S8711A UXM 5G Test Application

Verify 5G NR Chipsets and Devices Throughout the Development Workflow

Around the world, commercial deployment of 5G 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.

5G introduces new challenges with the use of millimeter-wave (mmWave) frequencies and beam management and the need for validating complex, integrated next-generation devices over the air (OTA). 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 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 test application provides the most comprehensive solution for 5G device development in the market.

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Characterize 5G NR Device Behavior

The test application software configures and controls Keysight's E7515B UXM 5G Wireless Test Platform emulating a 5G 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. The GUI is more responsive, and colors are brighter with the latest release supporting Windows Presentation Foundation (WPF).

Figure 1. Keysight's E7515B UXM 5G Wireless Test Platform and S8711A Test Application software

The most powerful and integrated 5G NR network emulator	Easy to use with flexible, interactive testing
Maximizes lab space with small footprint	Controls the UXM 5G wireless test platform
Provides simultaneous 5G new radio (NR) and long-term evolution (LTE) multi-RAT (Radio Access Technology), and collaborative Internet of things (C-IoT)	Configure many parameters flexibly to test RF and functional key performance indicators (KPI)
Supports frequency range 1 (FR1) and frequency range 2 (FR2); baseband interface; non-signaling calibration, layer 1 (L1) test, and full 3rd Generation Partnership Project (3GPP) signaling	Run RF Tx measurements according to 3GPP test specifications or use the full range of PathWave X-Series Measurement Application capabilities to explore beyond the standards
Includes internal remote file input/output (RFIO) switch matrix for flexible port mapping	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
Provides high RF port density with scalable bandwidth: eight transmitter (Tx) downlink (DL) and four receiver (Rx) uplink (UL) RF ports at 800 MHz bandwidth	Benchmark functional KPI such as data rates or battery consumption under realistic conditions such as different propagation models or during mobility
Offers baseband fading for advanced performance testing	Create realistic scenarios with the easy-to-use GUI, sweeping over many network parameters
Supports more than 10 Gigabit Ethernet connectivity for very high data rates	Automate custom scenarios using Standard Commands for Programmable Instruments (SCPI)
Includes internal personal computer (PC) and touchscreen interface for benchtop use	

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Integrate, verify, and troubleshoot

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

- 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, 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 simulates 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.
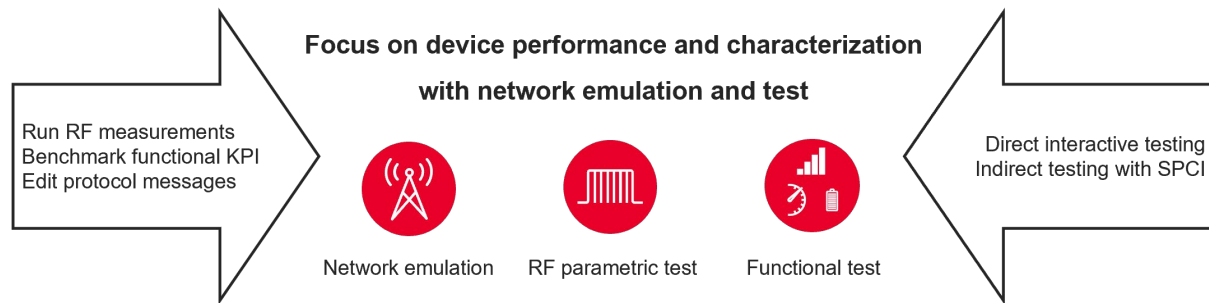

Figure 2. Test application use cases

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 operations 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 operations.

The test application 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 4G, 5G FR1, FR2, non-standalone (NSA), standalone (SA), TDD (time division duplex), FDD (frequency division duplex), cellular vehicle-to-everything (C-V2X), and C-IoT	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 configuration tools	Compatible with the network emulation solutions portfolio by activating software test package licenses

Emulate a 5G NR Network

The S8711A UXM 5G Test Application provides essential cell and connection settings required for a communications test set. 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 3):

1. Aggregate cells from the CA/HO (carrier aggregation/handovers) button. Primary and aggregated cells are displayed.

2. Configure cell settings (Figures 4 and 5), switch cell ON to transmit, and switch device ON.
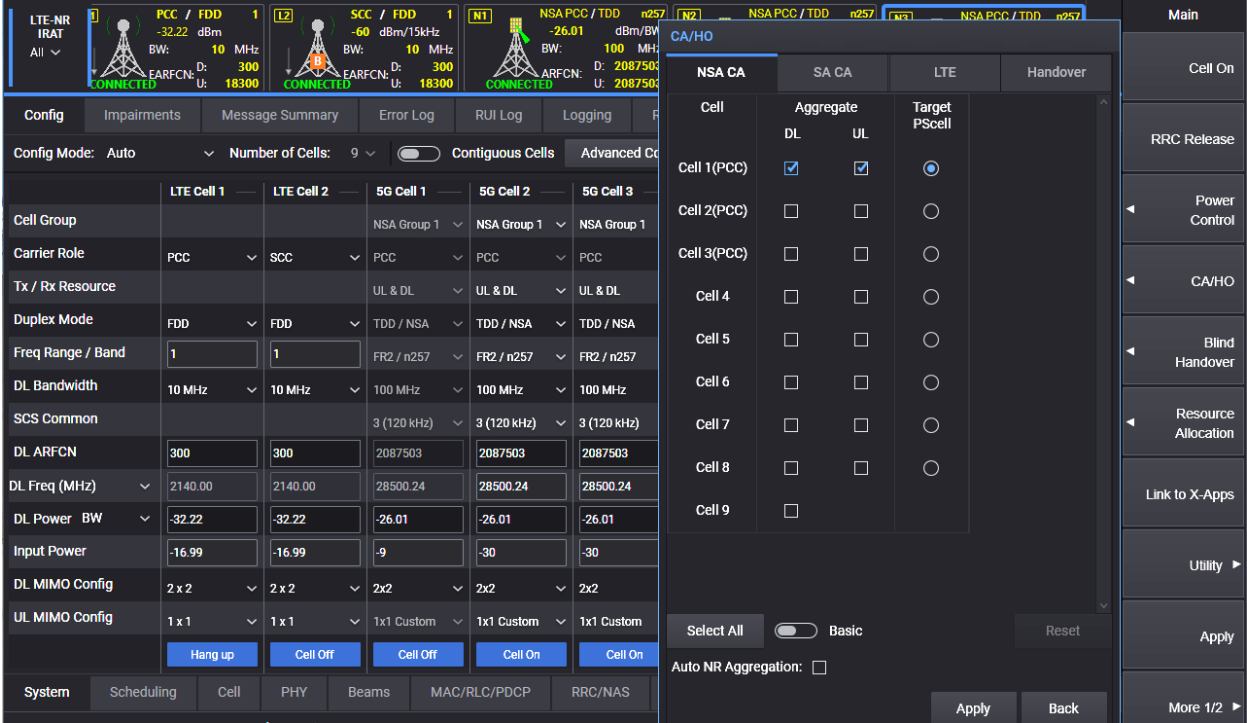
Figure 3. Test application system configuration screen

3. Monitor the progress of the test and modify parameters with the powerful GUI and SCPI.
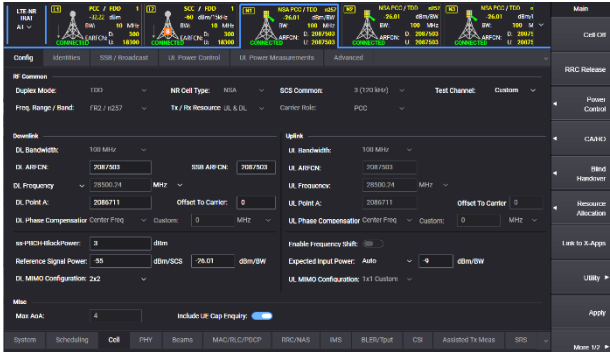

Figure 4. Power and frequency for each cell

Figure 5. Scheduling map for the selected cell

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 6).
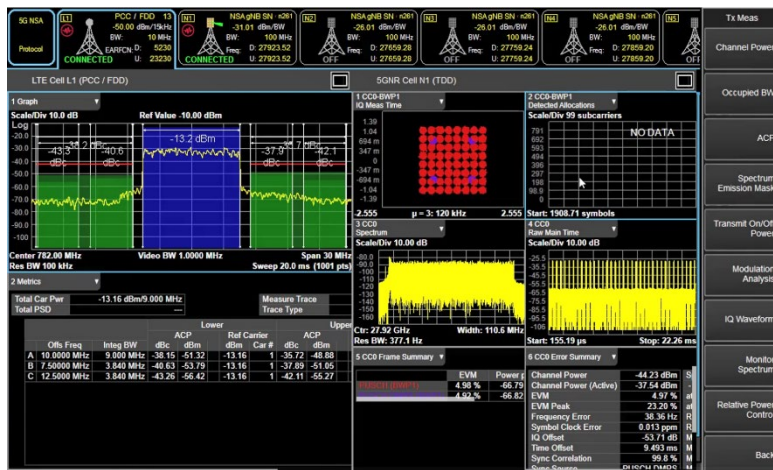

Figure 6. Transmit measurements with the PathWave X-Series Measurement Applications

Use these RF measurements to test the transmitter or UL of the user equipment (UE) based on 3GPP test specification (TS) 36.521 and 38.521. View results sooner in the latest release of the test application software with faster IQ data captures implemented with 64-bit drivers also providing more memory.

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 test application software automatically sets other parameters, including absolute RF channel number (ARFCN), point A, 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 test application 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 resource blocks (RB), RB start, modulation and coding scheme (MCS), or downlink 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

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 test application 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

The S8711A UXM 5G Test Application provides extensive analysis and statistics to test UE receivers to their maximum possible throughput. Generate data externally from a server connected to the UXM 5G wireless test platform (Figure 7) to test the following scenarios.

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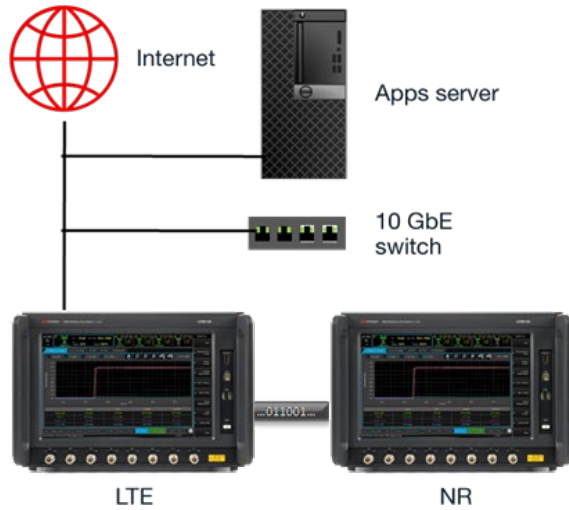- Connect to the Internet to test over-the-top (OTT) applications

Figure 7. Data throughput test configuration

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 8)
- Activate multiple fading channels to simulate real receive conditions selecting from multiple 5G NR baseband fading model packages for FR1 and FR2 (Figure 9)
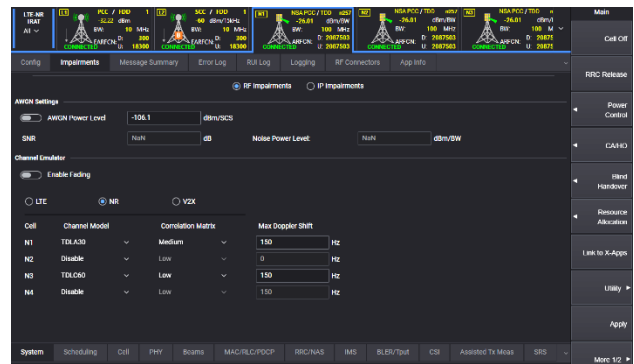

Figure 8. Throughput graph example

Figure 9. 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.

Perform handovers 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 handovers based on Radio Resource Control (RRC) events
- 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 LTE, 5G NR NSA, 5G NR SA, and inter-RAT. Modify the primary component carrier (PCC) easily from the all-inclusive window (Figure 10).

Figure 10. Handover test configuration

Use link adaptation to evaluate device behavior

On a live network, the downlink and uplink 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 test application software to create link adaptation scenarios (Figures 11 and 12).

- 5G NR BLER-based link adaptation in the downlink and uplink
- 5G NR downlink adaptation based on PMI (precoding matrix indicator), RI (rank indicator), or BLER
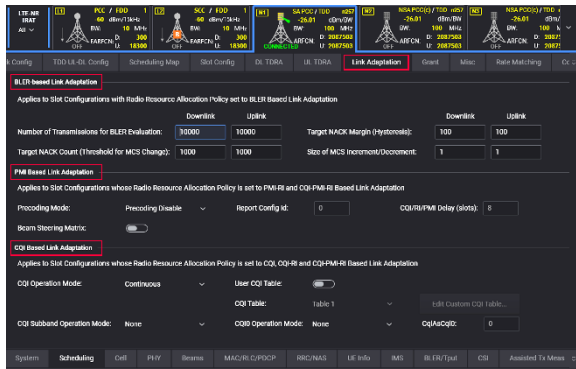- 5G NR and LTE downlink adaptation based on CQI behavior
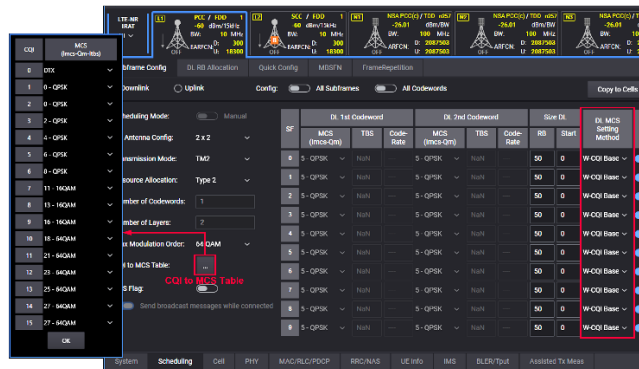
Figure 11. 5G NR link adaptation parameters

Figure 12. LTE link adaptation parameters

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 services operating over an IMS core. A full client and server implementation performs end-to-end functional testing (Figure 13).

Figure 13. IMS test configuration for voice and video

IMS is easy to configure from the IMS tab of the test application software. It provides an OTA network connection between the UE and the IMS-SIP (Session Initiation Protocl) 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

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 message editor. Use a custom RRC reconfiguration message seed and overwrite the settings in the GUI to exploit simple parameterization capabilities:

The PDU Editor is modern and easy-to-use.

- Modify ASN.1 messages directly with no direct XML use
- 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 14)
- Access any information element not exposed by the test application software
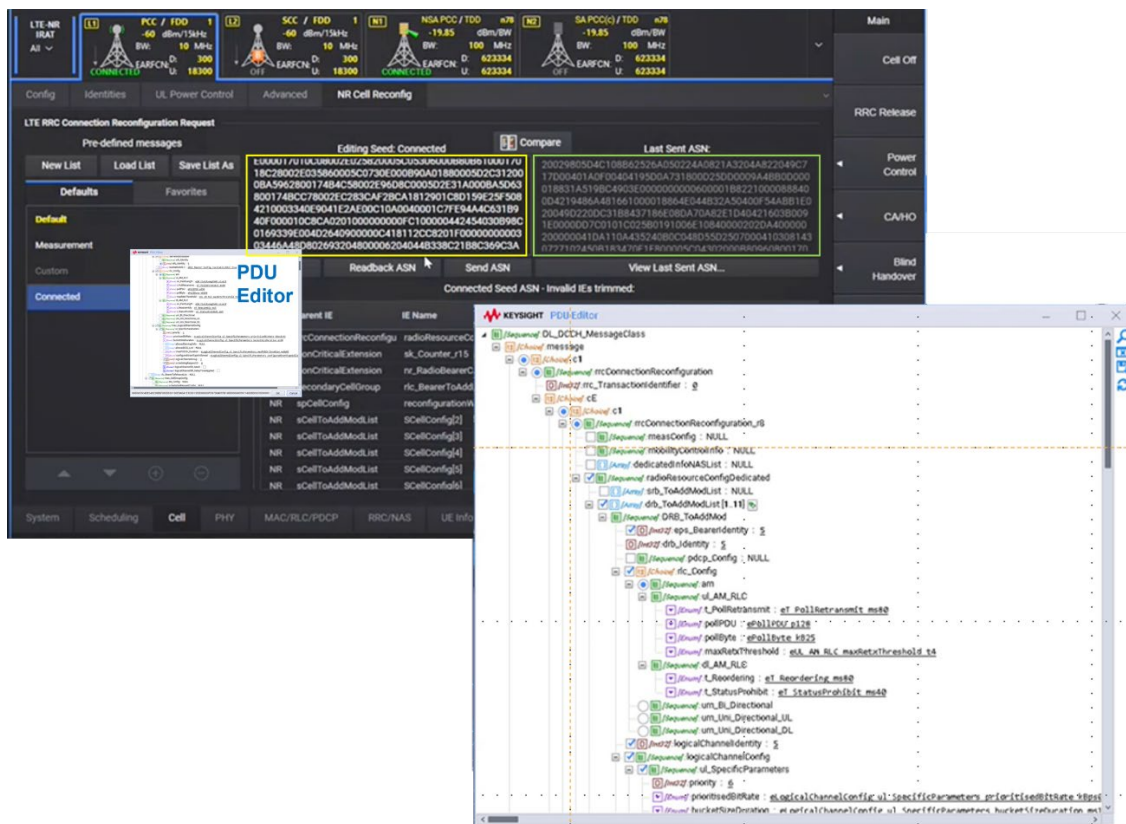- Send modified reconfiguration messages on a live connection

Figure 14. Modifying the 5G NR RRC reconfiguration using the PDU Editor

Test Using 5G NR Beam Management

5G NR FR2 requires an OTA test environment (Figure 15), 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 16). Characterize mmWave beam acquisition, tracking, and management. This test mode emulates the signals as they reach the UE. Evaluate these scenarios:

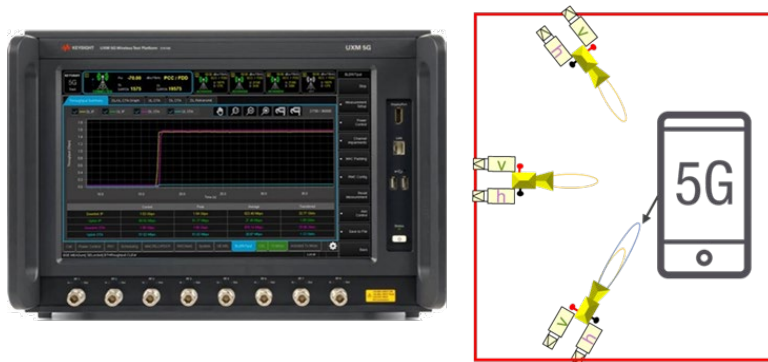- Synchronization signal block (SSB) detection
- Beam acquisition
- Beam reporting and switching

Figure 15. 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 (Medium Access Control control element) based on the UE reports
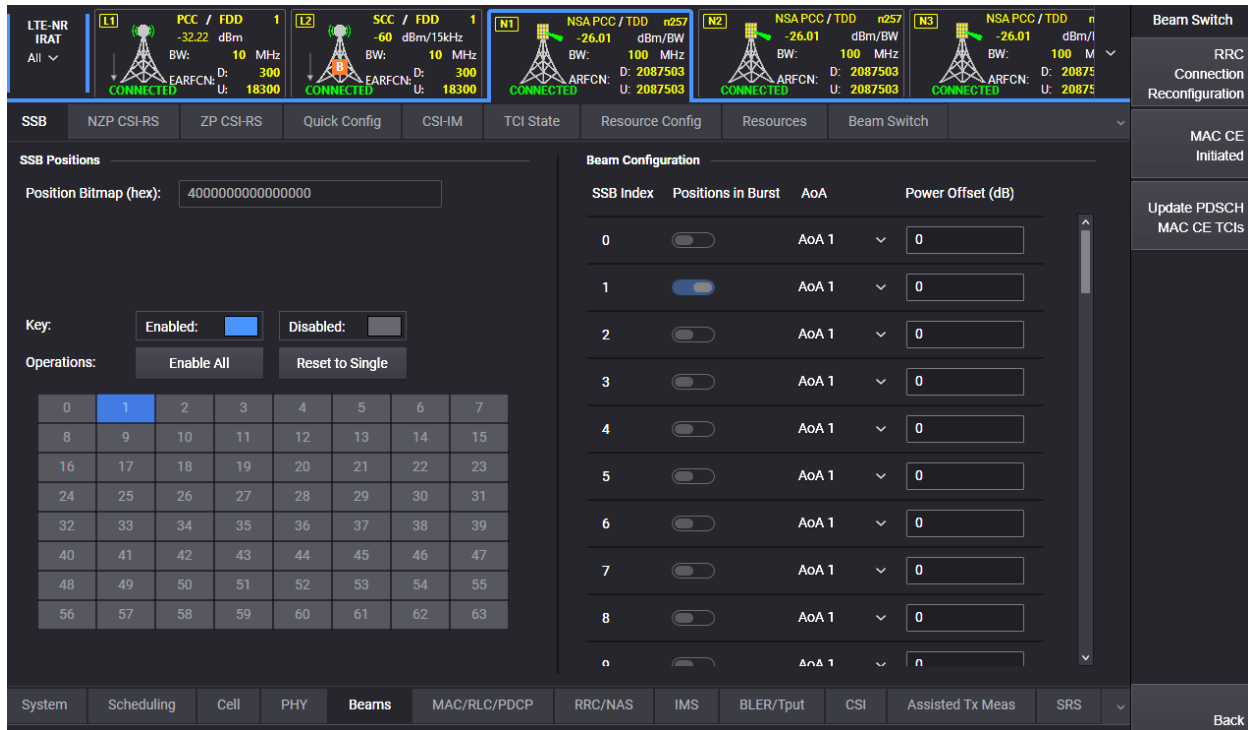- Use the Quick Config tab to configure multiple parameters for beam resources

Figure 16. Flexible beam management configuration

Troubleshoot with Log Viewer

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.

Log Viewer is a user-friendly GUI that displays several windows in one view. It is common across Keysight's network emulation solutions, including the RF/RRM DVT & conformance toolset, the functional KPI toolset, and the protocol R&D toolset.

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

Bookmarks facilitate troubleshooting by enabling viewing of any record in the log (Figure 17). The Bookmarks tab displays all created bookmarks.

Log Viewer logs the following records:

- 5G NR and LTE protocol messages for all protocol layers: PHY (physical layer), MAC, 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
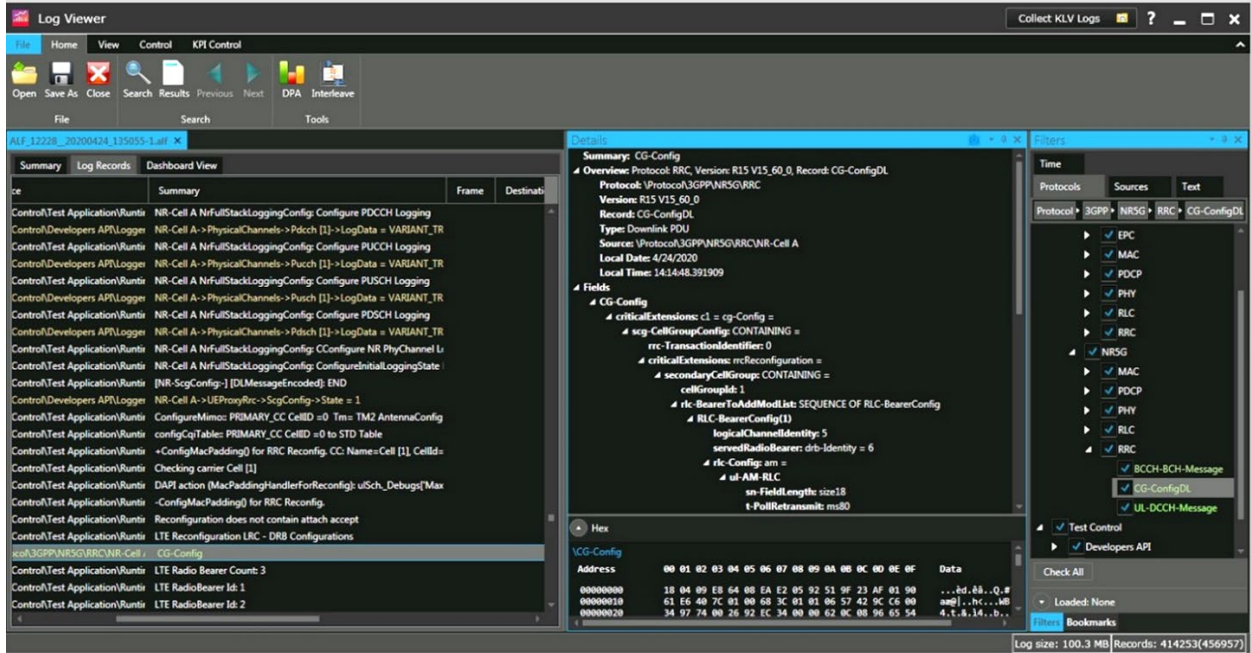- Control information such as the activation or deactivation of physical and transport channels

Figure 17. Debugging with Log Viewer

The Dashboard Viewer displays predefined or customized graphs using a list of KPI previously captured in Log Viewer. Display graphs and data for different KPI in the same view and create a dashboard (Figure 18). Display KPI data numerically or graphically with the style option. Select from different types of graphs such as histograms and time or scatter graphs. Launch the Dashboard Viewer during or after test execution.
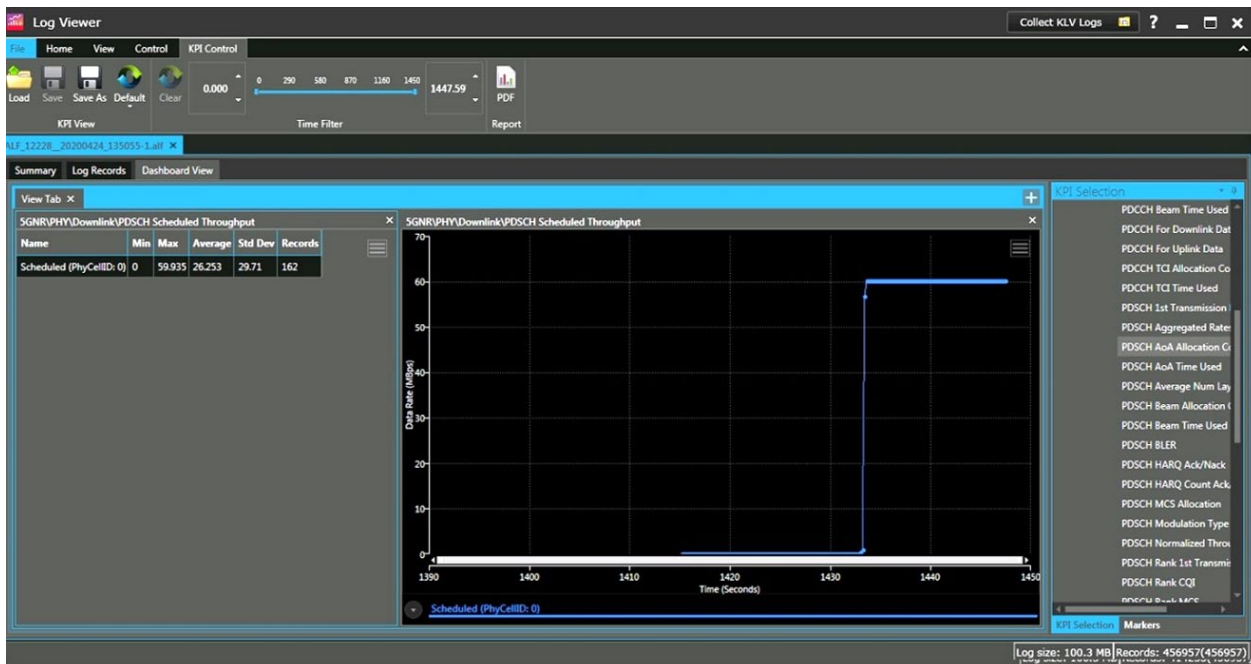

Figure 18. Dashboard Viewer shows graphical KPI data in one view

Automate Test Procedures

Each operation performed by the test application 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 19). It is easy to create an operational environment with automated testing campaigns.
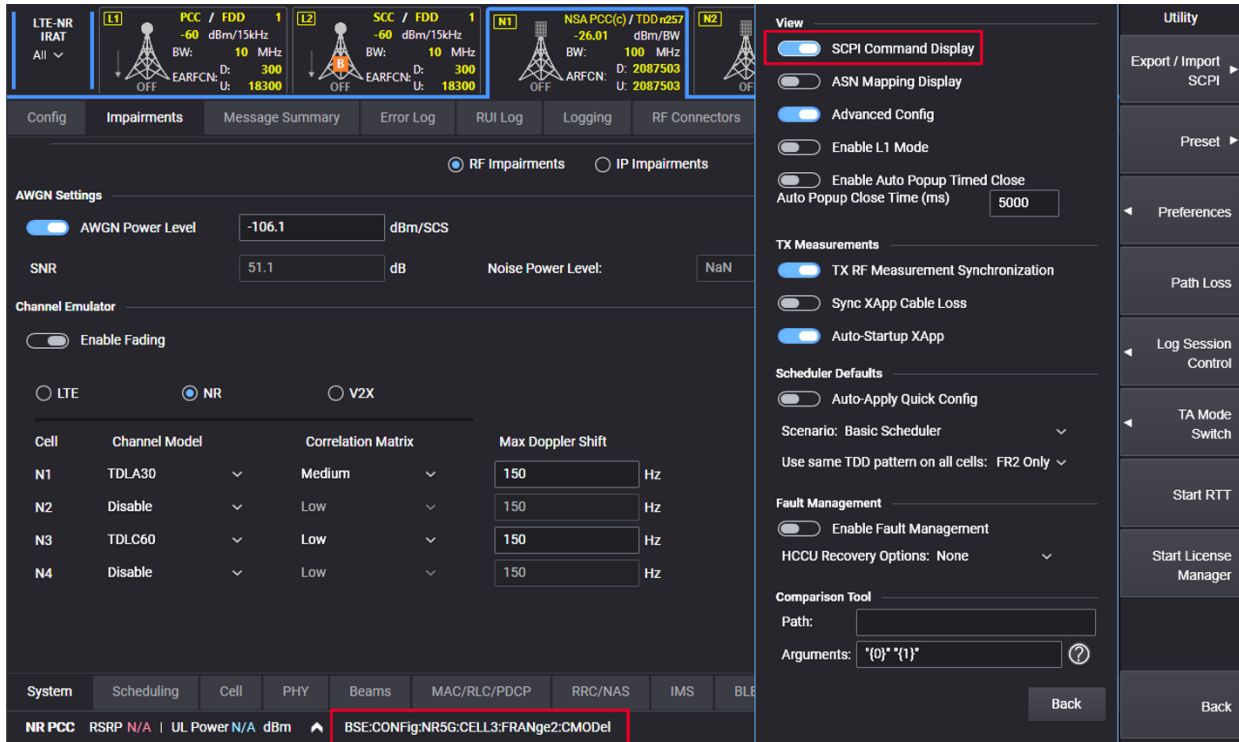

Figure 19. Baseband fading SCPI display enabled

Alternatively, Keysight automation toolsets provide quick development of automated testing. Program RF tests based on 3GPP standards using the RF automation toolset combined with the test application. Similarly, the functional KPI toolset provides automation for functional tests such as power consumption and mobility with the test application.

Optimize Test with Scalable Hardware

The hardware configuration depends on network requirements and frequency ranges. Figure 20 shows the hardware components in 5G NR / LTE test configurations:
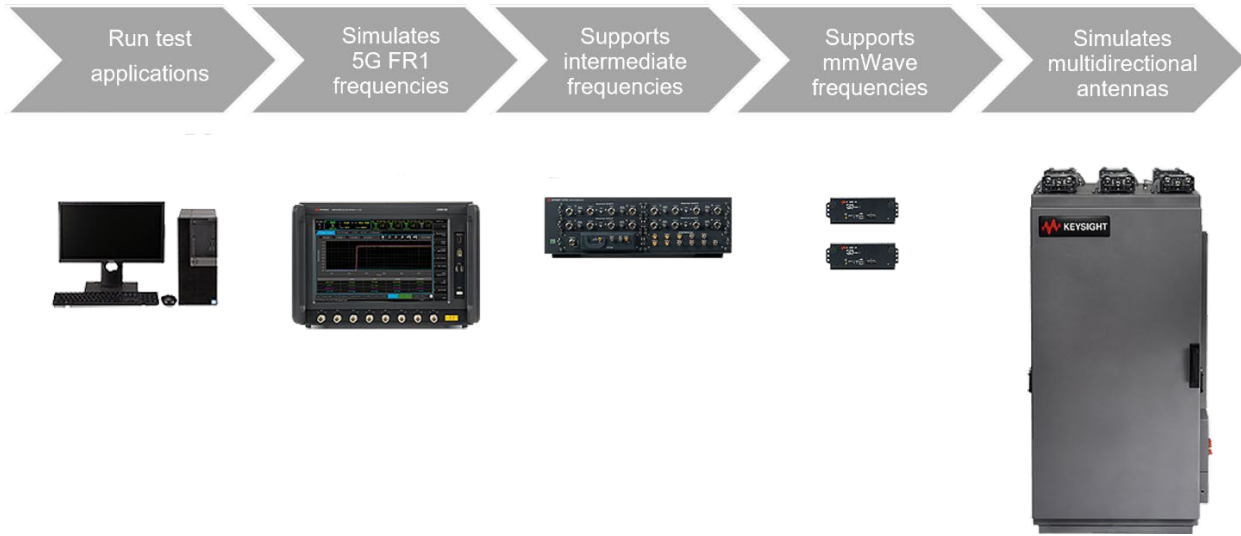
Figure 20. 5G NR and LTE test configuration

For 5G NR FR1 SA or NSA testing, the test application software is embedded in the UXM 5G wireless test platform or installed on a 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 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 21). 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 21. 5G NR FR2 mmWave test 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 E7515B 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. New releases regularly add new capabilities as defined by 3GPP with most of Release-16 functionality covered today and Release-17 features soon to come.

More Information

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

- S8711A UXM 5G Test Application
- 5G Network Emulation Solutions

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

- 5G Chipset Manufacturers
- 5G Device Manufacturers
- 5G Mobile Network Operators