S8714A RF Application

Designed for RF Testing

Simplify RF Verification of 5G NR and WLAN Devices

Fifth-generation new radio (5G NR) is a complex technology as is 802.11bn - also known as Wi-Fi 8, from Institute of Electrical and Electronics Engineers (IEEE).

Performing Radio Frequency (RF) measurements requires deep knowledge of protocol, and the complexity continues to increase with successive releases of the standards. The Third-Generation Partnership Project (3GPP) and IEEE add more tests and test configurations with each release, increasing the difficulty of performing measurements correctly, according to specified procedures. Devices must meet specifications despite time to market pressure, which necessitates fast test development and performance verification.

Keysight's S8714A RF Application (RA) is a solution to these challenges. Designed for RF testing, it provides quick development and execution of essential RF tests, comprehensive functionality including 5G NR including NR-NTN, Long Term Evolution (LTE), NB-IOT over Non-Terrestrial Networks (NB-NTN), RedCap and Wireless Local Area Network (WLAN) RF tests at a low cost of ownership.

KEYSIGHT

Contents

Improve Time to Market for 5G NR Devices

Verifying the RF performance of device designs is essential. Developers interpreting standards and learning protocol spend less time analyzing and optimizing the RF behavior of their designs. Detailed knowledge of standards and protocol is not required for measuring RF performance with the S8714A. RF testing is quick and easy with built-in 3GPP tests and automatic signaling procedures.

Reduce Time Learning Standards with Built-In 3GPP Tests

Easily verify RF performance of 5G NR non-standalone (NSA) and standalone (SA) devices with built-in 3GPP tests. Simply select the test from the drop-down menu (Figure 1) and the S8714A RA automatically configures parameters according to 3GPP TS 38.521 and starts the measurement.

Save test development time since understanding the 3GPP specification in detail is not necessary.

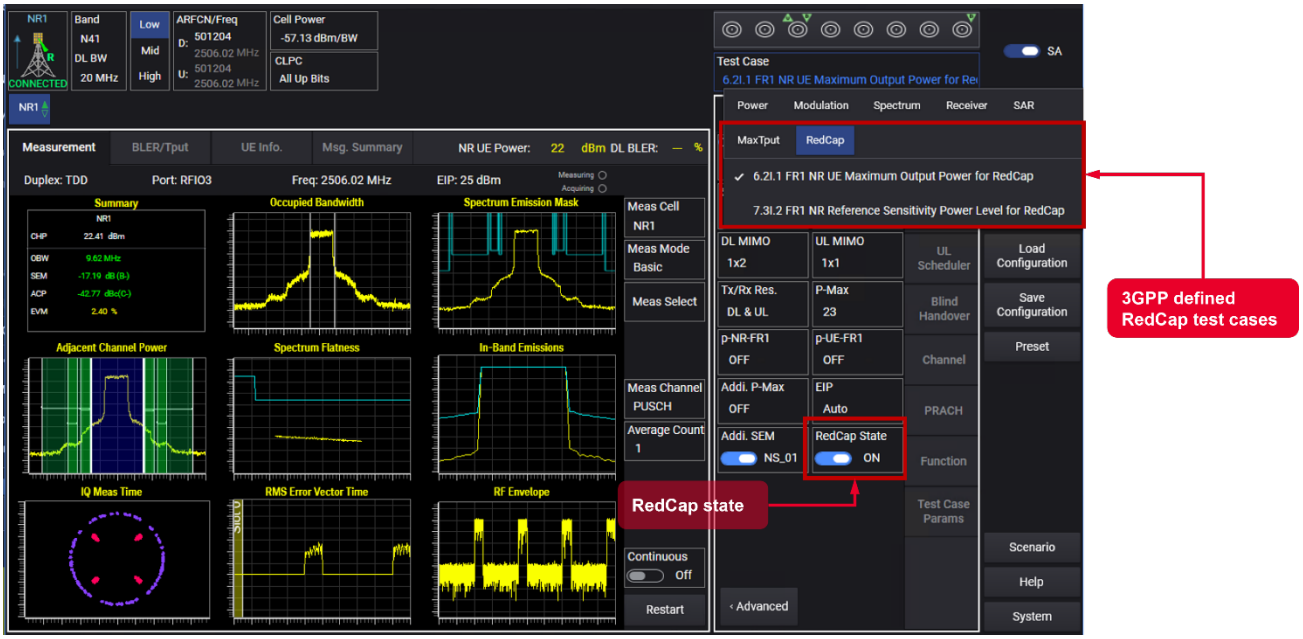

Figure 1. Test selection menu

Find specific tests quickly using selection groups: power, modulation, spectrum, receiver, Specific Absorption Rate (SAR), Maximum Throughput, Uplink Multiple Input Multiple Output (ULMIMO), UL Carrier Aggregation (ULCA), Transmit Diversity (TxDiversity), LTE, Supplementary Uplink (SUL), Narrow Band Non-Terrestrial Network (NB-NTN) and RedCap

Select in-band transmit and receive tests for frequency ranges 1 & 2 (FR1 & FR2) NSA, SA, 2UL CA, UL MIMO, Tx diversity, LTE, SUL, NB-NTN, NR-NTN and RedCap. Tables 1 through 13 list supported built-in tests based on 3GPP TS 36.521-1 (LTE), 38.521-1 (5G NR SA), 38.521-3 (5G NR NSA), 36.521-4 (Satellite Access), 38.521-5 (NR-NTN) and 38.521-1 (RedCap)

List of Built-in 3GPP Tests

Table 1. Built-in 3GPP LTE Tests

TS 36.521-1	LTE tests
6.2.2	UE maximum output power
6.2.3	Maximum output power reduction (MPR)
6.2.5	Configured UE transmitted output power
6.3.2	Minimum output power
6.3.3	Transmit OFF power
6.3.4.1	General ON/OFF time mask
6.3.4.2.1	PRACH time mask
6.3.4.2.2	SRS time mask
6.3.5.2	Power control relative power tolerance
6.3.5.3	Aggregate power control tolerance
6.5.1	Frequency error
6.5.2.1	Error Vector Magnitude (EVM) (PUSCH, PUCCH, PRACH)
6.5.2.2	Carrier leakage
6.5.2.3	In-band emissions for non-allocated RB (PUSCH, PUCCH)
6.5.2.4	EVM equalizer spectrum flatness
6.6.1	Occupied bandwidth
6.6.2.1	Spectrum emission mask
6.6.2.3	Adjacent channel leakage power ratio
7.3	Reference sensitivity level
7.4	Maximum input level

Table 2. Built-in LTE 2UL CA Tests

TS 36.521-1	LTE 2UL CA tests
6.2.2A	UE Maximum Output Power for CA
6.2.3A	Maximum Power Reduction (MPR) for CA
6.2.4A	Additional Maximum Power Reduction (MPR) for CA
6.2.5A	Configured UE transmitted Output Power for CA
6.3.2A	Minimum Output Power for CA
6.3.4A	ON/OFF time mask for CA
6.5.1A	Frequency error for CA
6.5.2A.1	Error Vector Magnitude (EVM) for CA
6.5.2A.2	Carrier Leakage for CA
6.5.2A.3	In-band emissions for non-allocated RB for CA
6.6.1A	Occupied bandwidth for CA
6.6.2.1A	Spectrum Emission Mask for CA
6.6.2.3A	Adjacent Channel Leakage Power Ratio for CA
	Reference Sensitivity level for CA

Table 3. Built-in 3GPP 5G NR FR1 SA tests

TS 38.521-1	5G NR FR1 SA tests
6.2.1	User equipment (UE) maximum output power
6.2.2	UE maximum output power reduction
6.2.4	Configured transmitted power
6.3.1	Minimum output power
6.3.3.2	General ON/OFF time mask
6.3.3.6	SRS time mask - NEW
6.3.4.3	Power control relative power tolerance
6.3.4.4	Power control aggregate power tolerance
6.4.1	Frequency error
6.4.2.1	Error vector magnitude (EVM) (PUSCH, PUCCH, PRACH)
6.4.2.2	Carrier leakage
6.4.2.3	In-band emissions (PUSCH, PUCCH)
6.4.2.5	EVM equalizer spectrum flatness for Pi/2 BPSK
6.5.1	Occupied bandwidth (OBW)
6.5.2.2	Spectrum emission mask (SEM)
6.5.2.4	Adjacent channel leakage ratio (ACLR)
7.3.2	Reference sensitivity power level
7.4	Maximum input level

Table 4. Built-in 3GPP 5G NR FR1 SA 2UL CA tests

TS 38.521-1	5G NR FR1 SA 2UL CA tests
6.2A.1.1	UE maximum output power for CA (2UL CA)
6.2A.2.1	UE maximum output power reduction for CA (2UL CA)
6.2A.4.1	Configured transmitted power for CA (2UL CA)
6.3A.1.1	Minimum output power for CA (2UL CA)
6.4A.1.1	Frequency error for CA (2UL CA)
6.4A.2.1.1	Error vector magnitude (EVM) for CA (2UL CA) (PUSCH)
6.4A.2.2.1	Carrier leakage for CA (2UL CA)
6.4A.2.3.1	In-band emissions for CA (2UL CA) (PUSCH)
6.5A.1.1	Occupied bandwidth for CA (2UL CA)
6.5A.2.2.1	Spectrum emissions mask for CA (2UL CA)
6.5A.2.4.1.1	NR ACLR for CA (2UL CA)

Table 5. Built-in 3GPP 5G NR SUL tests

TS 38.521-1	5G NR SUL tests
6.2C.1	Configured Transmission Power
6.2C.3	UE Maximum Output Power
6.2C.4	UE Maximum Output Power Reduction
6.3C.1	Minimum Output Power
6.3C.3.1	General ON/OFF Transmission Mask
6.3C.4.2	Relative Power Tolerance
6.3C.4.3	Aggregate Power Tolerance
6.4C.1	Frequency Error
6.4C.2.1	EVM for PUSCH, PUCCH, PRACH
6.4C.2.2	Carrier Leakage
6.4C.2.3	In-Band Emission for PUSCH, PUCCH
6.4C.2.4	Spectrum Flatness
6.5C.1	Occupied Bandwidth
6.5C.2.2	Spectrum Emission Mask
6.5C.2.4.1	Adjacent Channel Leakage Ratio
7.3C.2	Reference Sensitivity Power Level

Table 6. Built-in 3GPP 5G NR FR1 SA UL MIMO tests

TS 38.521-1	5G NR FR1 SA UL MIMO tests
6.2D.1	UE maximum output power for UL MIMO
6.2D.1	UE maximum output power for UL MIMO (2 layers)
6.2D.2	UE maximum output power reduction for UL MIMO
6.2D.4	Configured output power for UL MIMO
6.3D.1	Minimum output power for UL MIMO
6.3D.3	Tx ON/OFF time mask for UL MIMO
6.3D.4.2	Power control relative power tolerance for UL MIMO
6.3D.4.3	Power control aggregate power tolerance for UL MIMO
6.4D.1	Frequency error for UL MIMO
6.4D.2.1	Error vector magnitude (EVM) for UL MIMO (PUSCH)
6.4D.2.2	Carrier leakage for UL MIMO
6.4D.2.3	In-band emissions for UL MIMO (PUSCH)
6.4D.2.4	EVM equalizer flatness for UL MIMO
6.4D.3	Time alignment error for UL MIMO
6.5D.1	Occupied bandwidth for UL MIMO
6.5D.2.2	Spectrum emissions mask for UL MIMO
6.5D.2.4	Adjacent channel leakage ratio for UL MIMO
7.3D.2	Reference sensitivity power level for UL MIMO
7.4D	Maximum input level for UL MIMO

Table 7. Built-in 3GPP 5G NR FR1 SA Tx diversity tests

TS 38.521-1	5G NR FR1 SA Tx diversity tests
6.2G.1	User Equipment (UE) maximum output power for Tx diversity
6.2G.2	UE maximum output power reduction for Tx diversity
6.4G.2.1	EVM for Tx diversity (PUCCH, PUSCH, PRACH)
6.4G.2.3	In-band emission for Tx diversity (PUSCH, PUCCH)
6.5G.2.3.1	NR ACLR for Tx diversity

Table 8. Built-in 3GPP 5G NR SA RedCap tests

TS 38.521-1	5G NR SA RedCap test selection
6.2I.1	UE maximum output power for RedCap
7.3I.2	Reference sensitivity power level for RedCap

Table 9. Built-in 3GPP NR FR2 SA tests

TS 38.521-2	5G NR FR2 SA test selection
6.2.1	UE Maximum Output Power for SA FR2
6.2.2	UE Maximum Output Power Reduction for SA FR2
6.3.1	Minimum Output Power for SA FR2
6.3.3.2	General ON/OFF Transmission Mask for SA FR2
6.4.1	Frequency Error for SA FR2
6.4.2.1	EVM of PUSCH for SA FR2 (PUSCH, PUCCH, PRACH)
6.4.2.2	NR Carrier Leakage for SA FR2
6.4.2.3	In-Band Emission of PUSCH for SA FR2 (PUSCH, PUCCH)
6.4.2.5	Spectrum Flatness for SA FR2
6.5.1	Occupied Bandwidth for SA FR2
6.5.2.1	SEM for SA FR2
6.5.2.3	ACLR for SA FR2

Table 10. Built-in 3GPP 5G NR FR1 NSA tests

TS 38.521-3	5G NR FR1 NSA tests
6.2B.1.3	UE maximum output power for inter-band E-UTRA-NR dual connectivity (EN-DC) within FR1
6.2B.1.4	UE maximum output power EN-DC FR2
6.2B.2.3	UE maximum output power reduction for inter-band EN-DC within FR1
6.2B.4.1.3	Configured output power for inter-band EN-DC within FR1
6.3B.1.3	Minimum output power for inter-band EN-DC within FR1
6.3B.3.3	Tx ON/OFF time mask for inter-band EN-DC within FR1
6.3B.8.2.3	Power control relative power tolerance for inter-band EN-DC within FR1
6.3B.8.3.3	Power control aggregate power tolerance for inter-band EN-DC within FR1
6.4B.1.3	Frequency error for inter-band EN-DC within FR1
6.4B.2.3.1	Error vector magnitude (EVM) for inter-band EN-DC within FR1 (PUSCH, PUCCH, PRACH)
6.4B.2.3.2	Carrier leakage for inter-band EN-DC within FR1
6.4B.2.3.3	In-band emissions for inter-band EN-DC within FR1 (PUSCH, PUCCH)
6.4B.2.3.4	EVM equalizer flatness for inter-band EN-DC within FR1
6.5B.1.3	Occupied bandwidth for inter-band EN-DC within FR1
6.5B.2.3.1	Spectrum emissions mask for inter-band EN-DC within FR1
6.5B.2.3.3	Adjacent channel leakage ratio for inter-band EN-DC within FR1
7.3B.2.0.3	Reference sensitivity for inter-band EN-DC within FR1
7.4B.3	Maximum input level for inter-band EN-DC within FR1

Table 11. Built-in NB-NTN tests

TS 36.521-4	NB-NTN tests
6.2B.1	UE Maximum Output Power
6.2B.2	Maximum Power Reduction (MPR)
6.2B.4	Configured transmitted Power
6.3B.1	UE Minimum Output Power
6.3B.2	Transmit Off Power
6.3B.3.1	General ON/OFF Transmission Mask
6.3B.3.2	PRACH Time Mask
6.4B.1	Frequency Error with GSO Ephemeris
6.4B.2.1	EVM for NPUSCH
6.4B.2.2	Carrier Leakage
6.4B.2.3	In-Band Emissions
6.5B.2	Occupied Bandwidth
6.5B.3.2	Spectrum Emission Mask
6.5B.3.4	Adjacent Channel Leakage
7.3B	Reference Sensitivity Power Level
7.4B	Maximum Input Level

Table 12. Built-in NR NTN Tests

TS 38.521-5	5G NR FR1 NTN tests
6.2.1	UE Maximum Output Power for NTN
6.2.2	UE Maximum Output Power Reduction for NTN
6.2.4	Configured Transmission Power for NTN
6.3.1	Minimum Output Power for NTN
6.3.3	General ON/OFF Transmission Mask for NTN
6.3.4	Relative power tolerance for NTN
6.3.4	Aggregate power tolerance for NTN
6.4.1_1	NTN Frequency error with GSO ephemeris
6.4.1_2	NTN Frequency error with NGSO ephemeris
6.4.2.1	EVM for NTN (PUSCH, PUCCH)
6.4.2.2	Carrier Leakage for NTN
6.4.2.3	In-Band Emission for NTN (PUSCH, PUCCH)
6.4.2.5	Spectrum Flatness for NTN
6.5.1	Occupied Bandwidth for NTN
6.5.2.1	Spectrum Emission Mask for NTN
6.5.2.3	Adjacent Channel Leakage Ratio for NTN
7.3.2	Reference Sensitivity Power Level for NTN
7.4	Maximum Input Level for NTN

Reduce Cost of Ownership for RF Testing

The cost of RF test is more important now than ever, with numerous bands, bandwidths, and modulation types creating large numbers of test configurations for verification. Keysight's S8714A RA helps reduce the cost of ownership with tailored feature licenses and support subscriptions useful for RF testing.

Purchase what is needed now, and update capabilities as needed later with the S8714A RA's specific feature licenses such as for 3GPP Release 18 (R18) RF features. Software subscriptions provide feature updates and technical support over a length of time (term) for each software license. A support subscription is required when any software is purchased initially. However, after the initial term expires, the support subscription only for the S8714A RF application must be renewed to continue receiving updates for RF test.

Core software support subscriptions must be renewed for use with other Network Emulation Solution (NES) software such as the S8711A Test Application (TA).

Test RF Performance Efficiently

Time to market pressure is inevitable in device design. Develop designs efficiently using the S8714A RA with its intuitive Graphical User Interface (GUI), ability to change parameters on a live connection, simultaneous results from multiple measurements, support for multiple hardware platforms, and easy automation. Characterize 5G NR and adjacent technologies such as LTE and WLAN.

Modify Parameters Essential for RF Testing

The multitude of test conditions required to verify RF performance seems endless. Save time with the S8714A RA by modifying parameters essential for RF testing such as channel, band, and bandwidth while on a live connection. Change multiple parameters simultaneously by configuring and executing a blind handover. Essential procedures such as paging, Expected Input Power (EIP), Subscriber Identity Module (SIM) authentication, and cell state are handled automatically in the background with no user intervention necessary.

Specify the desired channel as low, medium, or high for automatic selection of the Absolute RF Channel Number (ARFCN) to match the 3GPP specifications. Optionally, enter the frequency or ARFCN for the channel to be tested when performing tests beyond the 3GPP specifications.

View Results of Multiple Measurements

Speed up RF verification of 5G NR devices by viewing results of multiple measurements simultaneously (Figure 2 and Figure 3). Configure desired measurements for viewing on the main screen.

Figure 2. LTE measurement results example

Figure 3. 5G NR measurement results example

Select the Optimal UXM Wireless Test Platform

Keysight has the optimal hardware configuration for 5G NR use cases through 3GPP Release 18 (R18) and for Wi-Fi use cases up to IEEE 802.11be. Choose the platform that meets test requirements for today and add more capability as needed for tomorrow (**Figure 4**).

Keysight's E7515W Wireless Connectivity Test Platform has just the right capability for testing Wi-Fi and 5G NR NSA and SA with signaling in one box. Especially useful for devices such as Customer-Premises Equipment (CPE), the E7515W and the S8714A RA are the optimal solution for RF testing with Wi-Fi including Coexistence Tests.

The Keysight E7515P is the most capable of the UXM family and includes the most resources for testing all corner cases, bands, and channel configurations for LTE, 5G NR, and Wi-Fi with network emulation.

The S8714A RA also supports the E7515R platform for RedCap. This is convenient for RedCap-only testing with only two licenses required – RedCap core signaling and the RF application.

For More Information on UXM Wireless Platforms:

5G Wireless Test Platforms

E7515W Wireless Connectivity Test Platform

E7515R UXM 5G Wireless Test Platform

Accelerate Time to Market with the E7515W (spotlight video)

Enabling a New Class of 5G Devices with E7515R (spotlight video)

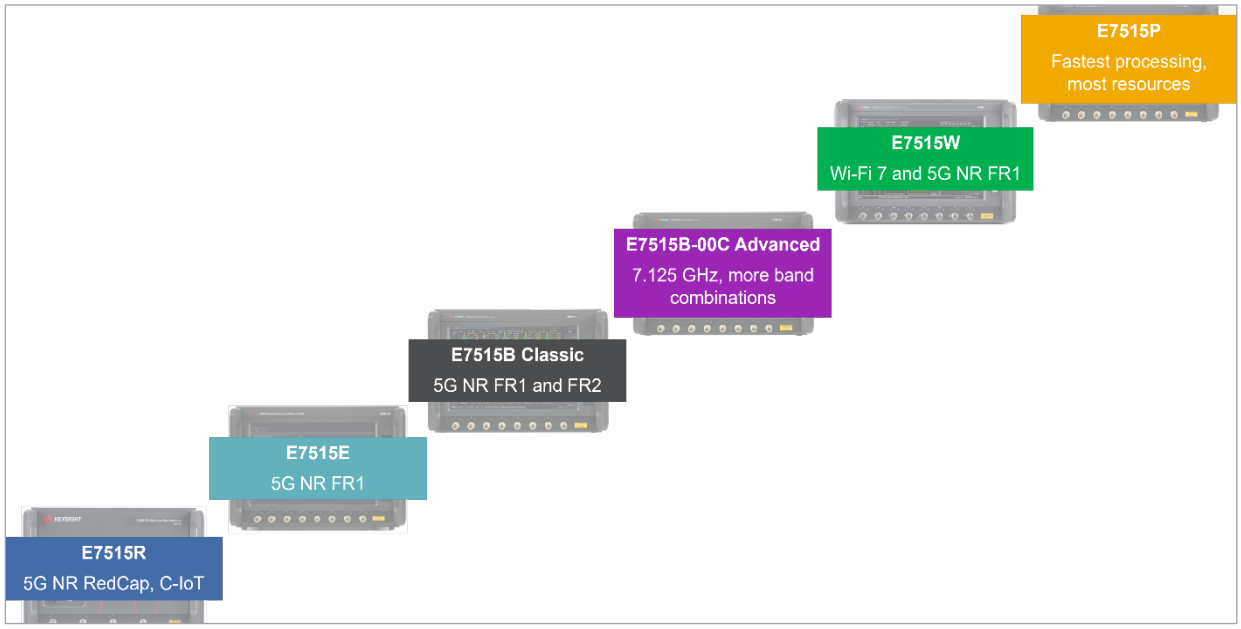

Figure 4. UXM wireless test platform

Test 5G NR and Adjacent Technologies

Keysight's S8714A RA provides RF testing for more than 5G NR devices. Verify the RF performance of devices for 5G NR NSA and SA, LTE, NB-NTN and IEEE 802.11 (WLAN) standards. Evaluate SAR performance with key third parties. Verify performance over frequency ranges specified in 3GPP and IEEE standards: 5G NR-U (unlicensed) and Wi-Fi 6E up to 7.125 GHz, and 5G NR FR2. Perform RF tests over all these technologies and conditions with a single application on one test platform.

Test 802.11 (WLAN) Access Points and Stations

Keysight's S8714A RA is optimal for testing multiple-technology devices such as CPE. Connect once using the flexible RFIO on the UXM platform to test RF performance of 5G NR and Wi-Fi. Testing the latest Wi-Fi 7 Access Point (AP) and client/station (STA) RF performance with signaling closely emulates device behavior in the real world (see **Figure 5** and **Figure 6**). Besides Transmitter and Receiver tests related to power, modulation, bandwidth, and BER the RA also supports Range Vs Rate and Throughput tests. Currently supported standards are 802.11a/b/g/n/ac/ax/be.

Figure 5. Wi-Fi 7 AP measurement results example

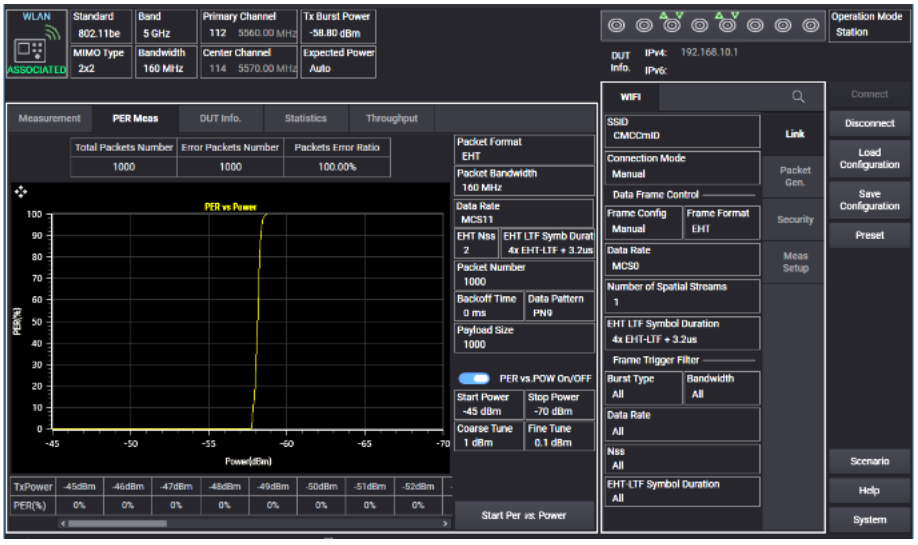

Figure 6. Wi-Fi RF sensitivity measurement example

Develop Automated Tests Quickly

Automation is a requirement for several phases of development such as regression and design verification testing. Develop tests quickly with the simple Standard Commands for Programmable Instruments (SCPI) of the S8714A RA.

Alternatively, use Keysight's S8702A RF Automation Toolset (RFA) to automate RF tests quickly. 3GPP 5G NR SA test cases including those for UL MIMO, 2UL CA, and Tx diversity are supported as are 3GPP 5G NR NSA test cases and IEEE 802.11 test cases. **Figure 7** shows RFA test results for an IEEE 802.11be device.

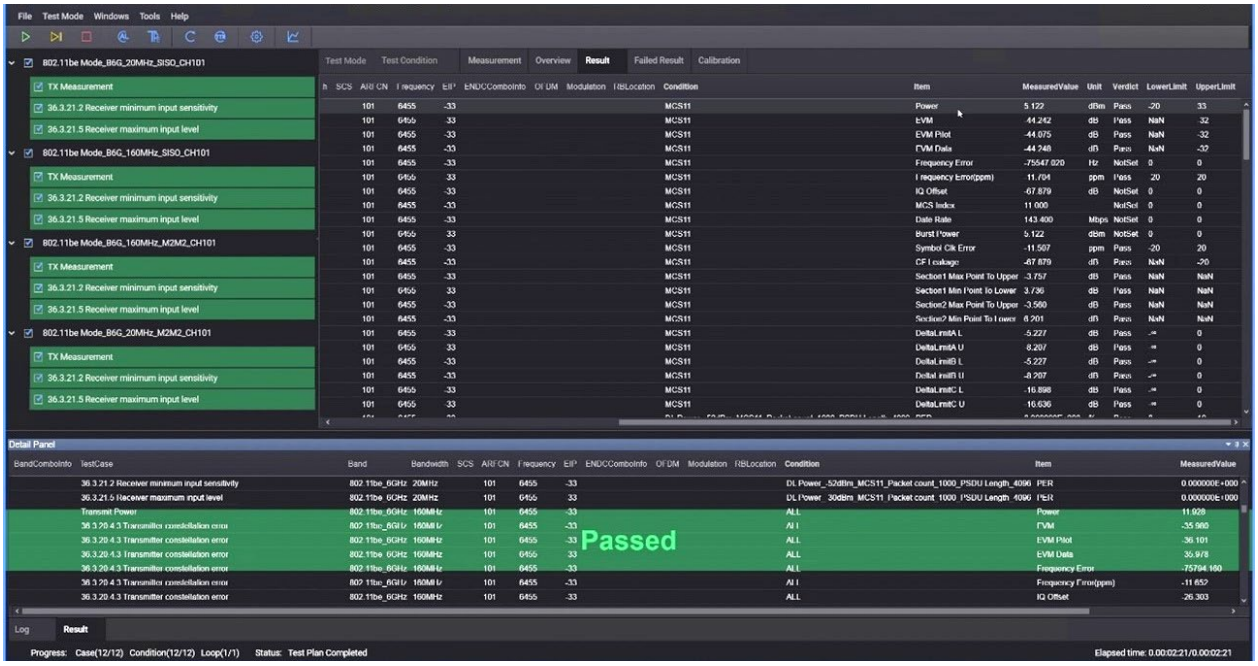

Figure 7. Wi-Fi 7 RFA test results example

For More Information on Automation with RFA:

S8702A RF Automation Toolset

Verify WLAN RF Performance (Application note)

Verify Performance Cross the Workflow

Test solutions that can be reused in multiple parts of the workflow are in demand as they optimize the cost of test equipment. Manual and automated testing is quick and easy to deploy for the workflow stages of modem and RF bring up, device integration, performance optimization, and device repair using the RF-focused user interface of the S8714A RA.

Characterize Modem RF Behavior Over Multiple Conditions

Modems provide the foundation for signaling and RF performance in wireless devices. Initialization of modem hardware requires testing RF performance while parameters such as frequency, power, and bandwidth are varied over their full ranges. Modems support multiple combinations of frequency and bandwidth so they can be used in devices worldwide.

View All Reported Bands and Band Combinations

Wireless devices today, support numerous frequency bands to enable use across multiple regions of the world. Knowing which frequencies each modem supports eases the development of test plans. The same is true for combinations of frequency bands, since not every band can coexist with all other bands.

The RA provides GUI and SCPI access to the bands and band combinations reported by the Device Under Test (DUT) as shown in **Figure 8.** To display the most useful information, the GUI provides filtering selections (**Figure 9**).

Use the RA to monitor and analyze performance during a live connection with asymmetrical bandwidths and in SDL (supplementary downlink) bands as defined by the 3GPP standards.

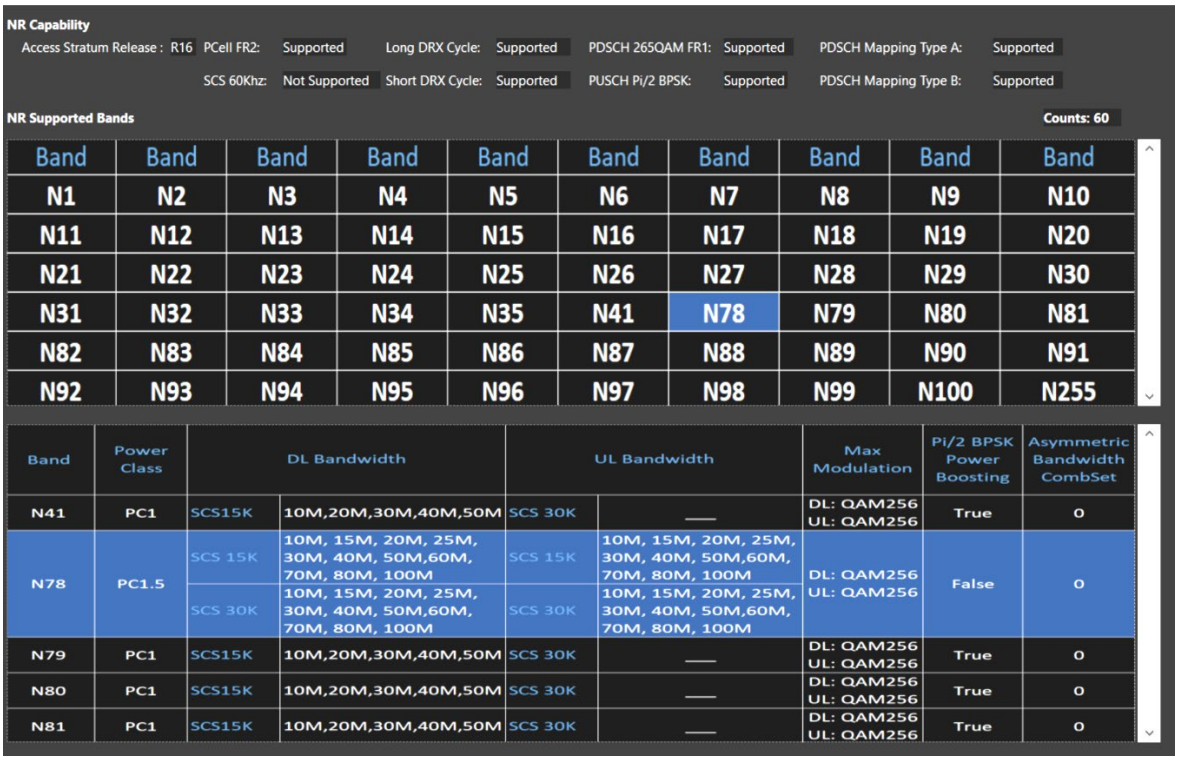

Figure 8. View of reported 5G NR bands

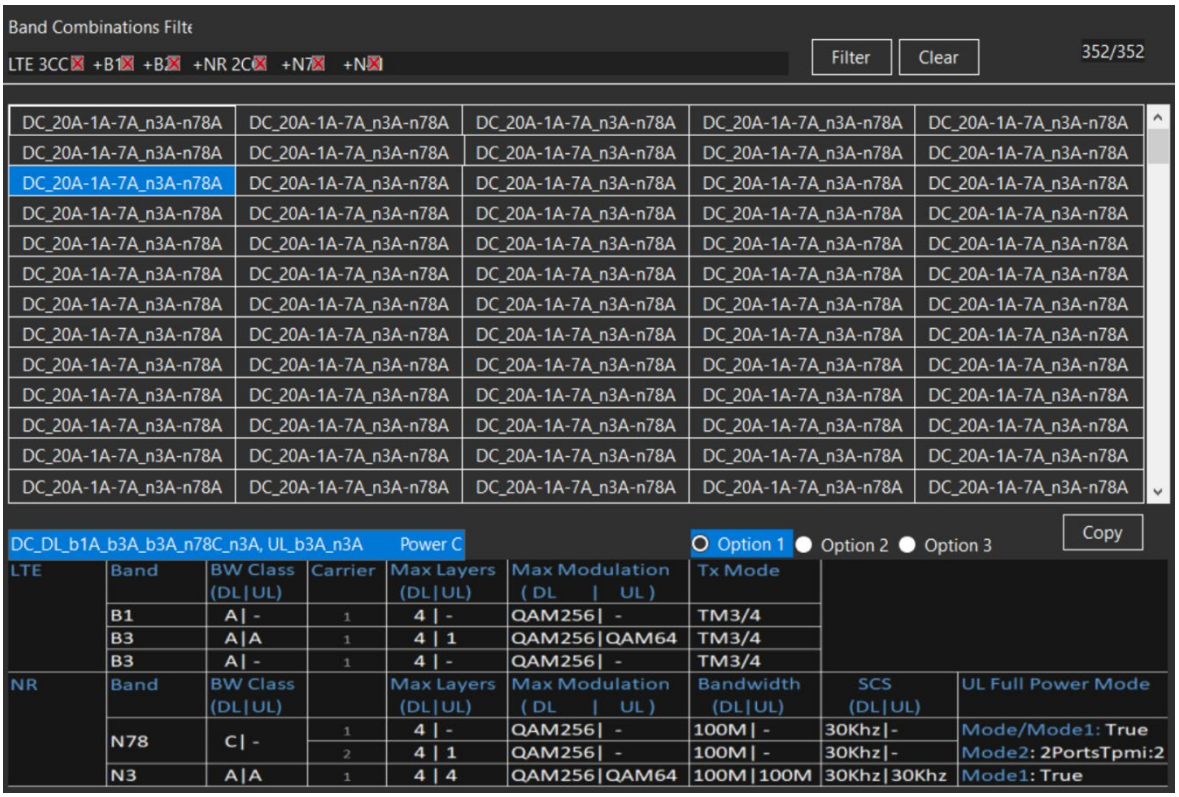

Figure 9. Filtering on desired band combinations

Evaluate Behavior with CA and MIMO

CA and MIMO also require extensive testing during initial modem characterization. 3GPP defines many combinations of LTE and 5G NR Component Carriers (CC). Verifying these combinations with the S8714A RA is easy. Use one screen to configure aggregated cell parameters for both LTE and 5G NR (**Figure** 10). Parameters from other cells can be copied simplifying re-test of previous conditions.

Also use the S8714A RA to analyze LTE and 5G NR performance with MIMO, up to 4x4, and with Tx diversity.

Figure 10. Configure multiple aggregated cell parameters Evaluate data throughput with NR-DC

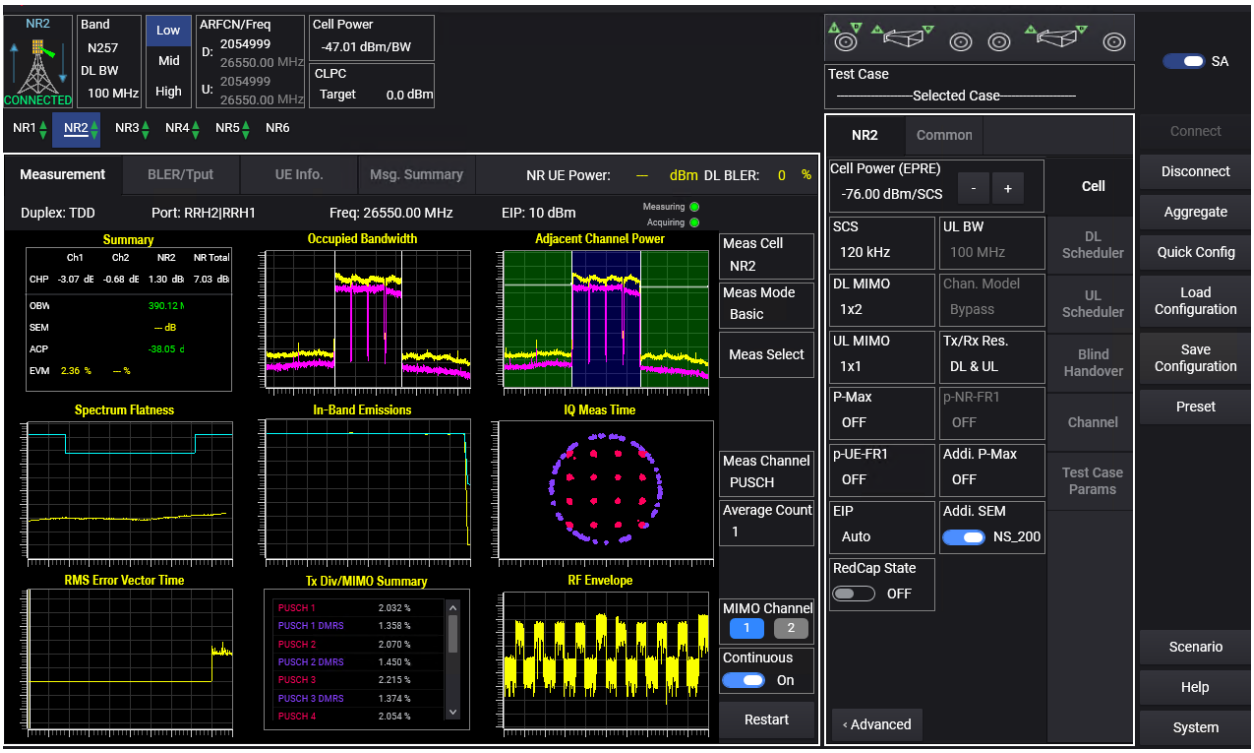

Figure 11. NR-DC connection and measurement

Test Device Behavior after Hardware and Software Integration

Device hardware design requires extensive RF testing. An especially important phase occurs after the hardware turn-on is complete and integration with software begins. For mobile devices, integration with a protocol stack is a key milestone.

Simplify RF Test Over Multiple Channels and Bandwidths

The S8714A RA helps with frequently used parameters and functions on the main screen (**Figure 12**):

- Make changes to band, channel, UE power, and modulation without dropping the connection
- Verify performance using RF measurements such as channel power, ACLR, SEM, EVM
- Establish and maintain connections easily without detailed protocol knowledge

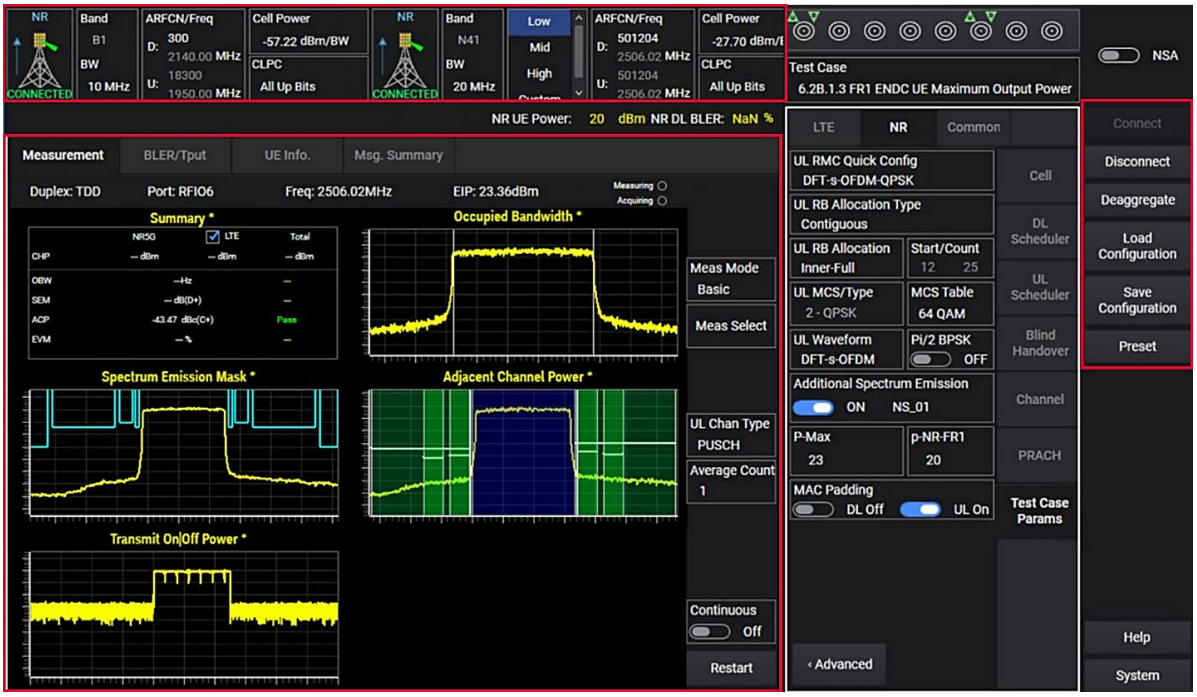

Figure 12. Frequently used parameters and functions on the main screen

Analyze Behavior at Mmwave Frequencies

FR2 adds more challenges to RF testing. Initial evaluation of RF performance in FR2 is easy with the RA. Establish a connection in an FR2 band and view multiple measurement results (**Figure 13**). Add Keysight's OTA software tools to control all system components for additional testing such as EIRP (Effective Isotropic Radiated Power), TRP (Total Radiated Power), and TIS (Total Isotropic Sensitivity) as required by 3GPP.

Figure 13. 5G NR FR2 RF measurement results example

Develop Tests to Verify New and Modified Designs

Design verification test is another area where RF test is important. The design is verified against internal and external specifications. Regression testing, where an existing design's RF performance is verified after new enhancements or modifications, requires automation because tests are typically performed over many hours or days.

The S8714A RA is a fast and stable solution for manual and automated RF testing. Use the built-in, pre-configured 3GPP tests or verify more general RF performance using configurable measurements such as channel power, ACLR, SEM, and EVM. Quickly develop automation within the S8714A RA with simple SCPI or verify design performance using specific 3GPP RF test cases with the S8702A RFA or using throughput tests with the S8703A FKPI.

Test RedCap Features using the E7515R UXM Platform

RedCap stands for Reduced Capability 5G NR devices. 3GPP approved this new device type in Release 17 to make it easier for 5G to be used with IoT devices. Test Rel. 17 5G RedCap and Cellular Internet of Things (CIoT) devices using the S8714A RA. (See **Figure 14**)

Figure 14. RedCap testing example

Perform NTN RF Tests

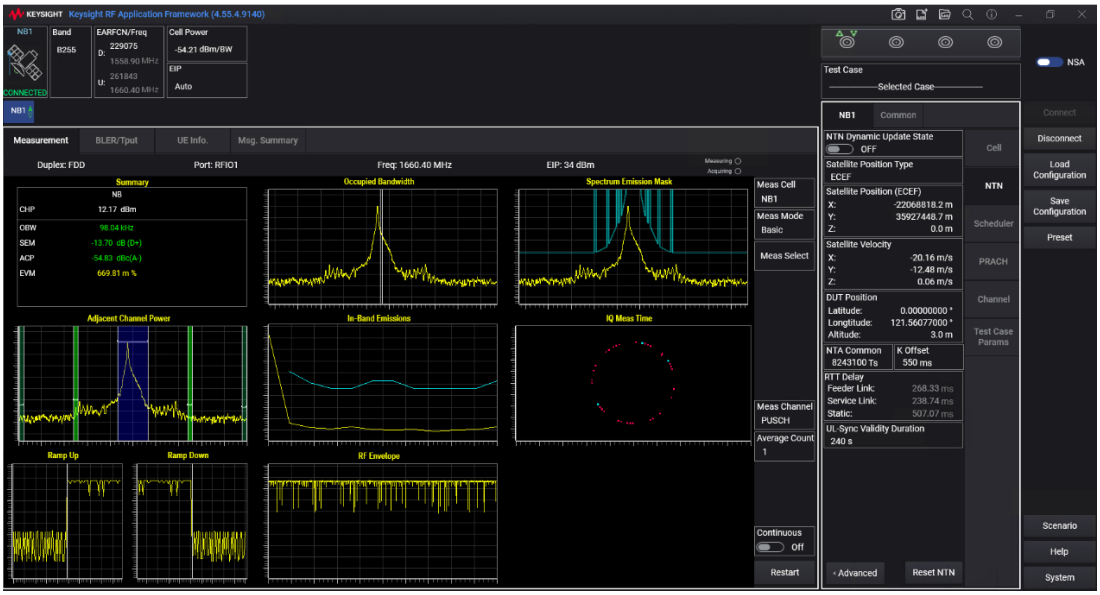

Figure 15. NB-NTN testing

Configure the UXM to emulate a NB-NTN cell with settable satellite and DUT position and then perform RF tests. An important feature to note here is configurable static GSO Doppler frequency shift on the UL and the DL thus enabling testing UEs that support both Non-Geostationary as well as Geostationary satellites.

Configure the UXM to perform NR-NTN tests. Channels n254, n255 and n256 are supported. Once NR-NTN is enabled in the UXM, satellite related parameters are visible to be configured.

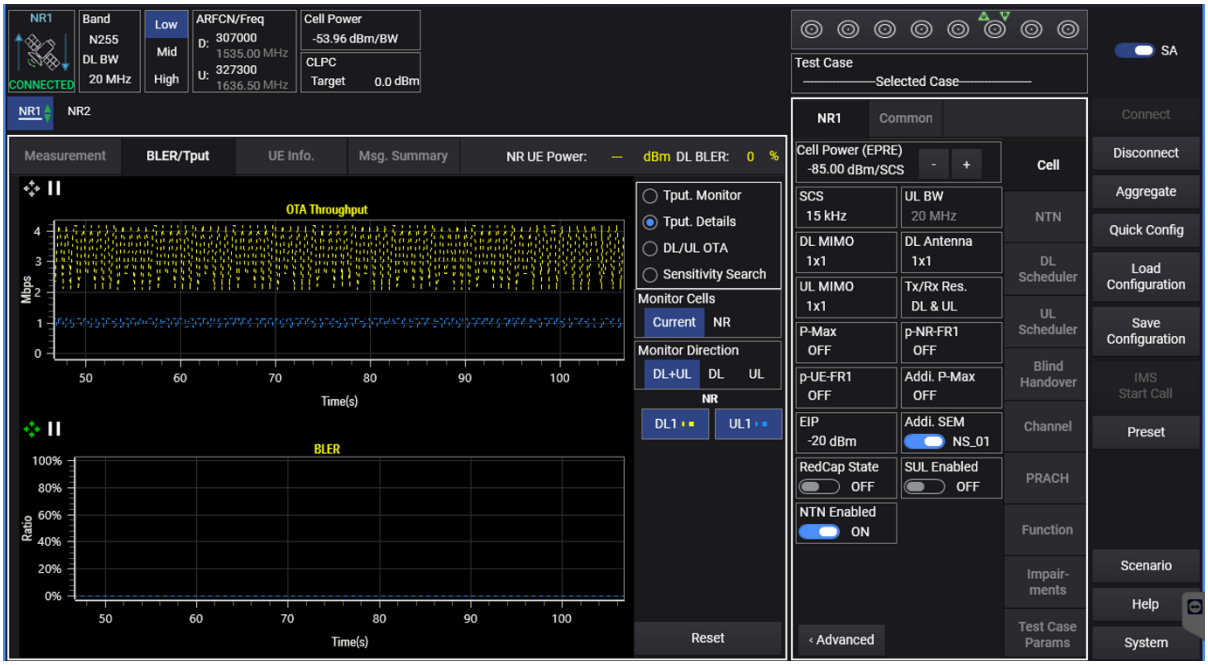

Figure 16. NR-NTN testing

Verify the UL and DL signaling using the message decode feature of the S8714A RA.

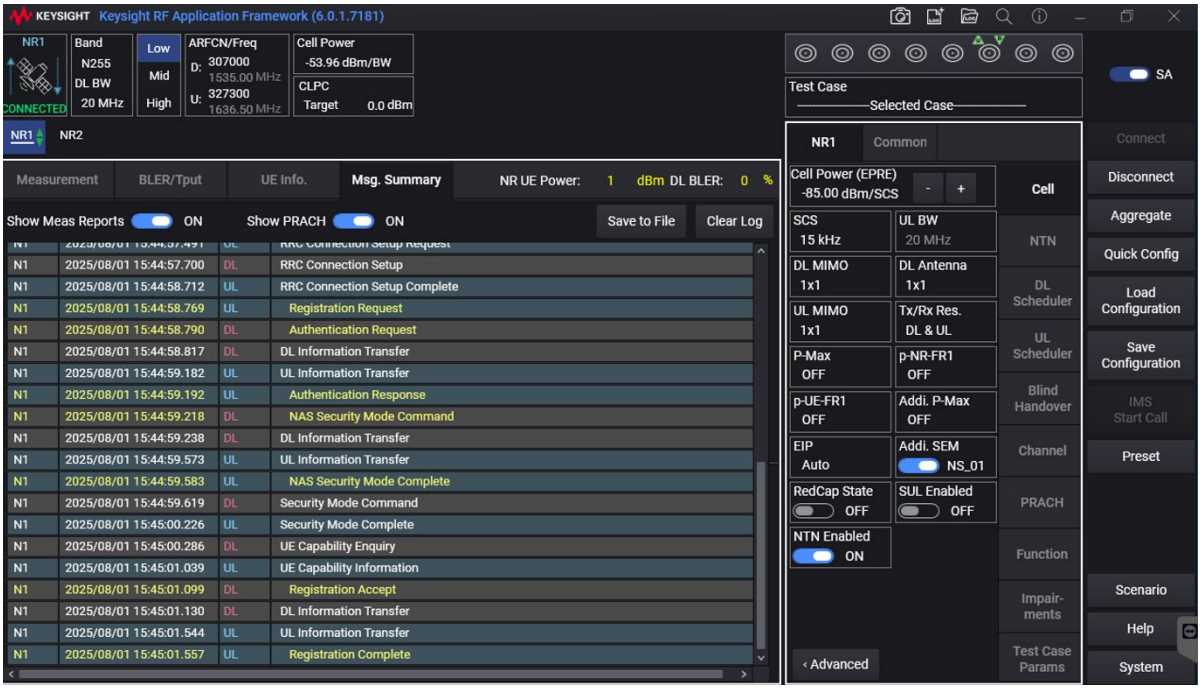

Figure 17. Message decode feature

WLAN RF, Functional and Throughput Testing

Characterize RF behavior with WLAN measurements. Many 5G NR devices also include WLAN capabilities. WLAN uses higher bandwidth and orders of modulation than 5G NR, so verifying RF performance is important.

Keysight's S8714A RA provides WLAN RF measurements based on IEEE standards. Characterize real-time Access Point (AP) (**Figure 18**) or client/station (STA) (**Figure 19**) behavior when link parameters are modified while viewing multiple measurement results. The UXM is the only test platform supporting RF verification of WLAN and 5G NR SA and NSA with signaling in one box.

Figure 18. WLAN AP measurement results example

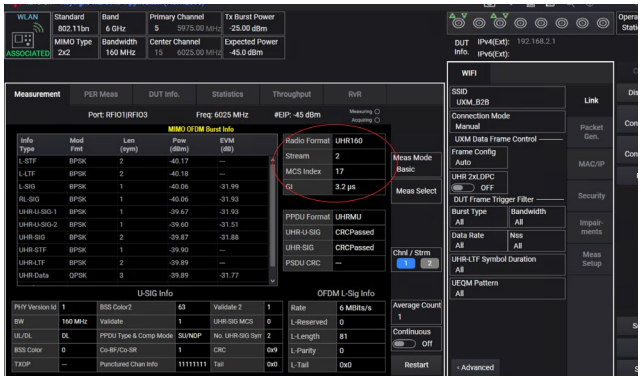

Figure 19. WLAN STA meas. results example

Test the RF performance of 802.11be using at 320 MHz bandwidth and 4x4 MIMO

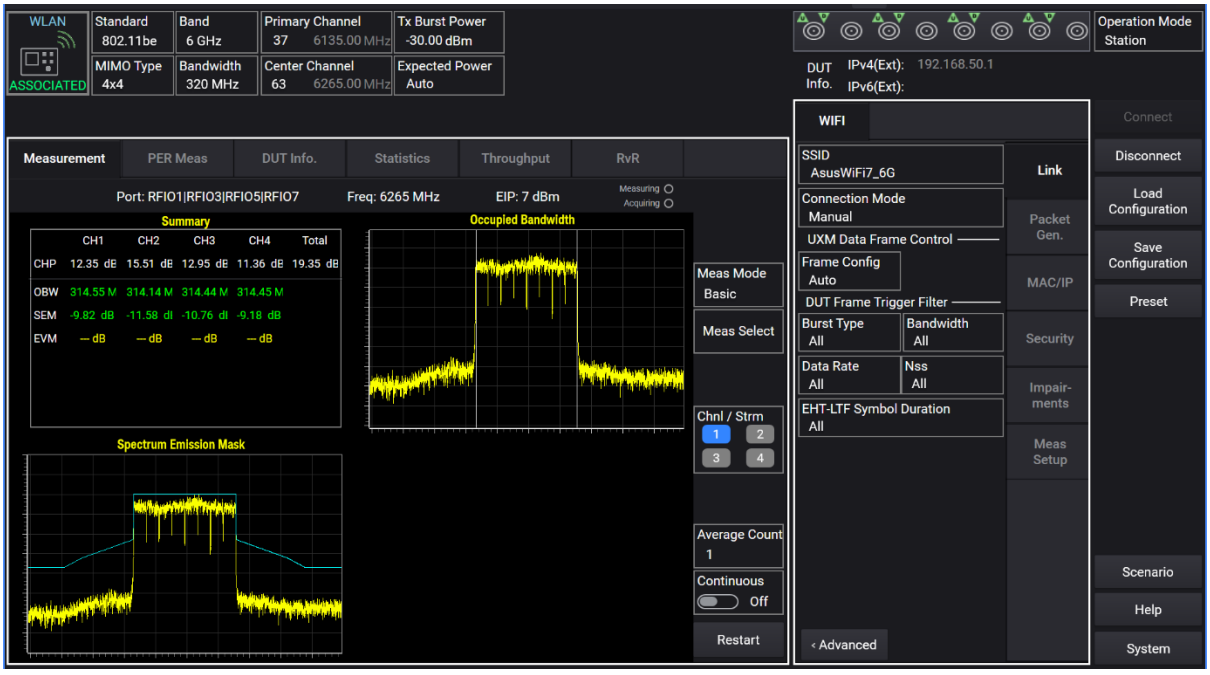

Figure 20. 802.11be 320 MHz bandwidth with 4x4 MIMO testing example

Use the new Non-Signaling mode to test WLAN. The latest release supports 802.11bn (Wi-Fi 8). This mode provides WLAN signal generation and analysis to test a WLAN DUT without the need for signaling. This mode is useful when characterizing the chipset even before the software stack is available for higher layers.

Figure 21. WLAN 802.11 bn Non-Signaling mode test example

Test Voice Over Wi-Fi

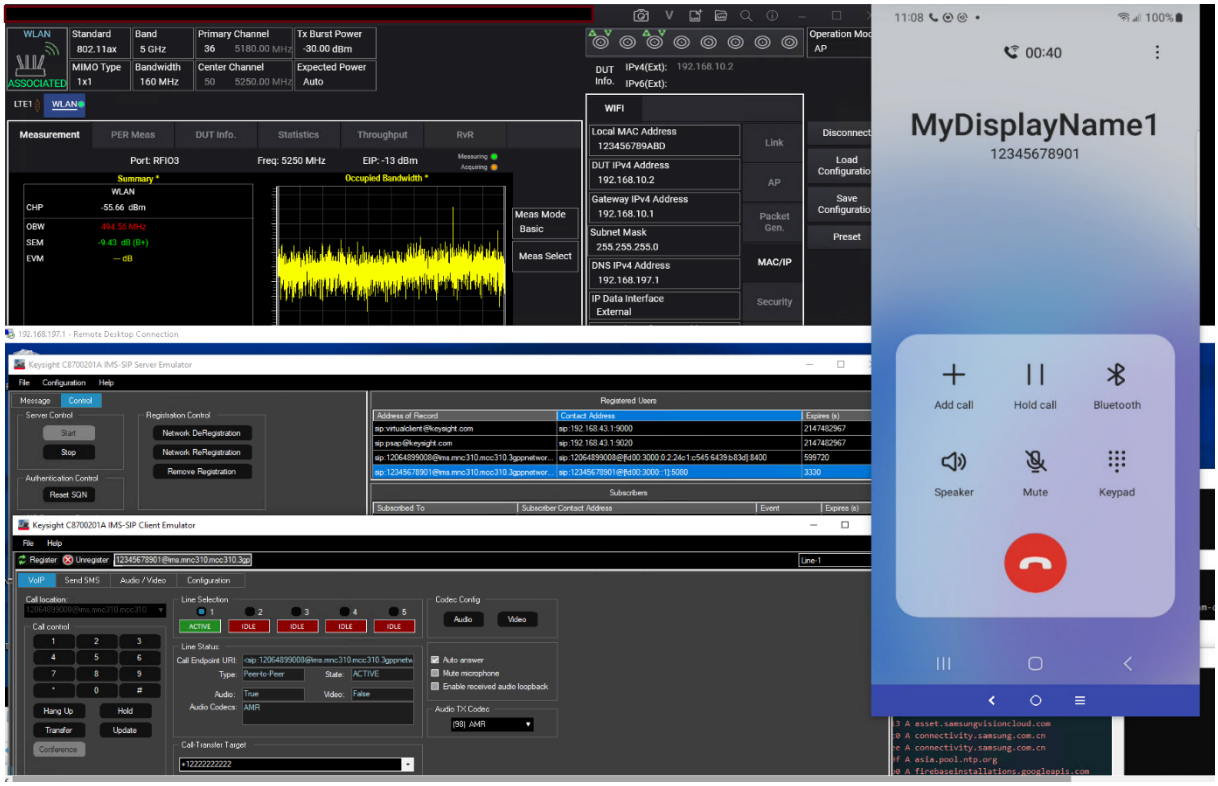

Figure 22. VoWi-Fi testing example

WLAN – Cellular (5G NR & LTE) Coexistence Testing

Figure 23. WLAN - 5G coexistence testing example

Perform WLAN-Cellular coexistence tests using the RA. The RA can emulate WLAN and 5G NR/ LTE simultaneously, thus enabling coexistence tests.

The UXM acts as the AP talking to the DUT through a Wi-Fi connection. Simultaneously it can simulate cellular interference to see how the performance changes on the Wi-Fi side. Similarly, for the AP as the DUT the UXM acts as the STA talking to the AP. The entire scenario pictured here is particularly useful for testing CPE devices. The UXM is used to simulate a cellular signal to the CPE or FWA device to cover a Wi-Fi signal. At the same time, the UXM acts as a Wi-Fi client and receives the Wi-Fi signal from the FWA device.

List of Built-in IEEE 802.11 Tests

RF tests for various WLAN standards are built-in to facilitate quick and easy testing.

Table 13. List of IEEE 802.11 Tests

Standard	Section	IEEE 802.11-2020 WLAN RF Tests
802.11b	15.4.5.2	Transmit power levels
	15.4.5.5	Transmit spectrum mask
	15.4.5.6	Transmit center frequency tolerance
	15.4.5.7	Chip clock frequency tolerance
	15.4.5.8	Transmit power-on and power-down ramp
	15.4.5.9	RF carrier suppression
	15.4.5.10	Transmit modulation accuracy
	15.4.6.2	Receiver minimum input power sensitivity
	15.4.6.3	Receiver minimum input level
802.11a/g	17.3.9.2	Transmit power levels
	17.3.9.3	Transmit spectrum mask
	17.3.9.5	Transmit center frequency tolerance
	17.3.9.6	Symbol clock frequency tolerance
	17.3.9.7.2	Transmitter center frequency leakage
	17.3.9.7.3	Transmitter spectral flatness
	17.3.9.7.4	Transmitter constellation error
	17.3.10.2	Receiver minimum input sensitivity
	17.3.10.5	Receiver maximum input level
	17.3.20.3	Adjacent channel rejection
	17.3.20.4	Nonadjacent channel rejection
802.11ac	21.3.17.1	Transmit spectrum mask
	21.3.17.2	Spectral flatness
	21.3.17.3	Transmit center frequency and symbol clock frequency tolerance
	21.3.17.4.2	Transmit center frequency leakage
	21.3.17.4.3	Transmitter constellation error
	21.3.18.1	Receiver minimum input sensitivity
	21.3.18.2	Adjacent channel rejection
	21.3.18.3	Nonadjacent channel rejection
	21.3.18.4	Receiver maximum input level
802.11ax	27.3.19.1	Transmit spectral mask
	27.3.19.2	Spectral flatness
	27.3.19.3	Transmit center frequency and symbol clock tolerance
	27.3.19.4.2	Transmit center frequency leakage
	27.3.19.4.3	Transmitter constellation error
	27.3.20.2	Receiver minimum input sensitivity
	27.3.20.3	Adjacent channel rejection
	27.3.20.4	Nonadjacent channel rejection

Standard	Section	IEEE 802.11-2020 WLAN RF Tests
	27.3.20.5	Receiver maximum input level
802.11be	36.3.20.1	Transmit spectrum mask
	36.3.20.2	Spectral flatness
	36.3.20.3	Transmit center frequency and symbol clock frequency tolerance
	36.3.20.3	Adjacent channel rejection
	36.3.20.4	Non-adjacent channel rejection
	36.3.20.4.2	Transmit center frequency leakage
	36.3.20.4.3	Transmitter constellation error
	36.3.21.2	Receiver minimum input sensitivity
	36.3.21.5	Receiver maximum input level
802.11bn	38.3.26.1	Transmit spectrum mask
	38.3.26.2	Spectral flatness
	38.3.26.3	Transmit center frequency and symbol clock frequency tolerance
	38.3.26.4.2	Transmit center frequency leakage
	38.3.26.4.3	Transmitter constellation error
	38.3.27.2	Receiver minimum input sensitivity
	38.3.27.3	Adjacent channel rejection
	38.3.26.4	Non-adjacent channel rejection
	38.3.26.5	Receiver maximum input level

Functional and Performance Tests

Perform RF Test of Two Devices Simultaneously with One UXM 5G

Optimize capacity, save time and space, and reduce power consumption when you test two devices using a single UXM 5G platform. Verify LTE, 5G NR SA, and 5G NR NSA RF performance and automate testing using two S8702A RF Automation Toolset (RFA) applications.

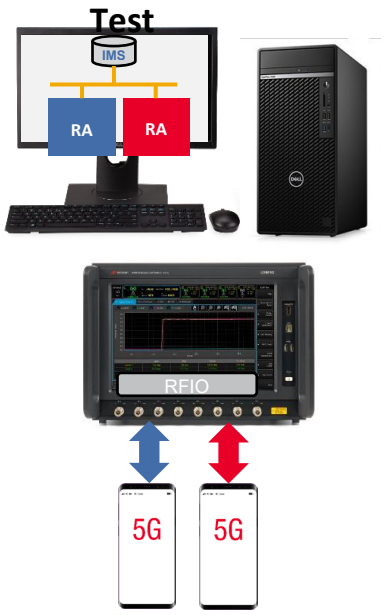

Figure 24. Dual device testing configuration

You need only one set of core signaling and UL RF measurement licenses.

Optimize Device Throughput, Video, And SAR Performance

Once the protocol stack and hardware are integrated with firmware and software, optimization of additional device behavior such as throughput begins. Internet Protocol (IP) data throughput is a measure of a device's real-time performance when downloading videos or uploading photos. Measuring and comparing a device's throughput to the theoretical maximum under different conditions and over time provides data to optimize performance during real-world scenarios.

Use the S8714A RA to select NR Maximum Throughput and automatically configure 5G NR parameters for maximum throughput. Then, measure downlink (DL) and UL IP throughput (**Figure 24**) to compare with theoretical performance.

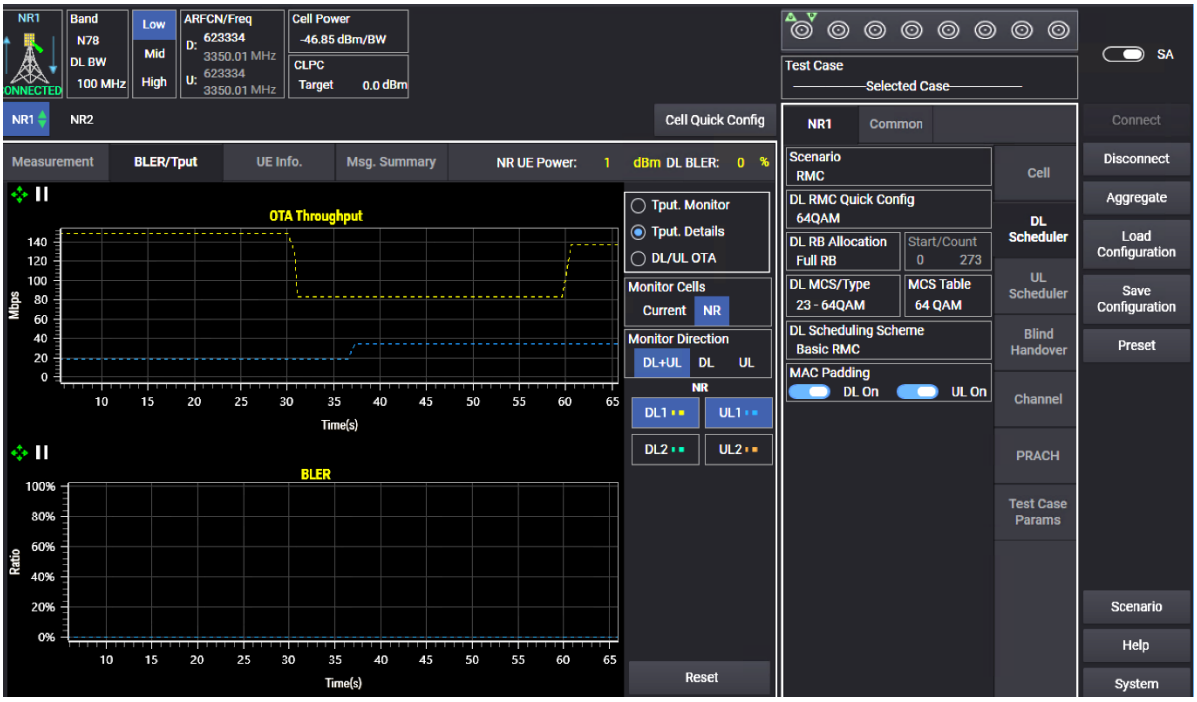

Figure 25. Throughput graph example for 5G NR SA

Establish Voice and Video Connections

Making voice and video calls with a wireless device are common use cases. Many algorithms are used to code and decode (codec) voice into data for transmission and reception. The S8714A RA uses its built-in IMS server and client with selectable codecs to emulate voice and video calls with a device.

Configure Parameters for SAR testing

Analyzing a device's SAR performance is another part of device optimization. SAR test conditions are defined by regulatory groups in each country or region. The S8714A RA makes SAR configuration easy with selections for specific conditions defined by region (Table 14). Testing SAR performance under maximum throughput conditions is another pre-configured selection.

Table 14. S8714A RA built-in SAR test selections

Built-In SAR Test Selection	Country and Duty Cycle
CN Duty Cycle 33% 2x2.5 ms	China 33%
CN Duty Cycle 63% 2.5 ms	China 63%
CN Duty Cycle 60% 2.5 ms	China 60%
CN Duty Cycle 10% 5 ms	China 10%
CN Duty Cycle 71% 2.5	China 71%
EU Duty Cycle 30% 2.5 ms	EU 30%
JP Duty Cycle 50% 2.5 ms	Japan 50%
KR Duty Cycle 23% 2.5 ms	Korea 23%
US Duty Cycle 25% 5 ms	USA 25%
Duty Cycle 23% 5 ms	23%
Maximum Duty Cycle	Maximum
Flexible Duty Cycle (FDD, TDD)	Flexible
User Defined	User Defined

Test IMS Calls

The UXM embedded server can run an IMS server. This set-up can be used for functional tests of features like Emergency Call with or without SIM, MO or MT SMS, Audio or Video call, and Voice over Wi-Fi (VoWi-Fi).

Troubleshoot and Repair Wireless Devices

Repairing wireless devices is an essential part of the workflow. Keysight's S8714A RA helps with troubleshooting of RF, throughput, audio, video, and SMS issues. Automation is important for verification of device performance after repair. RFA and FKPI are toolsets providing quick and easy automation for RF and throughput testing with the RA.

Keysight Solutions Test the Device Workflow

Optimized for speed, Keysight's S8714A RA is designed for RF testing with intelligent signaling and efficient usability. Reduce time to market with this essential solution for RF verification of wireless devices.

Running on the first-to-market UXM wireless test platform, the S8714A RA is an important solution in Keysight's device test portfolio (**Figure 25**).

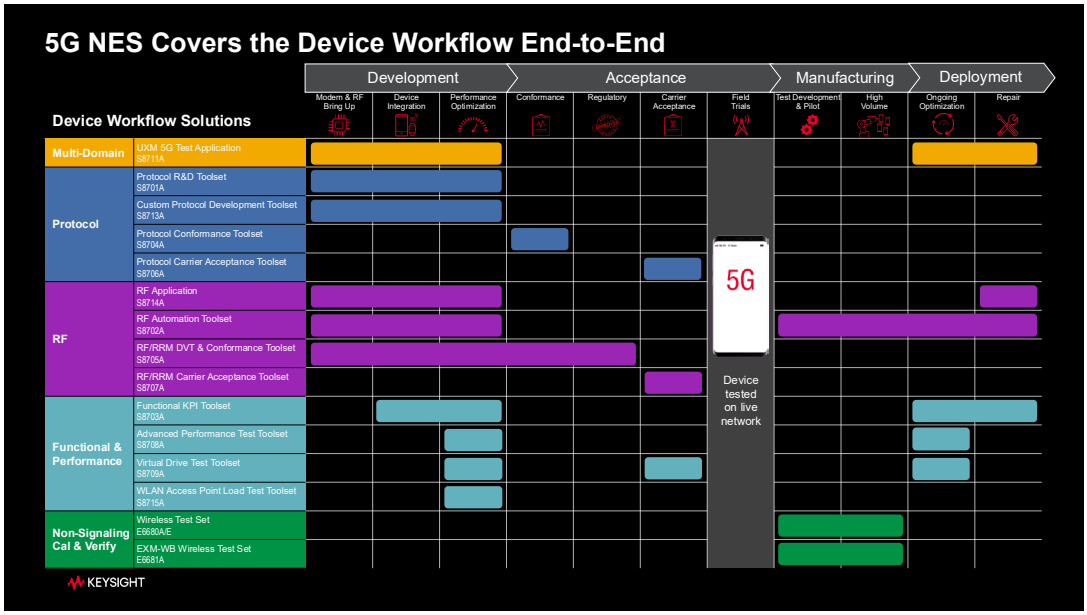

Figure 26. Network emulation solutions

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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