

S8711A UXM 5G Test Application

Verify 5G NR Chipsets and Devices Throughout the Development Workflow

Around the world, commercial deployment of 5G (fifth generation) technology is accelerating to address a wide range of exciting use cases for consumers and industry verticals. Enabling 5G deployment requires rolling out new chipsets and devices at the right price and time.

Most recently, non-terrestrial networks (NTN), reduced capability (RedCap) and 1024QAM (quadrature amplitude modulation) in the downlink (DL) are introducing new challenges for efficient testing of 5G devices used in a large variety of applications. Keysight addresses these 5G design challenges by delivering a comprehensive range of solutions and services that span the device workflow and accelerate innovation for next-generation devices.

The Keysight S8711A UXM 5G Test Application (TA) is a scalable solution that spans the development and acceptance stages of the 5G device workflow. The solution provides a high level of customization for network parameters and testing scenarios.

Keysight's first-to-market 5G network emulation solutions are mature and have been adopted by key 5G players. The TA provides the most comprehensive solution for 5G device development in the market.



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Characterize the Latest 5G NR Device Behavior

The TA software configures and controls Keysight's UXM 5G wireless test platform emulating a 5G new radio (NR) network (Figure 1). The solution spans the development and acceptance stages of the chipset and device workflow, from early prototype testing to integration and verification. It offers significant configuration and customization capabilities for research and development (R&D) purposes.

The S8711A UXM 5G Test Application includes a comprehensive suite of tools for network emulation, radio frequency (RF) parametric testing, functional testing, and application-level testing. The easy-to-use graphical user interface (GUI) handles operations related to emulation and testing across all scenarios, accelerating time to market.



Figure 1. Keysight's UXM 5G wireless test platform and S8711A Test Application software

The most powerful, integrated 5G NR network emulator

Maximizes lab space with small footprint

Supports 5G NR, NTN, RedCap, long-term evolution (LTE) multi-RAT (Radio Access Technology), emergency calls (eCall) with 2G and 3G, cellular vehicle-to-everything (C-V2X), and narrow-band Internet of things (NB-IoT)

Provides full 3rd Generation Partnership Project (3GPP) signaling in frequency range 1 (FR1) to 7.125 GHz, and frequency range 2 (FR2), baseband interface, non-signaling calibration, and layer 1 (L1) testing

Eliminates the need for an external switch matrix and complex cabling with internal RF input/output (RFIO) switching for flexible and dynamic port mapping

Provides high RF port density with scalable bandwidth for flexible band combination testing and carrier aggregation (CA): 8 Tx DL and 4 receiver (Rx) uplink (UL) RF ports at 800 MHz bandwidth

Offers baseband fading for advanced performance testing of 5G NR and LTE technologies including NTN

Supports more than 10 Gigabit Ethernet connectivity for very high data rates

Easy to use with flexible, interactive testing

Control the UXM 5G wireless test platform with internal personal computer (PC) and touchscreen interface

Characterize a device receiver quickly by inspecting block error rate (BLER) and hybrid automatic repeat request (HARQ) statistics reported in real time for each technology and component carrier

Run RF transmitter (Tx) measurements according to 3GPP test specifications or use the full range of PathWave X-Series Measurement Application capabilities to explore beyond the standards

Configure many parameters flexibly to test RF and functional key performance indicators (KPI) across technologies

Benchmark functional KPI such as data rates or battery consumption under realistic conditions such as different propagation models or during mobility

Create realistic scenarios with the easy-to-use GUI, sweeping over many network parameters

Automate custom scenarios using Standard Commands for Programmable Instruments (SCPI)

Test real-world behaviors with network simulation

R&D expert teams that require high configuration and parameterization capabilities in the following organizations benefit from using the TA:

- Device and chipset manufacturers testing RF parameters and performing functional and regression tests during early development
- Laboratories and research institutes requiring specific configurations for network emulation, callbox, over the air (OTA), specific absorption rate (SAR), or electromagnetic compatibility (EMC) testing
- Mobile network operators (MNO) making custom RF and functional measurements for network scenarios easily scaling from conformance to acceptance testing

The S8711A UXM 5G Test Application emulates a network in real time to verify the performance of chipsets and devices (Figure 2). Use it in the lab by interacting with the touchscreen of the UXM 5G wireless test platform or access it from a remote desktop.

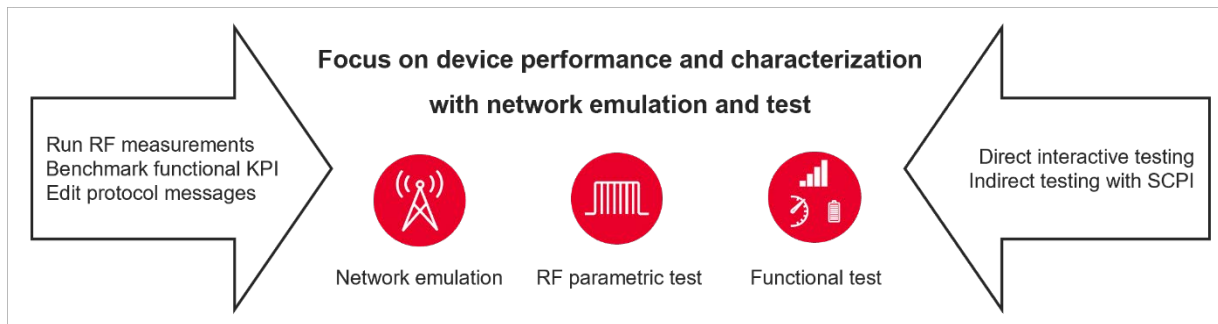


Figure 2. TA use cases

Create operational environments in minutes and conduct testing and debugging in real time. The software generates detailed logs, automatically facilitating troubleshooting, integration, and verification.

Conduct automated tests using SCPI to create operational environments and perform complex testing campaigns such as the verification of full firmware releases. Configuration shortcuts such as full throughput testing, 3GPP reference measurement channels, and multiple-input multiple-output (MIMO) settings facilitate development.

The TA is the most cost-effective tool on the market for performing 5G NR RF and functional tests with network emulation.

Ready for the future	Interactive testing	Scalable solution
Complete network emulation for NTN with NB-IoT and 5G, LTE, 5G FR1, RedCap, FR2, non-standalone (NSA), standalone (SA), TDD (time division duplex), FDD (frequency division duplex), and V2X	High level of parameter configurability	Scale from development to acceptance stage of the workflow
Dynamic port mapping, up to 800 MHz per port	Easy to use with quick config. tools	Create network emulation solutions by activating software test package licenses

Optimize test with scalable hardware

Keysight has the optimal hardware configuration for 5G NR use cases through 3GPP Release 17 (R17).

For 5G NR FR1 SA or NSA testing, the TA software is embedded in the UXM 5G wireless test platform or installed on an external test system PC connected to the platform. Add more UXM 5G wireless test platforms to increase system capability and test additional component carriers, if desired.

Devices that support mmWave (millimeter-wave) frequencies are complex and have integrated antenna arrays requiring OTA testing. To address these challenges, the test configuration includes a UXM 5G wireless test platform providing network emulation, a common interface unit (CIU), and at least two remote radio heads (RRH) to convert between intermediate and mmWave frequencies (Figure 3). Connect up to eight RRH to a CIU or use a CIU without an RRH to generate 6 to 12 GHz for intermediate frequency (IF) testing.



Figure 3. 5G NR FR2 mmWave test configuration

Emulate a Non-Terrestrial Network

As 5G network rollouts continue globally, the drive for subscribers in unserved and underserved locales and applications such as the IoT draws attention to a new opportunity: the non-terrestrial network (NTN). Terrestrial 5G network installations feature the familiar antenna towers mounted on the ground or atop buildings. NTN installations break signaling away from terrain limits, using spaceborne or airborne platforms projecting 5G coverage over previously hard-to-reach, too hazardous to set up, or economically unfeasible-to-service locations safely. 5G NTNs provide economies of scale for operators by superseding proprietary networks and delivering a consistent user experience for subscribers regardless of the mechanics of generating services.

5G NTN technology is guided by working groups within 3GPP with elements defined in R17 (current) and Release 18 (R18, pending) of their 5G specifications. 5G NTN is bringing together the traditional space and satellite industry and cellular networks (Figure 4). NTN services are divided into three main categories:

- Proprietary satellite networks
- 3GPP 5G NTN, which covers both NB-IoT and NR over NTN
- Un-modified cell phone direct-to-device NTN access

Proprietary satellite networks require dedicated user terminals, which are built to connect with their infrastructure. The 3GPP 5G NTN standard requires modifications for both network and devices but supports both narrow-band and wideband services, namely NB-IoT-NTN and NR-NTN. Unmodified cell phone access aims to provide satellite service for any existing LTE or 5G phone by modifying the network to make the satellite resemble a regular terrestrial cell.

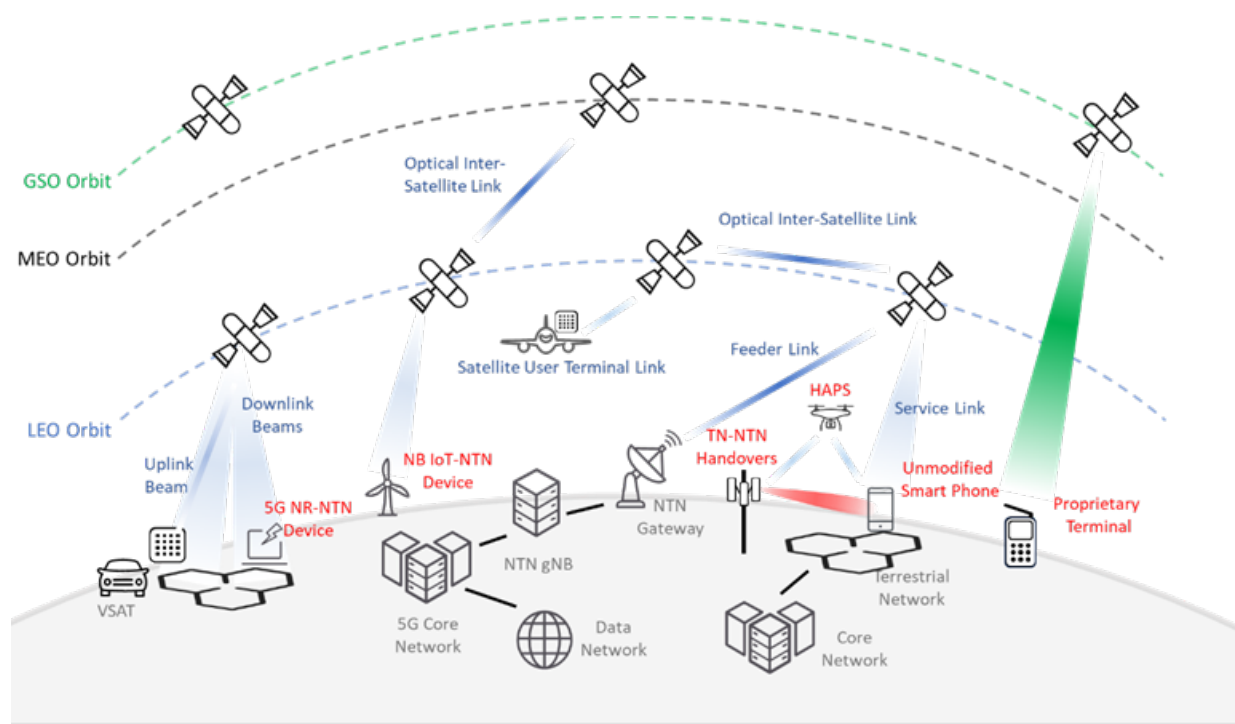


Figure 4. Integration of terrestrial and non-terrestrial networks

Incentives are high for solving system-level complexity and detailed engineering challenges, considering many potential use cases for 5G NTNs such as:

- Additional coverage in remote areas and edges of networks
- Logistics in-transit tracking for long-haul trucking routes, rail lines, and maritime shipping lanes
- Industrial applications for oil fields, mines, offshore platforms, and climate monitoring stations
- Commercial service for airline, high-speed rail, or shipboard passengers, or vast rural areas too sparsely populated for economical tower operation
- Restoring coverage in disaster areas suffering widespread infrastructure outages

Virtual simulation and end-to-end emulation test solutions are crucial for overcoming NTN deployment challenges including providing the consistently high data rates demanded by handheld and vehicle-based devices using video and mapping services and establishing many reliable connections when needed for IoT devices.

Keysight's solutions address these challenges. NTN test solutions are based on the TA where NTN signaling works seamlessly with 5G or NB-IoT signaling to emulate the complete network.

Test C-IoT devices designed to operate with NTN

The test application used with the UXM 5G platform emulates the terrestrial and non-terrestrial networks to communicate with a device using NB-IoT and NTN signaling as defined by 3GPP. Delay, Doppler, and fading emulate the satellite links within the test software to characterize a device's transmitter and receiver RF and functional performance under varying conditions. Data throughput, connection stability, battery life, signal quality, and RF sensitivity are examples of device behavior that is typically tested. Figure 5 shows a TA configuration for orbit emulation.

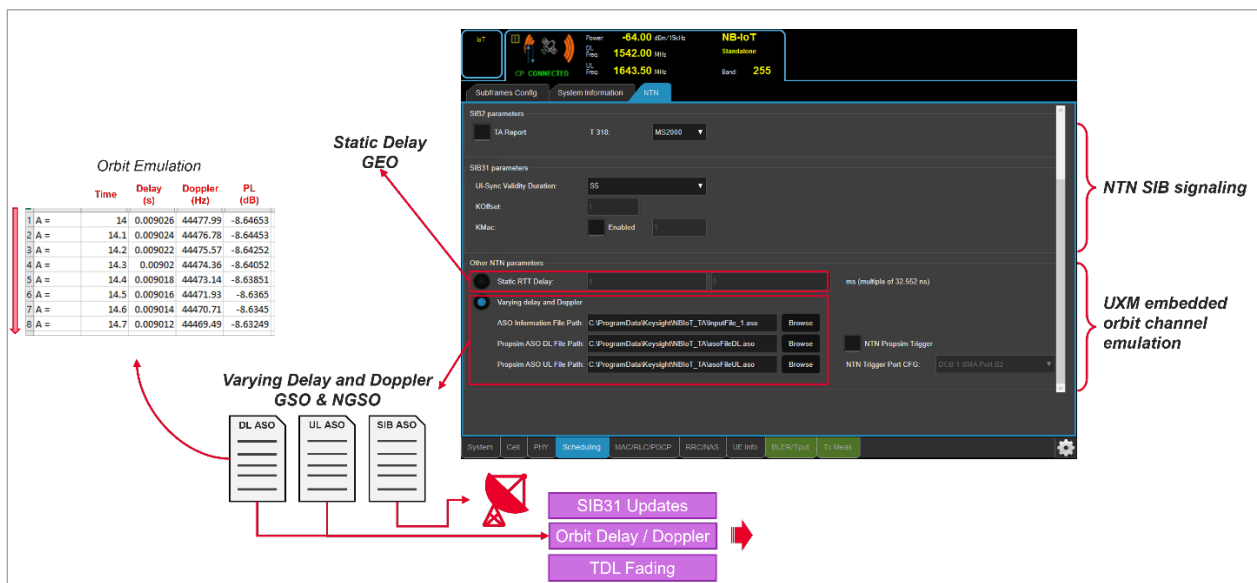


Figure 5. Example of NB-IoT NTN orbit emulation

Test 5G NR devices designed to operate with NTN

Just as with NB-IoT, delay, Doppler, and fading emulate the satellite links within the TA to characterize a 5G NR device under varying conditions. Analyze performance in new frequency bands and mobility scenarios as defined by 3GPP including terrestrial network (TN) to NTN handovers. Import real satellite orbit data and configure up to four NR-NTN cells for mobility testing. Emulate 5G NR TN and NTN end-to-end (Figure 6).

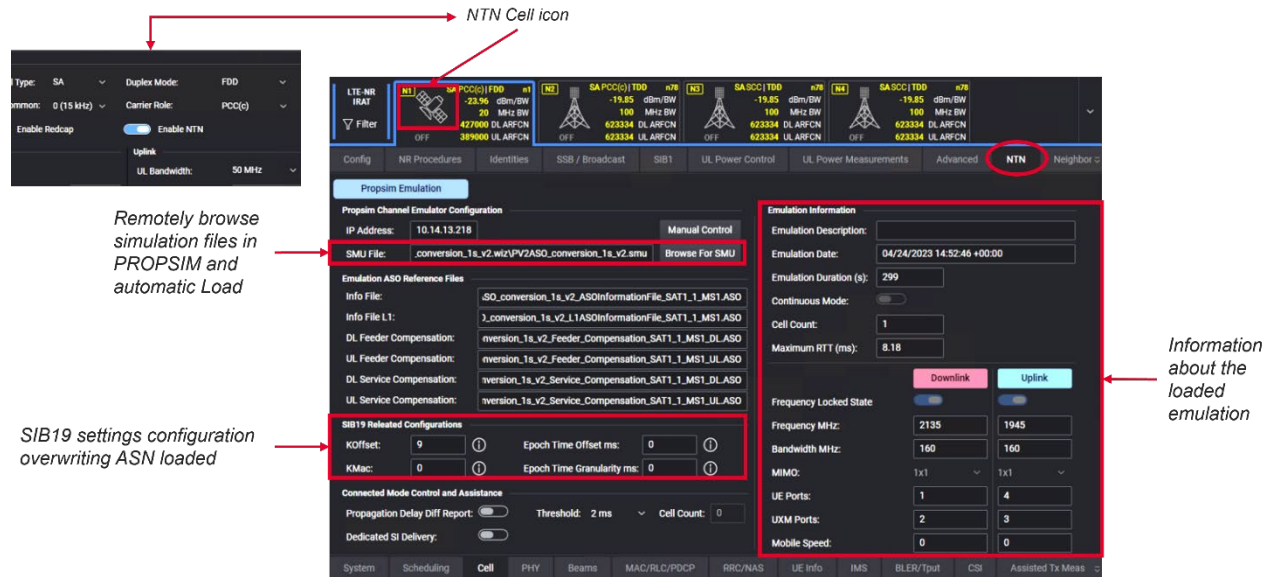


Figure 6. Example of end-to-end test configuration for NR-NTN

Emulate a 5G NR RedCap Network

RedCap is a new feature defined in 3GPP R17. RedCap defines a new type of 5G NR device that has fewer capabilities, thus making it ideal for smaller, lower-cost devices that especially benefit from longer battery life such as those used for surveillance, in smart homes, and wearables.

Keysight's E7515R UXM 5G Wireless Test Platform and S8711A Test Application are the first solution to support testing RedCap devices. While the original E7515B platform also supports RedCap, the E7515R was specifically designed to test RedCap and C-IoT devices. Configure a RedCap cell using TDD or FDD half-duplex, send and receive RedCap messages, and verify functional and RF performance of RedCap devices with the TA (Figure 7).



Figure 7. RedCap device testing with the TA

Emulate a Network with the Latest Features

Keysight's S8711A UXM 5G Test Application provides essential cell and connection settings required for a network emulator. Parameters for R&D customization and control beyond the 3GPP test standards are also available. Configure the desired network in just a few taps or clicks (Figure 8):

1. Aggregate cells from the CA/HO (handovers) button. Primary and aggregated cells are displayed.
2. Configure cell settings (Figure 9 and Figure 10), switch on the cell to transmit, and switch on the device.

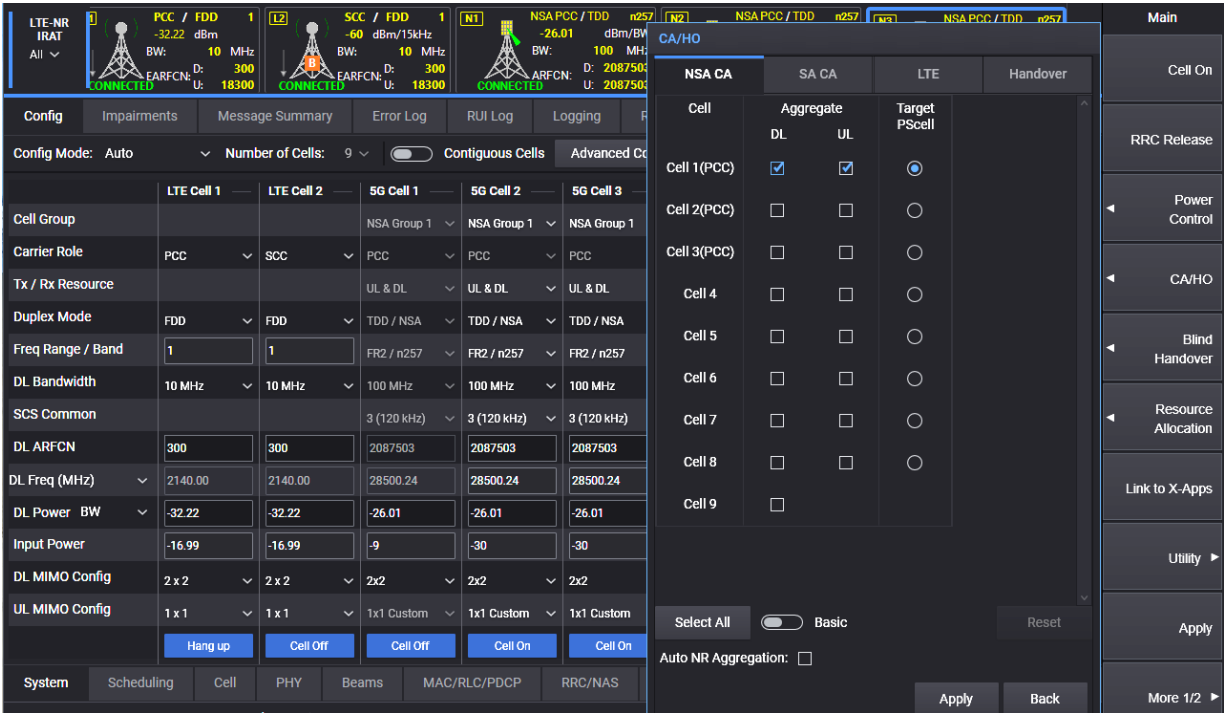


Figure 8. TA system configuration screen

3. Monitor the progress of the test and modify parameters with the powerful GUI and SCPI as shown in Figure 9 and Figure 10.

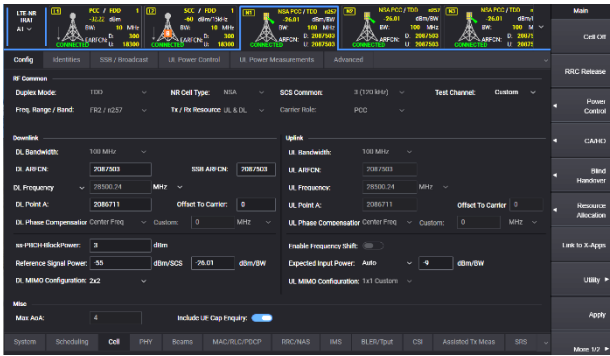


Figure 9. Power and frequency for each cell



Figure 10. Scheduling map for the selected cell

3GPP continues to develop and approve enhancements for 5G NR. Release 16 (R16) features are mostly implemented, R17 features are in development, and R18 features are just starting.

Keysight's solutions are aligned with the latest enhancements from 3GPP. Verify R16 and R17 features in these categories including semi-persistent scheduling (SPS).

- NTN
- RedCap
- 5G NR FR1 DL 1024QAM
- UE (user equipment) power saving
- Small data transmissions (SDT)
- Coverage enhancements such as demodulation reference signal (DMRS) bundling

Execute Functional Tests

Verifying the RF performance of a new design is important, but so is ensuring the end user experience is exceptional. Use the TA to perform functional testing of throughput and voice and video connections under many conditions to increase confidence in device behavior.

Validate throughput under faded conditions

Keysight's S8711A UXM 5G Test Application provides extensive analysis and statistics to test UE receivers to their maximum possible throughput. Test the following scenarios.

- Benchmark 5G NR IP (Internet Protocol) data throughput performance in a fully automated environment
- Verify end-to-end receiver performance for different MCS and RB (resource blocks)
- Achieve sustained maximum data rate for most common transport protocols (File Transfer Protocol (FTP), Transmission Control Protocol (TCP), User Datagram Protocol (UDP), and ping)
- Connect to the Internet to test over-the-top (OTT) applications

Use the Quick Config tool to schedule full throughput to challenge device performance. Modify the settings to see the impact on results during data throughput testing (Figure 11). Activate multiple fading channels to simulate real receive conditions selecting from multiple 5G NR baseband fading model packages for FR1 and FR2 (Figure 12).



Figure 11. Throughput graph example

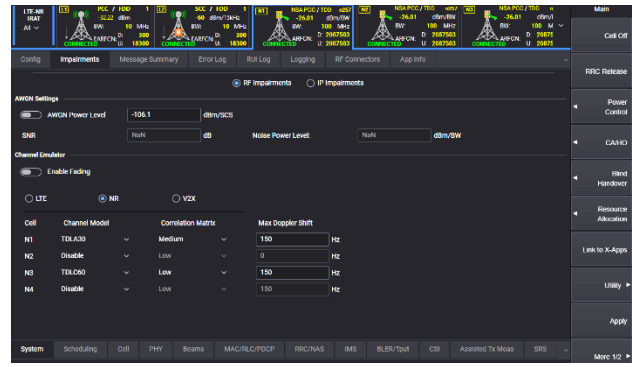


Figure 12. Baseband fading channel model configuration

View all information in reports and analyze the data with Keysight's log viewer, software that is common to all network emulation solutions. For even more detailed RF and signaling analysis, use Keysight's WaveJudge Wireless Analyzer.

Verify mobility scenarios for 5G NR NSA and SA

A handover changes the basic parameters of a cell while in a connected state. Handover testing ensures that a UE delivers the best quality of service under real network conditions. The S8711A UXM 5G Test Application sweeps quickly across all channels supported by the UE without dropping the connection:

- Perform SA-to-SA mobility scenarios based on Radio Resource Control (RRC) events (Figure 13)
- Capture OTA protocol and data throughput to see the data exchanged in real time, with full message decodes, providing a realistic view of how handoffs between cells affect data transfer
- Log, store, retrieve, and analyze previously captured message logs to troubleshoot handovers and ensure uninterrupted service even when crossing cell boundaries

Perform handover testing in many scenarios such as NR-NTN, LTE, 5G NR NSA, 5G NR SA, and inter-RAT. Modify the primary component carrier (PCC) easily from the all-inclusive display.

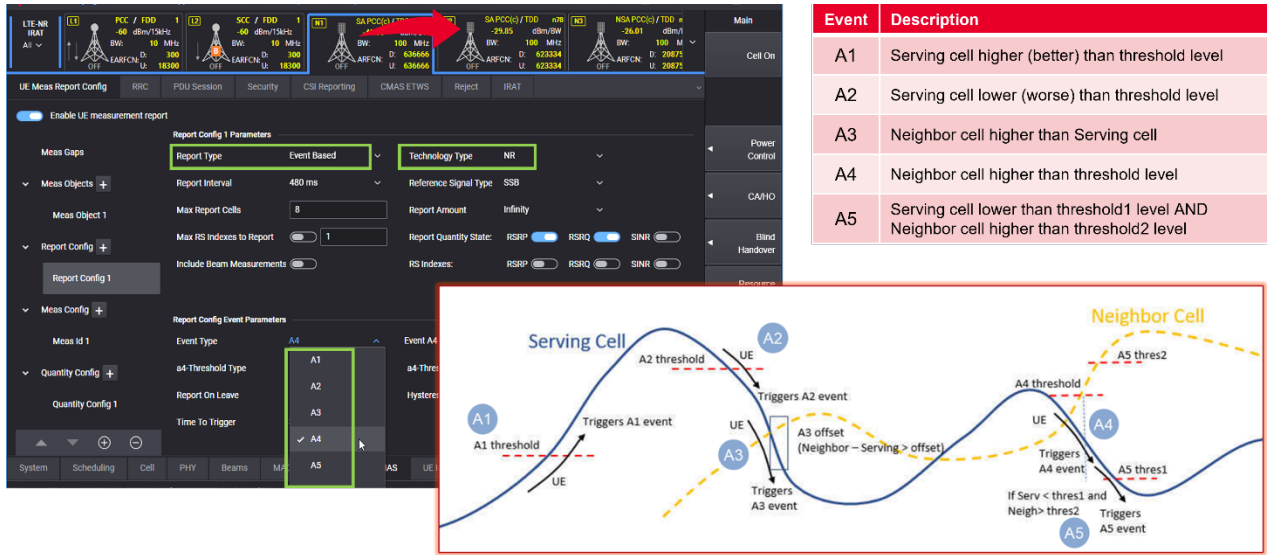


Figure 13. 5G NR SA-to-SA mobility scenario based on RRC events

Use link adaptation to evaluate device behavior

On a live network, the DL and UL are continuously adapting to network conditions to provide the best possible user experience. Verifying a device behaves as expected during such link adaptations minimizes the risk of issues at the end user.

Use the TA software to create link adaptation scenarios

- 5G NR BLER-based link adaptation in the DL and UL
- 5G NR downlink adaptation based on PMI (precoding matrix indicator), RI (rank indicator), or BLER
- 5G NR and LTE downlink adaptation based on CQI (channel quality indicator) behavior

Establish voice and video connections with IMS

Testing the functionality and performance of a wireless device is essential to achieving a good end-user experience.

The S8711A UXM 5G Test Application includes an integrated IMS (Internet protocol multimedia subsystem) server for that purpose. It tests UE voice, video, and SMS (short message service) connections operating over an IMS core. A full client and server implementation performs end-to-end functional testing.

IMS is easy to configure from the IMS tab of the TA software. It provides an OTA network connection between the UE and the IMS-SIP (Session Initiation Protocol) infrastructure emulating a range of network conditions to verify UE performance in a controlled environment:

- Autonomous configuration of data radio bearer (DRB) and packet data network (PDN)
- Direct access to most common actions
- Capability for multiple clients
- Voice over LTE (VoLTE) for LTE and 5G NR NSA networks, and voice over NR (VoNR) for 5G NR networks
- IP impairments for voice connections simulate packet loss, jitter, or delay (Figure 14)

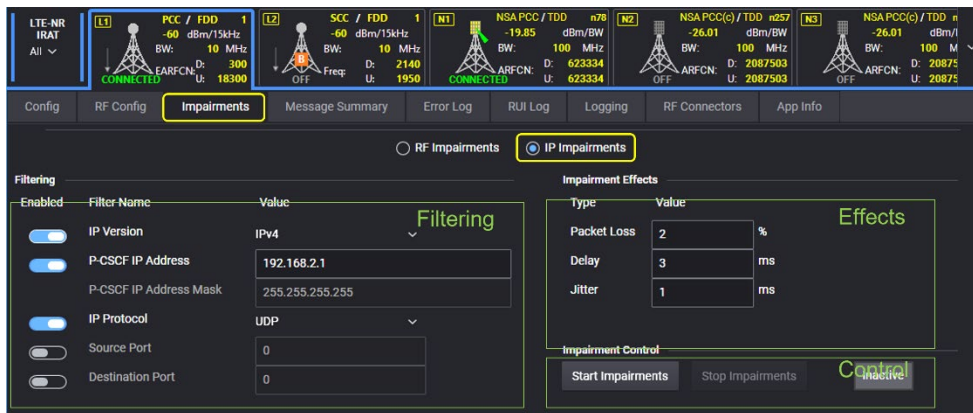


Figure 14. Add IP impairments to voice packets

Perform deep protocol analysis

The S8711A UXM 5G Test Application provides full protocol flexibility on the 5G NR cell reconfiguration message via the ASN.1 (abstract syntax notation) message editor. Use a custom RRC reconfiguration message seed and overwrite the settings in the GUI to exploit simple parameterization capabilities:

The PDU (packet data unit) editor is modern and easy to use.

- Modify ASN.1 messages directly with no direct XML (extensible markup language)
- Sweep by settings in the GUI using a customized ASN seed as a template
- Create and edit customized protocol messages
- Tune RRC settings to enable interoperability at early stages (Figure 15)
- Access any information element not exposed by the TA software
- Send modified reconfiguration messages on a live connection

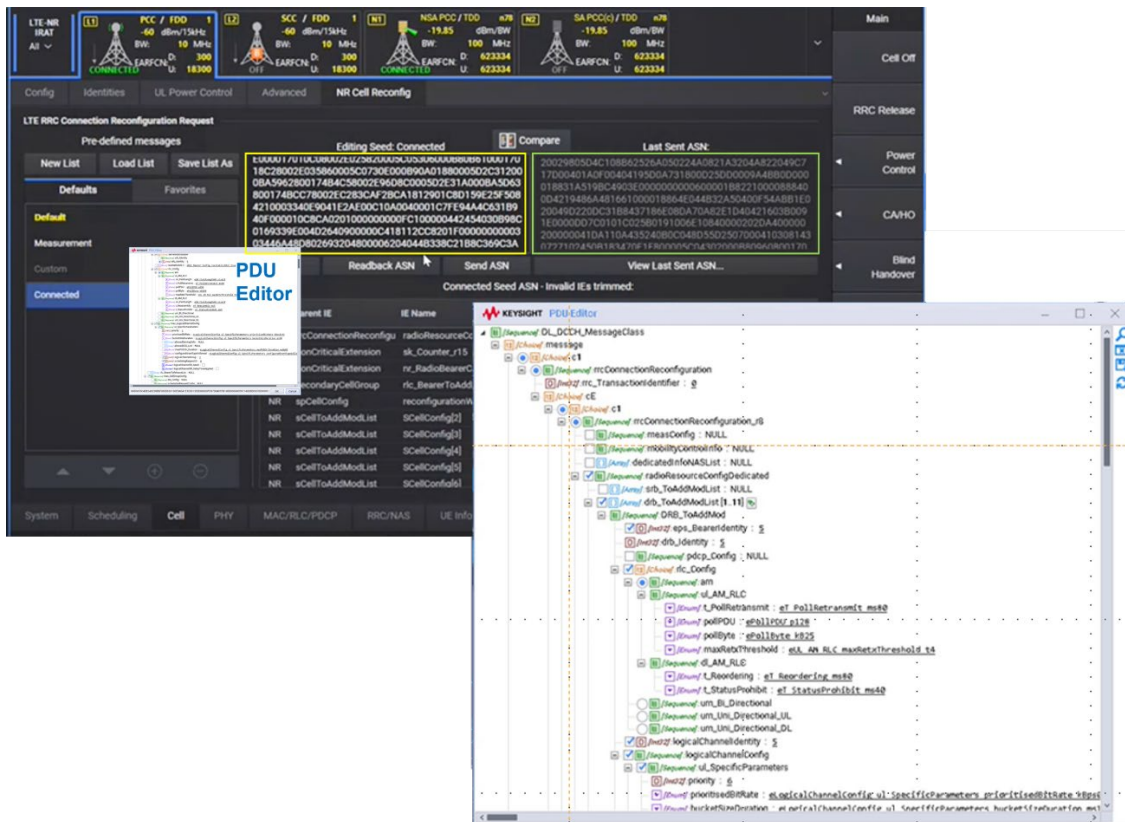


Figure 15. Modifying the 5G NR RRC reconfiguration using the PDU editor

Analyze Device RF Performance

Verifying the RF performance of wireless devices reduces failures at the end user and ensures that poorly performing hardware is reworked before shipment.

Perform RF parametric tests

The S8711A UXM 5G Test Application integrates with Keysight's PathWave X-Series Measurement Applications to provide consistent and familiar results across many hardware platforms (Figure 16).

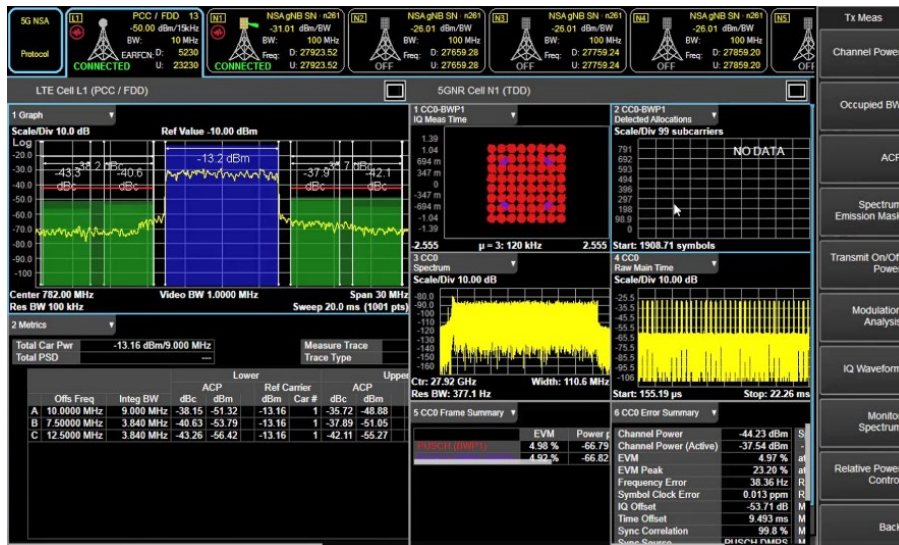


Figure 16. Tx measurements with the PathWave X-Series Measurement Applications

Use these RF measurements to test the transmitter or UL of the UE based on 3GPP test specification (TS) 36.521 and 38.521. View results sooner with faster IQ data captures implemented with 64-bit drivers.

Increase productivity by running 5G NR and LTE measurements simultaneously. Select which 5G NR and LTE cells to measure. Protocol and analyzer parameters are fully synchronized for 5G NR and LTE. View 5G NR and LTE results simultaneously to compare or use a single measurement for more in-depth analysis.

Use the Quick Config tool to configure the test channel frequency automatically according to 3GPP TS 38.508-1. The TA software automatically sets other parameters, including absolute RF channel number (ARFCN) and offset to the carrier.

Use the Quick Config tool for reference measurement channels (RMC) automatically starting the channel configuration when running Tx and Rx tests defined by 3GPP TS 38.521. The TA software automatically adjusts the corresponding parameters, scheduling, time-domain resource allocation (RA) tables, and TDD UL-DL configuration.

Customize the band or channel to analyze UE performance beyond 3GPP limits using user-defined bands, number of RB, RB start, modulation and coding scheme (MCS), or DL control information (DCI) type. Also, test 5G NR Rx sensitivity with diversity.

Calibrate chipsets and devices

Boost confidence in product quality with accurate terminal calibration. The S8711A UXM 5G Test Application provides non-signaling capabilities for chipset calibration. Save time when transitioning new devices to manufacturing by providing the same accuracy and repeatability in the lab as on the production floor. Keysight's solution provides many advantages:

- Only wireless test solution with both RF and high data rate tests to evaluate real-world behavior
- Industry's most accurate, repeatable, and standards-compliant RF measurements
- Return to original/factory performance and accuracy
- Low measurement uncertainties

Test efficiently over many band combinations

Verifying performance across all frequency bands supported by a device is one of the biggest test challenges. If done sequentially, this type of testing requires weeks, perhaps months. Testing across more than one band at a time is more efficient and is essential to reduce cost of test.

Keysight's UXM 5G Advanced has been enhanced to test across more band combinations with a single platform. Create an efficient and customizable solution for automated device verification across band combinations by adding the TA and the S8702A RF Automation Toolset (RFA) to the UXM 5G Advanced platform (Figure 17 and Figure 18).

Status	Band Combo	Description	Marker	RF0 Band	RF0 Status	LTE PCC	LTE SCC	NR PCC	NR SCC	NR BS Allocation
01	DL_3C_3A_4A_5A	5G		1.8E7-1.835E7	5G	PCCT-Band5C-Nul	SCCT-Band5C-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
02	DL_3A_3B_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
03	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
04	DL_3A_3A_4A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
05	DL_3A_3A_4A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
06	DL_3C_3C_3A_5A	5G		1.8E7-1.835E7	5G	PCCT-Band5C-Nul	SCCT-Band5C-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
07	DL_3C_3C_3A_5A	5G		1.8E7-1.835E7	5G	PCCT-Band5C-Nul	SCCT-Band5C-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
08	DL_3A_3C_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
09	DL_3A_3C_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
10	DL_3C_3A_3A_5A	5G		1.8E7-1.835E7	5G	PCCT-Band5C-Nul	SCCT-Band5C-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
11	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
12	DL_3C_3A_3A_5A	5G		1.8E7-1.835E7	5G	PCCT-Band5C-Nul	SCCT-Band5C-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
13	DL_3C_3C_3A_5A	5G		1.8E7-1.835E7	5G	PCCT-Band5C-Nul	SCCT-Band5C-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
14	DL_3C_3A_3A_5A	5G		1.8E7-1.835E7	5G	PCCT-Band5C-Nul	SCCT-Band5C-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
15	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
16	DL_3C_3C_3A_5A	5G		1.8E7-1.835E7	5G	PCCT-Band5C-Nul	SCCT-Band5C-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
17	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
18	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
19	DL_3C_3A_3A_5A	5G		1.8E7-1.835E7	5G	PCCT-Band5C-Nul	SCCT-Band5C-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
20	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
21	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
22	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
23	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
24	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
25	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E
26	DL_3A_3A_3A_5A	5G		1.83E7-1.835E7	5G	PCCT-Band5A-Nul	SCCT-Band5A-Nul	PCCT-Nul-Band5E	SCCT-Nul-Band5E	SCCT-Nul-Band5E

Figure 17. RFA example of band combo test mode

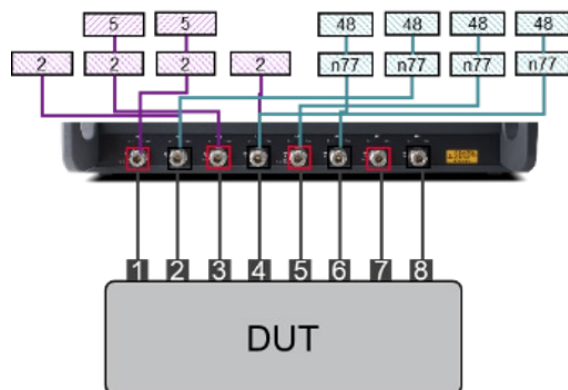


Figure 18. Example band combo configuration

Test Additional Technologies

Many devices support more than 5G NR and LTE. Automotive devices for communication between vehicles and infrastructure such as emergency responders typically support 2G, 3G, LTE, 5G NR, and PC5 signaling. Devices for the IoT such as doorbell cameras, appliances, and vending machines use other technologies such as NB-IoT in addition to cellular.

Verify additional technologies with the same TA software used for 5G NR. Establish and maintain a 3G eCall (Figure 19), verify IoT device performance with NB-IoT or enhanced machine-type communication (eMTC) Category M1, and test automotive devices with a PC5 sidelink and C-V2X (Figure 20).

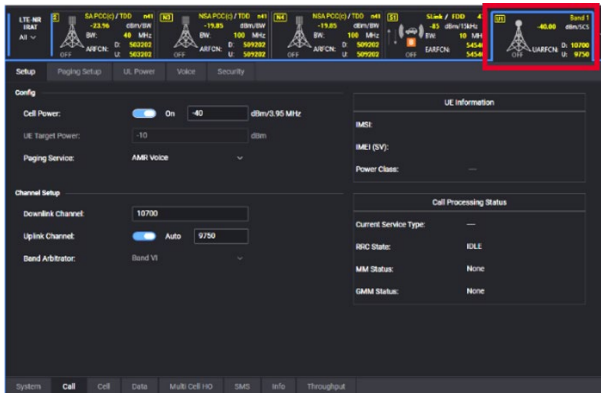


Figure 19. 3G cell for eCall

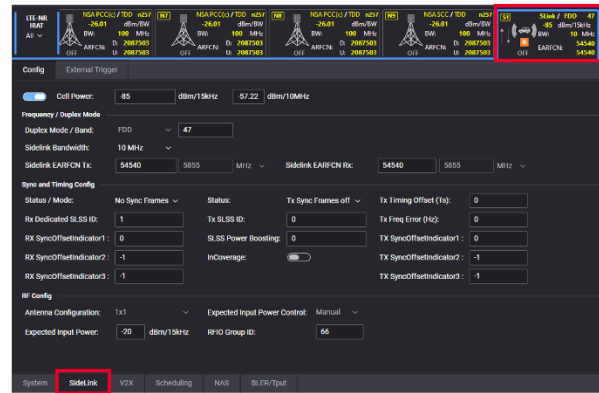


Figure 20. PC5 sidelink

Automate Test Procedures

Each operation performed by the TA software has assigned SCPI which can be optionally displayed on the GUI. For example, modifying a fading channel generates a SCPI command that is displayed at the bottom of the screen (Figure 21). It is easy to create an operational environment with automated testing campaigns.

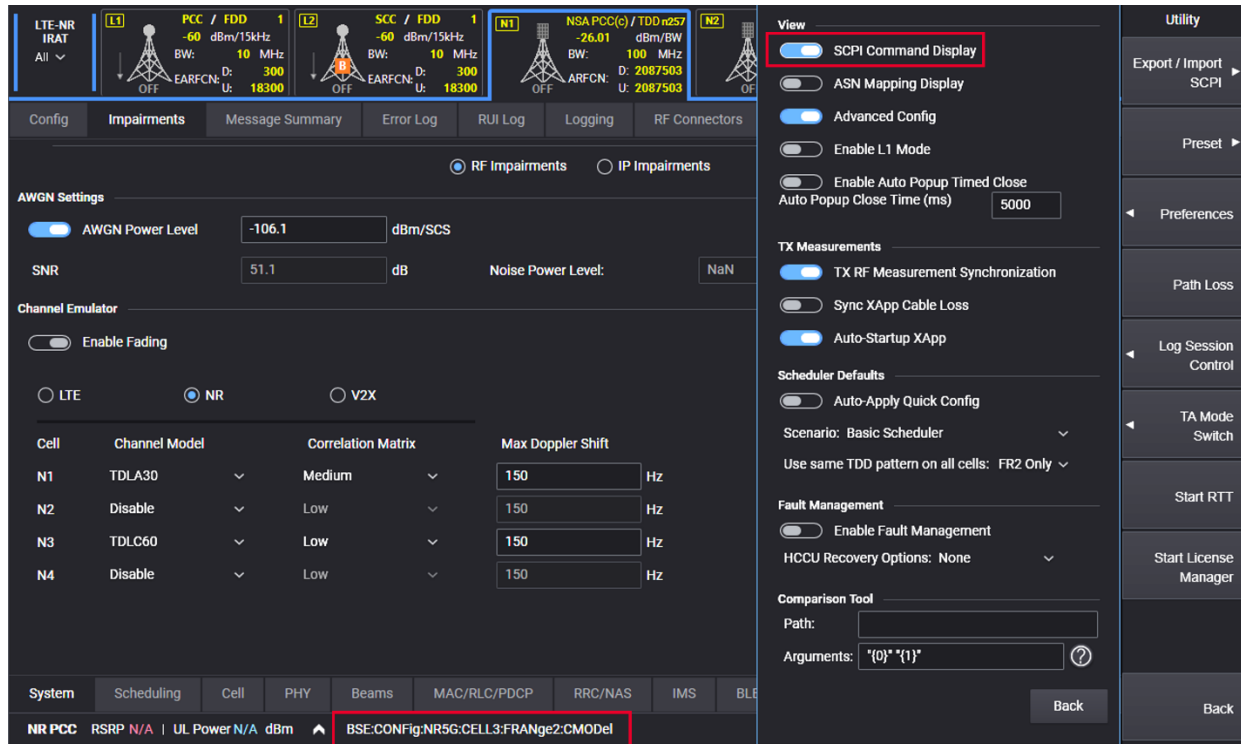


Figure 21. Baseband fading SCPI display enabled

Alternatively, Keysight automation toolsets provide quick development of automated testing. Program RF tests based on 3GPP standards using the RFA combined with the TA. Similarly, the S8703A Functional KPI Toolset (FKPI) provides automation for functional tests such as power consumption and mobility.

Troubleshoot Signaling Issues

The S8711A UXM 5G Test Application generates test activity for each executed test, as well as diagnostic data saved to log files. View and analyze the data during or after test execution.

The log viewer is a user-friendly GUI that displays several windows in at once. It is common across Keysight's network emulation solutions, including the RF/RRM DVT & conformance toolset, (RCT) FKPI, and the protocol R&D toolset (PRT).

View the layers and test information of interest with filtering. Use any of the default filters or create customized filters.

Bookmarks facilitate troubleshooting by enabling viewing of any record in the log (Figure 22). The bookmarks tab displays all created bookmarks.

The log viewer logs the following records:

- 5G NR and LTE protocol messages for all protocol layers: PHY (physical layer), MAC (Medium Access Control), RLC (Radio Link Control), PDCP (Packet Data Convergence Protocol), and RRC
- All information transmitted and received at the air interface, recorded at the MAC/PHY boundary
- Control information such as the activation or deactivation of physical and transport channels

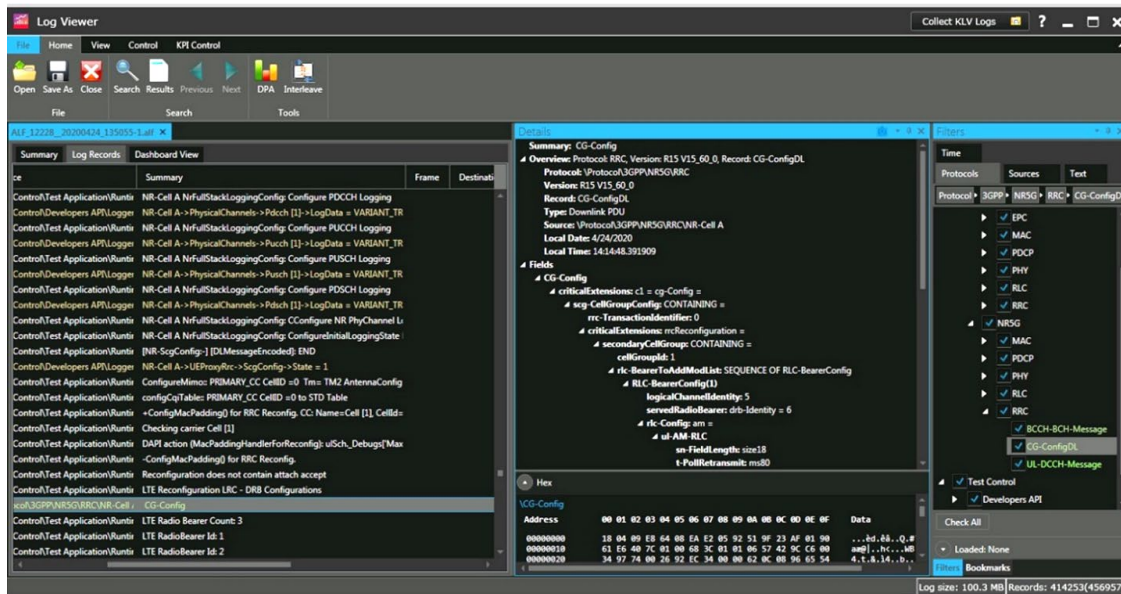


Figure 22. Debugging with the log viewer

Alternatively, Keysight's WaveJudge Wireless Analyzer provide in-depth RF and signaling analysis. Troubleshoot challenging issues with the latest technologies including 5G NR NTN (Figure 23).



Figure 23. Troubleshooting NTN signaling with WaveJudge

Test FR2 using 5G NR Beam Management

5G NR FR2 requires an OTA test environment (Figure 24), representing a major change from previous cabled test methodologies. The S8711A UXM 5G Test Application fully tests the beam management performance of a device (Figure 25). Characterize mmWave beam acquisition, tracking, and management. Emulate the signals as they reach the UE, then evaluate the scenarios:

- Synchronization signal block (SSB) detection
- Beam acquisition
- Beam reporting and switching

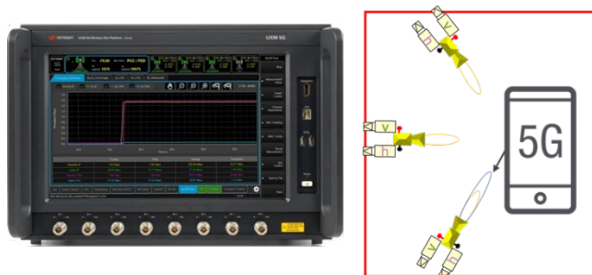


Figure 24. 5G NR beam management test configuration

The beam management menu defines the beams:

- Choose SSB, NZP CSI-RS (non-zero power channel status information root sequence), or ZP (zero power) CSI-RS beams
- Select whether to transmit the beam ID
- Map each beam to a specific angle of arrival (AoA) and power level for the UE to report different reference signal received power (RSRP) values
- Manually trigger the beam switch via RRC or MAC CE (control elements) based on the UE reports
- Use the Quick Config tab to configure multiple parameters for beam resources

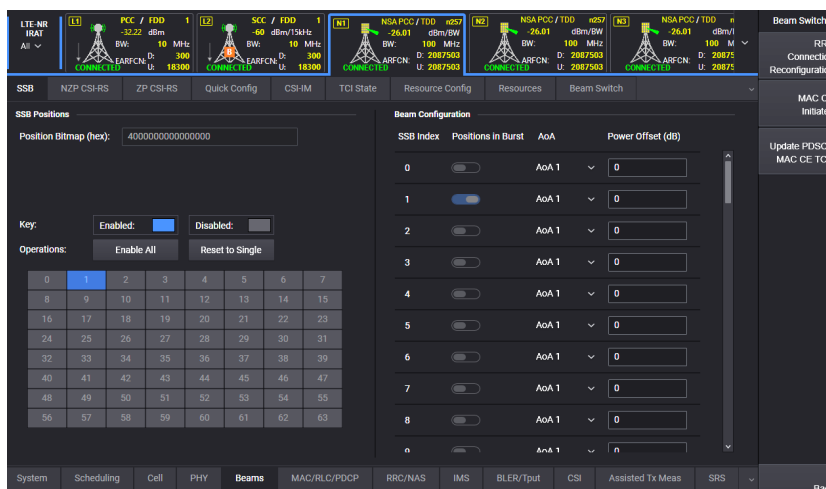


Figure 25. Flexible beam management configuration

Accelerate 5G Chipset and Device Development

5G networks open doors to new business models and provide an edge for those who seize the opportunity. Keysight has designed the UXM 5G wireless test platform to support a comprehensive portfolio of network emulation solutions helping 5G NR chipset and device makers accelerate the development workflow, from initial design to acceptance, and increase confidence in hitting the target performance before market launch.

The S8711A UXM 5G Test Application configures and controls Keysight's UXM 5G wireless test platform. Customize configurations for R&D test with a comprehensive suite of tools for network emulation, RF parametric testing, and functional and application-level testing. Regular releases add new capabilities as defined by 3GPP with R16 and some R17 functionality, such as RedCap, covered today.

Learn More about Keysight Solutions

To learn more about Keysight's network emulation solutions, visit:

- [S8711A UXM 5G Test Application](#)
- [5G Network Emulation Solutions](#)
- [S8702A RF Automation Toolset](#)
- [S8703A Functional KPI Toolset](#)
- [WJ5900A Wireless Analyzer Platform](#)

To learn more about 5G challenges and solutions, visit:

- [5G Chipset Manufacturers](#)
- [5G Device Manufacturers](#)
- [5G Service Providers](#)

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