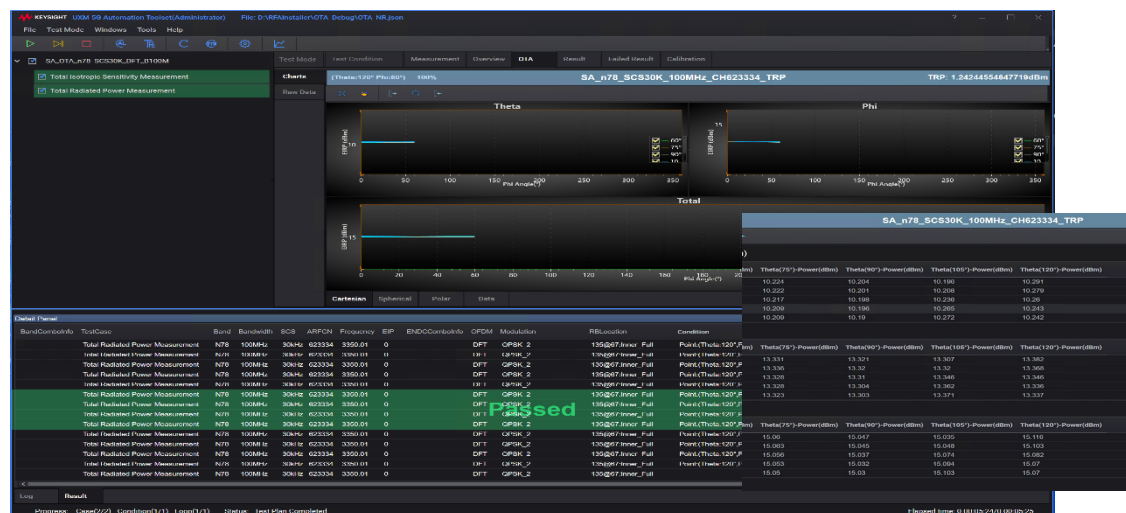


Figure 6. Real-time results information available in the RF Automation user interface

Report Generation

For post-campaign analysis, the RF Automaton Toolset allows the generation of summary reports in csv, xlsx and PDF formats.

Time	System	Test Case	Band	Bandwidth [MHz]	SCS [kHz]	ARFCN	Freq [MHz]	Expect Power [dBm]	OFDM	Modulation	RB Allocation	Condition	Item	Lower Limit	Value	Upper Limit	Unit	P/F
2019-07-31T15:58:30	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	InnerFull	UE MaxPower	PUSCH EVM	0	6.66	17.5	%	Pass
2019-07-31T15:58:38	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	InnerFull	UE MaxPower	PUSCH DMRS EVM	0	5.96	17.5	%	Pass
2019-07-31T15:58:47	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH EVM	0	2.1	17.5	%	Pass
2019-07-31T15:58:57	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH DMRS EVM	0	2.24	17.5	%	Pass
2019-07-31T15:59:06	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH EVM	0	3.06	17.5	%	Pass
2019-07-31T15:59:14	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH DMRS EVM	0	2.78	17.5	%	Pass
2019-07-31T15:59:23	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH EVM	0	2.13	17.5	%	Pass
2019-07-31T15:59:33	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH DMRS EVM	0	2.21	17.5	%	Pass
2019-07-31T15:59:42	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH EVM	0	4.66	12.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH DMRS EVM	0	4.25	12.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH EVM	0	1.99	12.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH DMRS EVM	0	1.83	12.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH EVM	0	3.27	12.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH DMRS EVM	0	3.24	12.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH EVM	0	2.23	12.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH DMRS EVM	0	2.15	12.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH EVM	0	2.55	17.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH DMRS EVM	0	2.51	17.5	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH EVM	0	2.19	8	%	Pass
2019-07-31T15:59:51	ENDC	6.4B.2.3.1 Error Vector Magnitude	N78	100MHz	SCS30K	636666	3549.99MHz	0	CP-OFDM	QPSK_2	OuterFull	UE MaxPower	PUSCH DMRS EVM	0	2.29	8	%	Pass

Figure 7. Example test campaign report in CSV format for post-execution analysis

RFA Analytics

RFA Analytics is a stand-alone software, accompanying the S8702A RF Automation Toolset. It is an interactive dashboard providing an easy-to-use analytics interface for the .csv result files generated with the RF Automation Toolset. Users can analyze the results, debug failures and identify developing trends in the testing.



Figure 8. Screen capture showing analysis capabilities with RFA Analytics tool

Important Features

5G NR & LTE Tests

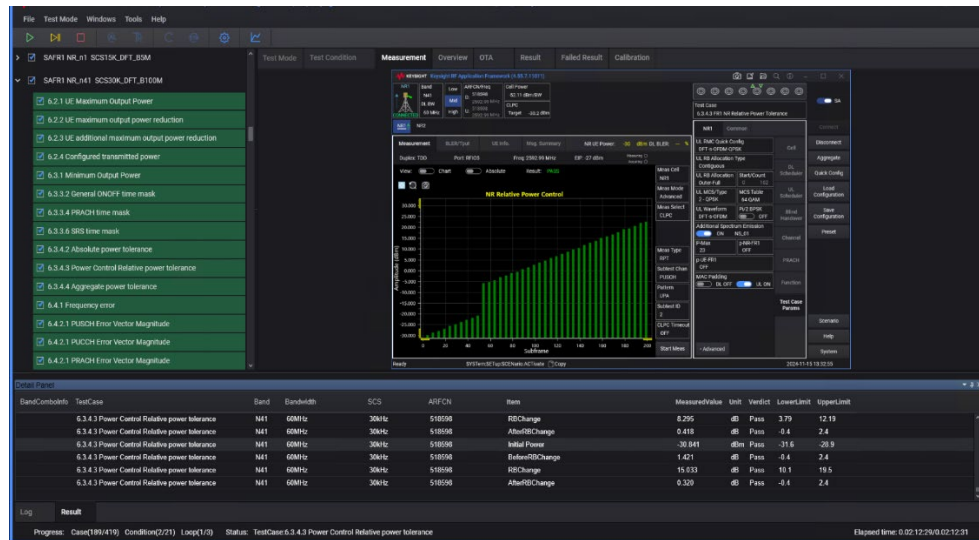


Figure 9. 5G NR tests

Use speed optimized tests for 5G NR including SA and NSA modes, FR1 and FR2 frequencies, using conducted and Over-the-air (OTA) methods. Test RF performance with features like Carrier Aggregation (CA), Supplementary Uplink (SUL). Transmit Diversity.

Use the LTE test modes for RF performance with single carrier, Carrier Aggregation and 4xRx antenna ports.



Figure 10. LTE tests

Automated Band-Combo Tests

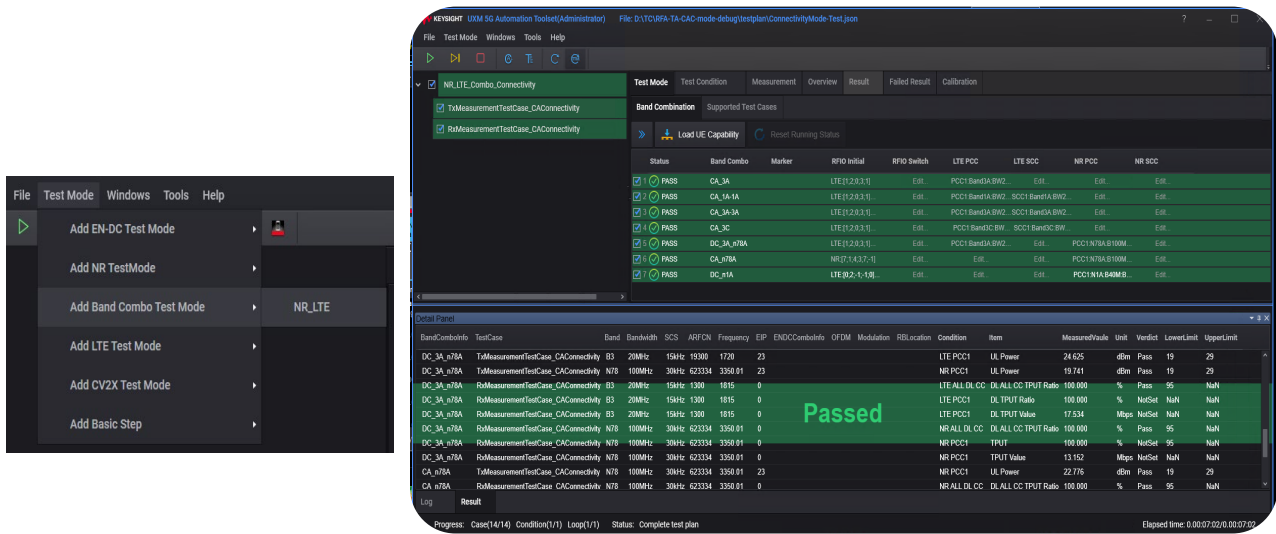


Figure 11. Band Combo tests

Users can provide their custom UE capability (.csv input) and load it to execute the Tx and Rx test cases supported by the UE.

NB-NTN Tests

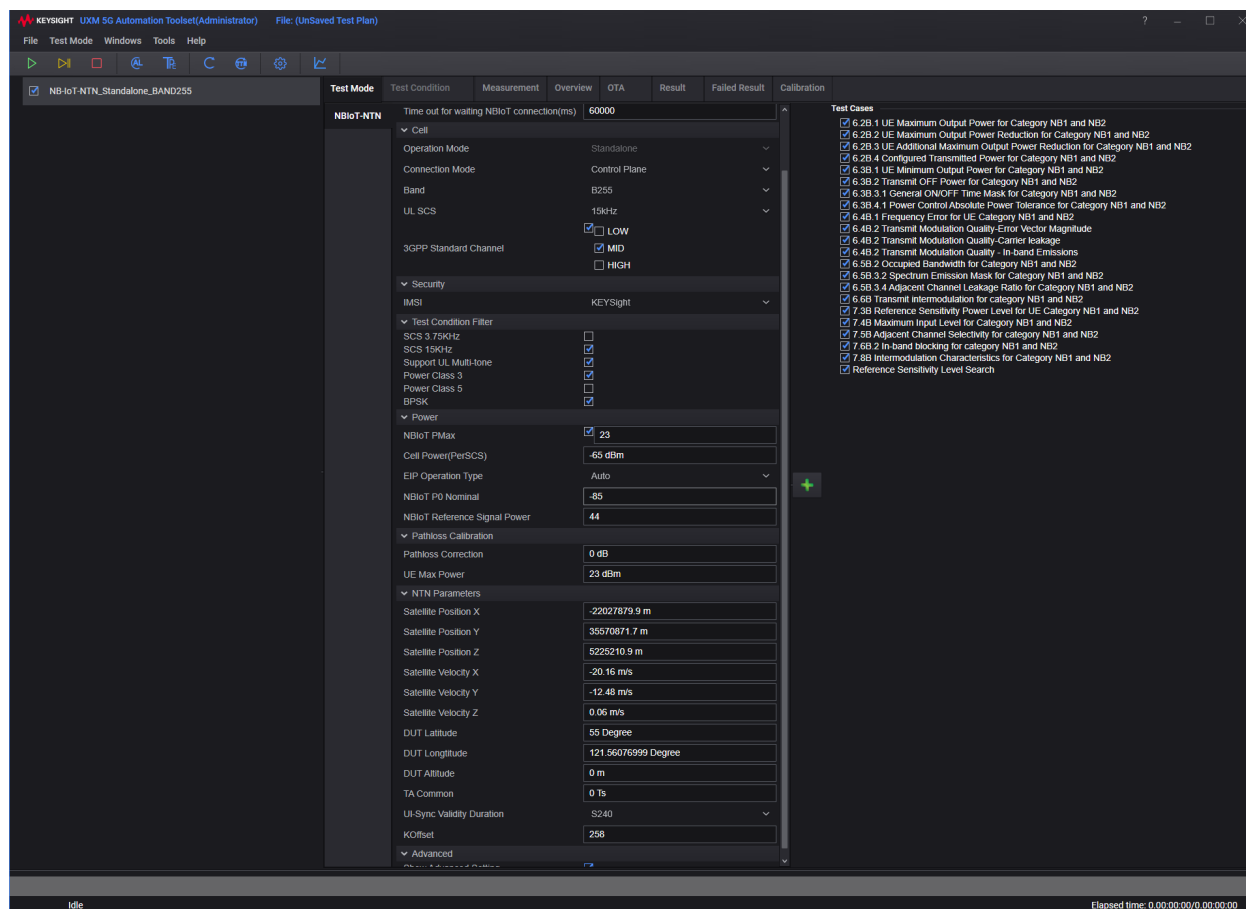


Figure 12. NB-NTN tests

The 3GPP Release 17 aims to extend NB-IoT's reach further by exploring its compatibility with Non-Terrestrial Networks (NTNs). NB-IoT over NTN (NB-NTN for short) devices and systems require rigorous testing to ensure reliability. Testing involves emulating orbit models in the lab to match field conditions.

NB-NTN devices are expected to support a wide variety of applications such as emergency services, mission-critical situations, or simple sensor surveillance. The satellites used range from Low-Earth-Orbit (LEO) where doppler shifts can affect communication, to Geo-Stationary Orbits (GSO) where path loss and delay may be the main challenges. NB-NTN devices can also be used for applications where power consumption needs to be minimized, or data throughput needs to be optimized.

NR-NTN Tests

Non-Terrestrial Networks provide unique challenges to cellular communication in terms of larger delays, greater doppler shifts as well as frequent handovers between various satellites. S8702A automates RF tests for testing cellular devices that support 5G NR-NTN communication.

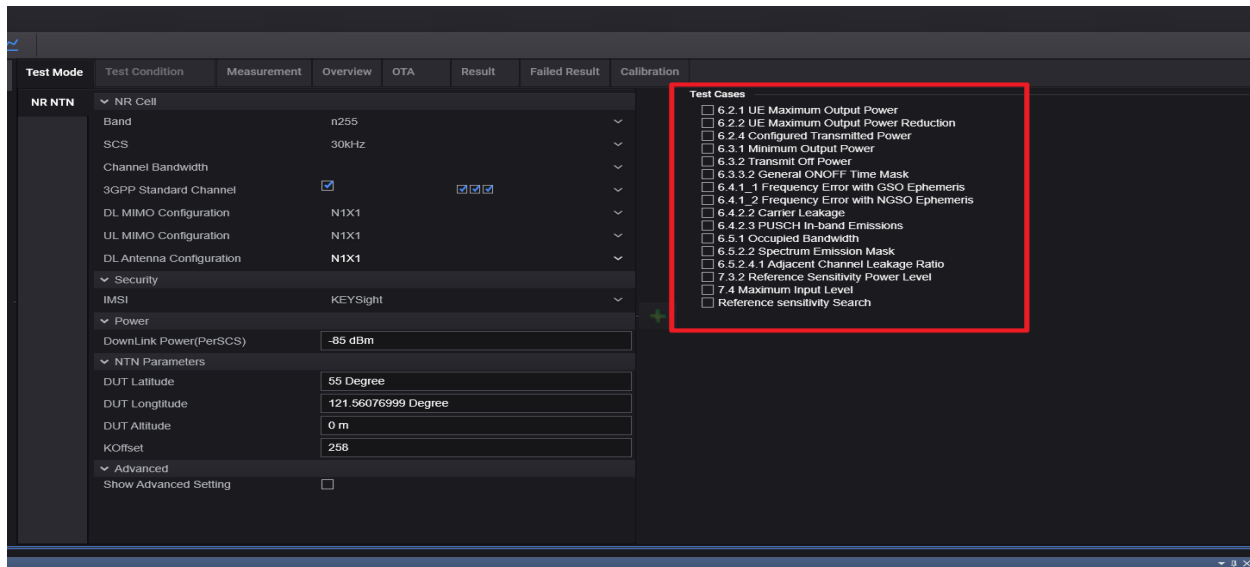


Figure 13. NR-NTN tests

RedCap Tests

The 3GPP RedCap NR feature reduces UE complexity through fewer RX/TX antennas, reduced UE use of bandwidth, lower UE power consumption, relaxed data rates, relaxed UE processing time and processing capability to help enable some exciting use cases, primarily around Industrial wireless sensors, Video surveillance and Wearables.

Use the RFA IOT test mode to test RedCap devices. The Keysight E7515R UXM 5G wireless test solution is a reduced capability hardware test platform optimized for 5G RedCap & Cellular Internet of Things (C-IoT) Technologies. RedCap devices can also be tested with E7515B and E7515P platforms.

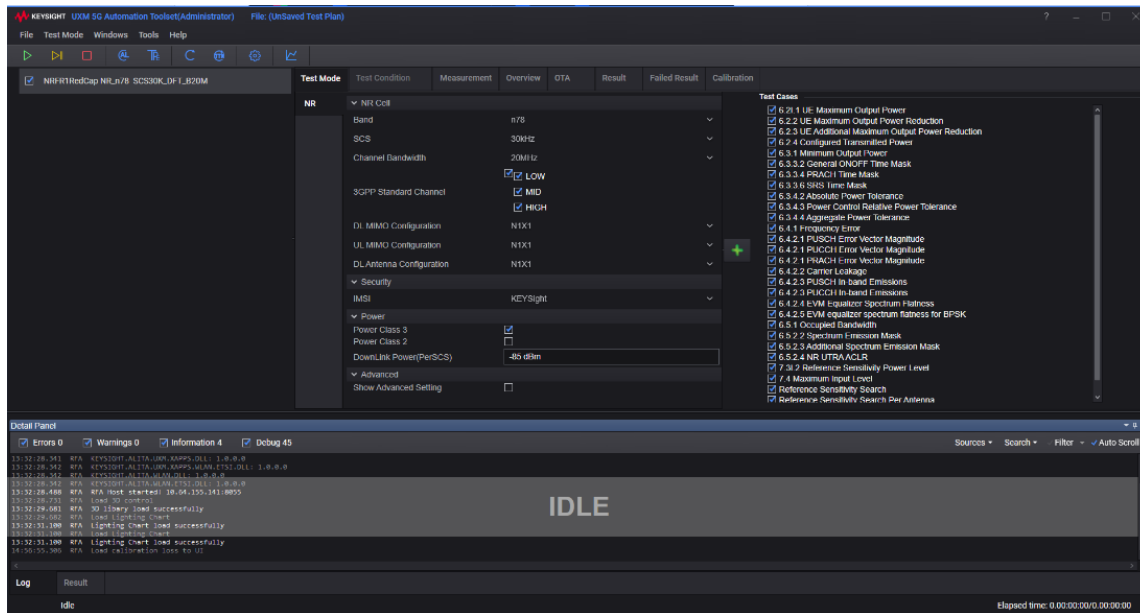


Figure 14. RedCap tests

OTA Tests

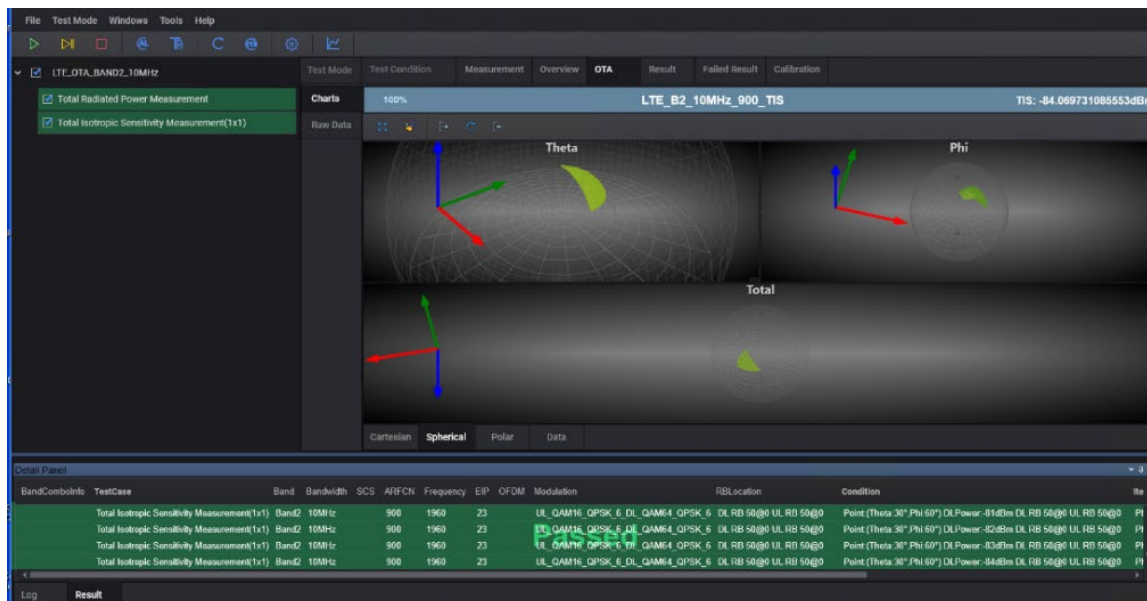


Figure 15. Over-the-air tests

RFA offers Over-the-Air (OTA) tests for 5G NR, LTE and WLAN devices using one of Keysight's array of OTA chambers to suit the device being tested.

WLAN RF Tests

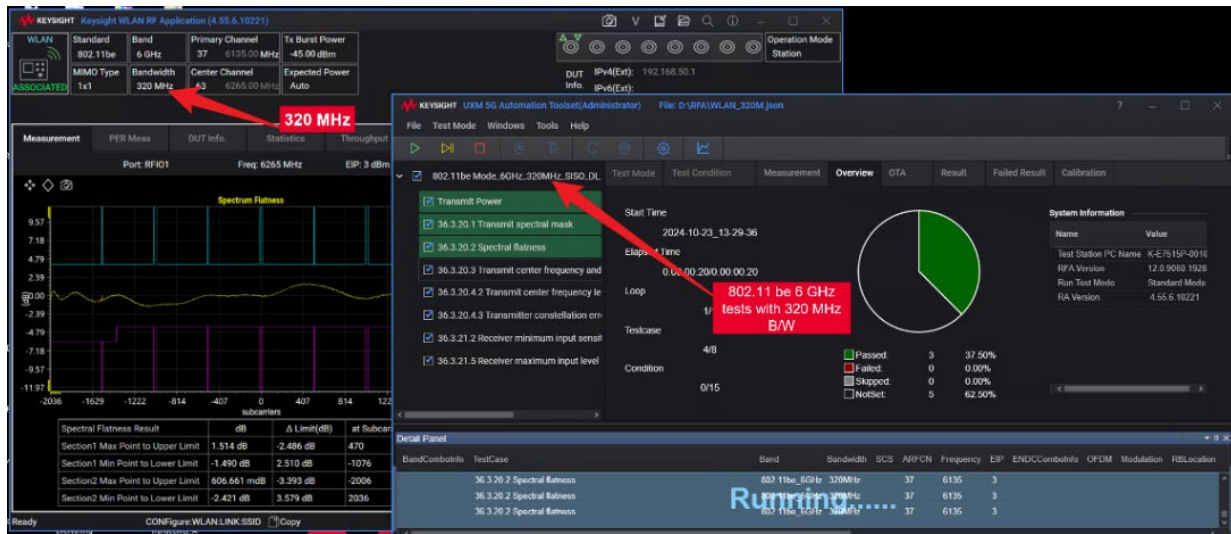


Figure 16. WLAN RF tests

RFA supports RF tests to WLAN IEEE specifications 802.11b/a/g/n/ac/ax/be. This includes transmitter and receiver tests as well as blocking tests.

C-V2X Tests

C-V2X is defined by 3GPP standard based on cellular modem technology which uses PC5 interface in the 5.9 GHz band to transmit and receive messages between vehicles, motorcycles, and Roadside Units (RSU). RFA has two test modes: One for 3GPP PC5 and another for OmniAir PC5.

Keysight's 5G RF Solutions

Keysight's Network Emulation Solutions portfolio offers a range of RF test solutions, covering the entire device development workflow.

Running on the first-to-market UXM wireless test platform, the S8702A RFA is an important solution in Keysight's device test portfolio (Figure 16).

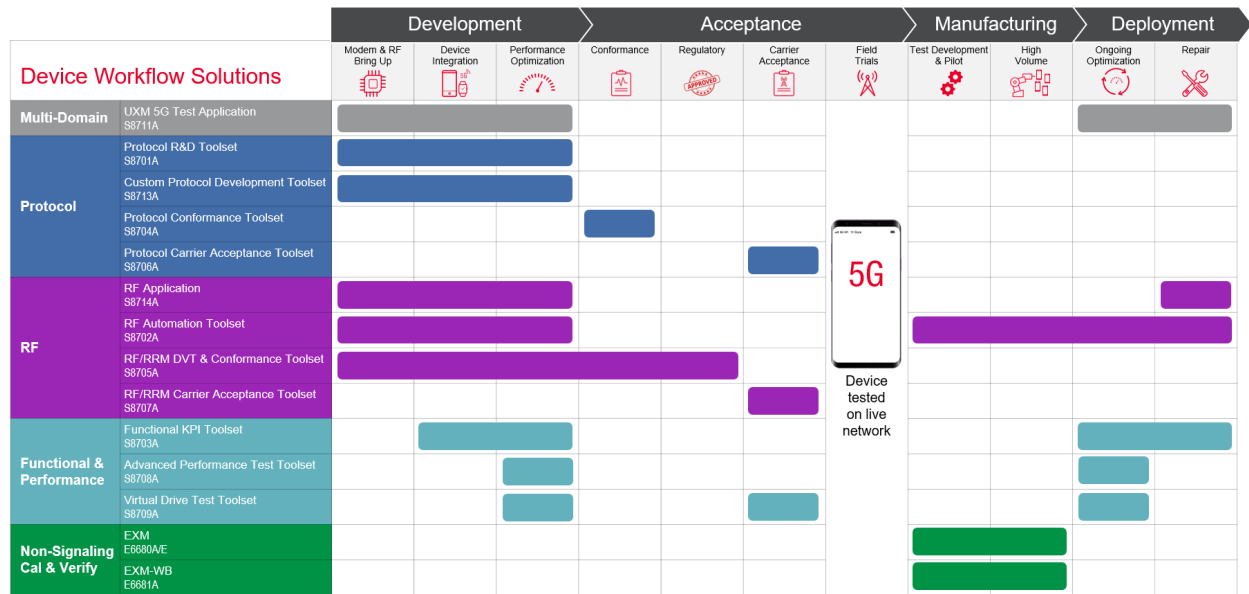


Figure 17. Network emulation solutions

For more information, visit these links.

- [S8714A RF Application](#)
- [S8702A RF Automation Toolset](#)
- [S8703A Functional KPI Toolset](#)
- [S8711A Test Application](#)
- [5G Device Test Solutions](#)
- [WLAN Testing](#)
- [Wireless Test Platforms](#)

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