UXM 5G Test Application

Features and Capabilities

Around the world, commercial development and deployment of 5G technology is accelerating to address a wide range of exciting use cases for consumers and industry verticals. Enabling 5G technology 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 enables you to address 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 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 the 5G key players. The UXM 5G Test Application provides the most comprehensive solution for 5G device development in the market.

UXM 5G Test Application Overview

The UXM 5G Test Application enables you to set up and control Keysight's UXM 5G network emulator (Figure 1). The software 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.

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

E7515B UXM 5G Wireless Test Platform

Figure 1. Keysight's UXM 5G network emulator and screenshot of the UXM 5G Test Application software

The most powerful and integrated 5G network emulator	Flexible, interactive testing and ease of use
Maximizes lab space with small footprint	Baseline software tool lets you control the UXM 5G platform.
Provides simultaneous 5G New Radio (NR) and LTE multi-RAT (radio access technology)	High configurability and parameterization for RF performance and functional key performance indicators (KPIs).
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 X-Series capabilities to explore beyond the standards.
Includes internal remote file input/output (RFIO) switch matrix for flexible port mapping	Characterize your device's 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: 8 transmitter (Tx) downlink (DL) + 4 receiver (Rx) uplink (UL) RF ports @ 800 MHz bandwidth	Benchmark functional KPIs like data rates or battery consumption under realistic conditions such as different propagation conditions or during mobility.
Offers baseband fading for advanced performance testing	Easy-to-use GUI allows you to sweep over different network settings and re-create realistic scenarios.
Supports 10 Gigabit Ethernet connectivity for very high data rates	Automate your own scenarios using Standard Commands for Programmable Instruments (SCPI).
Includes internal PC and touchscreen interface for benchtop use via test sets	

Who Benefits from Using the UXM 5G Test Application?

R&D expert teams that require high configuration and parameterization capabilities in the following organizations will benefit from using the UXM 5G Test Application:

- Device and chipset manufacturers for early development testing of RF parameters and functional and regression tests
- Laboratories and research institutes that need specific configurations for network emulation, callbox, OTA, specific absorption rate (SAR), or electromagnetic compatibility (EMC) testing
- Mobile network operators (MNOs) to make custom RF and functional measurements for their network scenarios and easily scale from conformance to acceptance testing

Application Coverage

The UXM 5G Test Application enables you to simulate a network and interact with it in real time to verify how your chipset or device perform with the network (Figure 2). It is typically used in the lab by interacting with the touchscreen of the UXM 5G network emulator or a remote desktop.

Focus on device performance and characterization

Network emulation & test

Run RF measurements
Benchmark functional KPIs
Edit protocol messages

Direct interactive testing
Indirect testing with SCPI commands

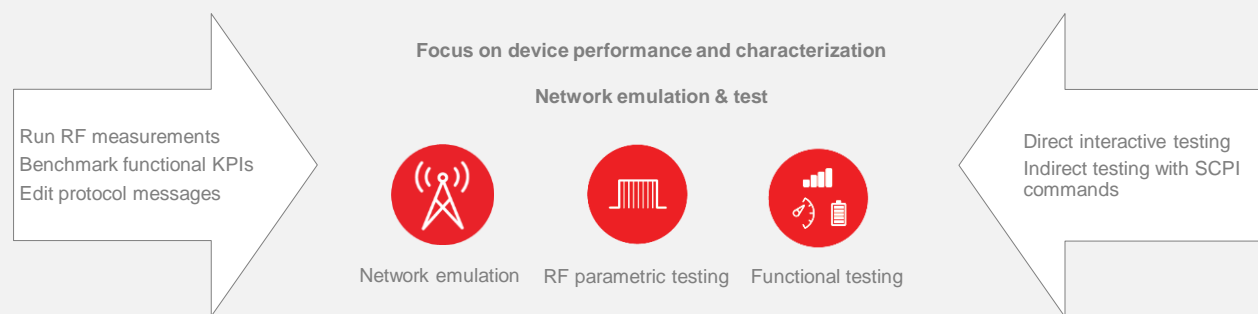Network emulation   RF parametric testing   Functional testing

Figure 2. UXM 5G Test Application coverage areas

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

You can also conduct automated operations using SCPI commands 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.

Its usability makes the UXM 5G Test Application the most cost-effective tool on the market for performing 5G network emulation.

Ready for the future	Interactive testing	Scalable solution
Complete network emulator covering 4G, 5G FR1, FR2, NSA, SA, TDD, FDD, and cellular vehicle-to-everything (C-V2X)	High level of parameter configurability	Scales from development to acceptance stage of the workflow
Dynamic port mapping, up to 800 MHz per port	Ease of use — quick configuration tools	Compatible with the whole Network Emulation Solutions portfolio by activating software test package licenses

Table 1. UXM 5G Test Application features

Test Application Framework — Network Emulation

The UXM 5G Test Application provides all the essential cell and connection settings required for a communications test set. It also features settings for R&D customization and control beyond the 3GPP test standards. You can configure the desired network in just a few clicks (Figure 3):

1. Aggregate cells by clicking on NR S-Cell Aggregation. The interface displays all the cells, primary and aggregated.
2. Configure your cell settings (Figures 4 and 5), switch cell ON to broadcast, switch UE ON.
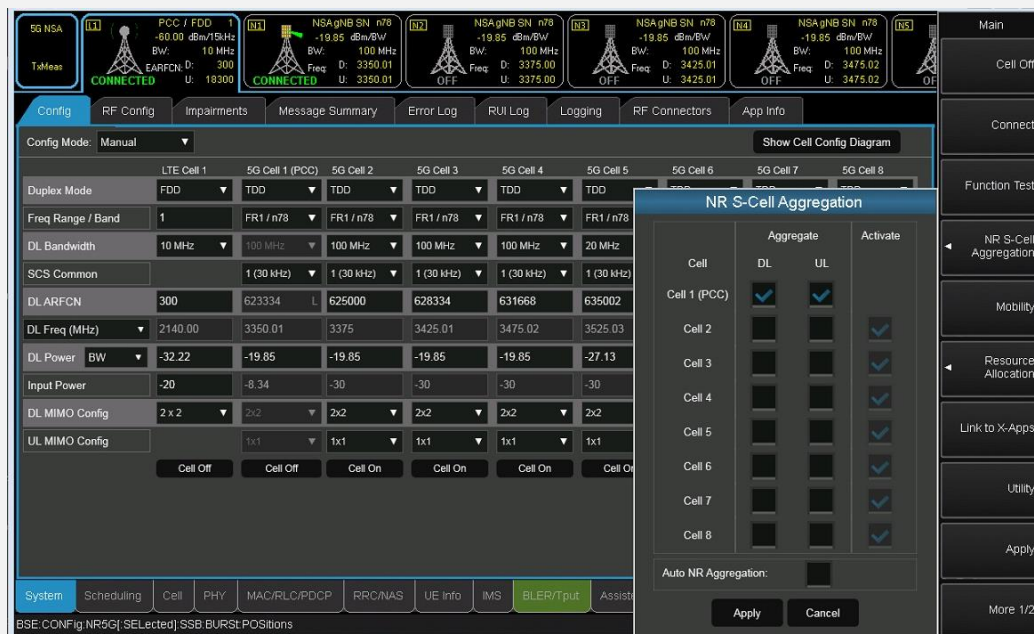

Figure 3. UXM 5G Test Application general network emulation screen

A powerful GUI provides full visibility into the progress of your test setup. You can access the settings via the GUI and SCPI.

Figure 4. Power and frequency support for each individual cell

Figure 5. Scheduling Map tab to configure the resource allocation for the selected cell

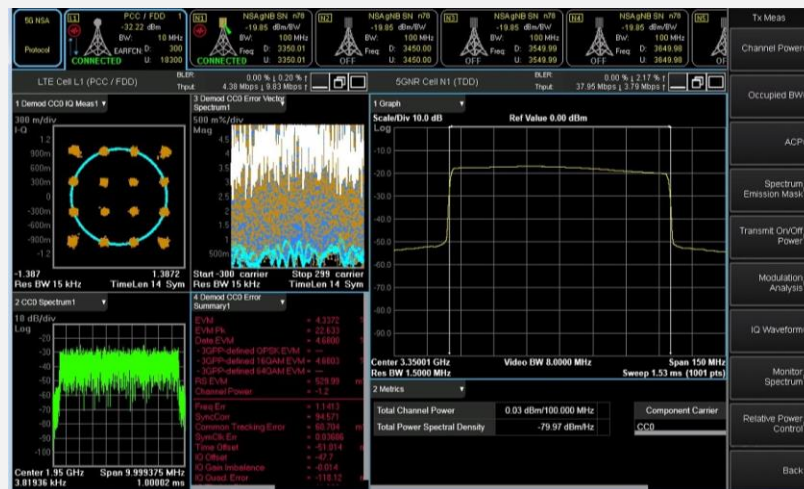# Test Application Framework — RF Testing
RF parametric testing

Figure 6. Tx measurements with the X-Series

The UXM 5G Test Application integrates with Keysight's X-Series measurement applications to provide consistent and familiar results and enhance usage experience.

You can use X-Series to test the transmitter or UL of the user equipment (UE) based on 3GPP's 36.521/38.521 specification.

- Increase your productivity by running LTE and NR measurements simultaneously:
  - Select which LTE and NR cells require Tx measurements.
  - Protocol and analyzer settings are fully synchronized for both LTE and NR.
  - See both technologies simultaneously to compare or use a single measurement for more comfortable debugging.
- Test NR diversity Rx sensitivity.
- Use the Quick Config tool for the frequency presets:
  - Configure the test channel frequency automatically according to 3GPP's TS 38.508-1.
  - The Test Application sets the other parameters, including absolute RF channel number (ARFCN), point A, and offset to the carrier.
- Use the Quick Config tool for the reference measurement channels (RMC):
  - Automatically state the channel configuration when running Tx and Rx tests defined by TS 3GPP 38.521.
  - Test Application adjusts the corresponding settings, scheduler, time-domain resource allocation (RA) tables, and TDD UL-DL configuration.
  - You can also customize the channel beyond 3GPP limits: number of resource blocks (RB), RB start, modulation and coding scheme (MCS), or downlink control information (DCI) type.

UE calibration

Boost your confidence in your product's quality with accurate terminal calibration. The UXM 5G Test Application provides non-signaling capabilities for chipset calibration. The test set saves you time when transitioning new devices to manufacturing by providing the same accuracy and repeatability in the lab as on the production floor.

- Only test set with both RF and high data rate performance for real-world mobile device test
- Industry's most accurate, repeatable, and standards-compliant RF measurements
- Return to original/factory performance and accuracy
- Lower measurement uncertainties

Test Application Framework — Functional Testing
End-to-end data throughput and baseband fading

The UXM 5G Test Application provides extensive analysis and statistics to test UE receivers to their maximum possible throughput. You can generate the data externally from a server connected to the UXM 5G network emulator (Figure 7).

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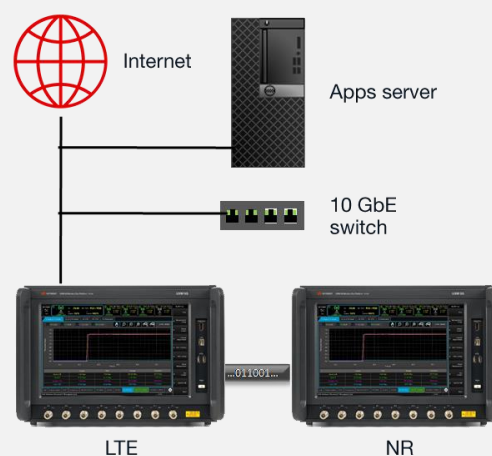

Figure 7. Data throughput test setup

Use the Quick Config tool to adjust the scheduler to full throughput and challenge your device performance:

- Modify the settings to see the impact on the results during data throughput testing (Figure 8).
- Activate multiple fading channels to simulate real receive conditions. Multiple 5G baseband fading model packages (bb fader) for FR1 and FR2 are available (Figure 9).

Figure 8. Throughput graph with the UXM 5G Test Application

Figure 9. Channel emulation support for baseband fading

You can view all information in reports and analyze the data with Keysight's Log Viewer, software that is common to all Keysight Network Emulation Solutions.

Functional KPI handover for 5G NSA and SA

Modify the primary component carrier (PCC) easily from the all-inclusive window. You can perform handover testing in all scenarios: LTE, NR nonstandalone (NSA), NR standalone (SA), and inter-RAT.

Figure 10. Functional KPI handover test setup

Handover is a mechanism used to change 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 UXM 5G Test Application enables you to quickly sweep across all channels supported by the UE without dropping the connection:

- Capture OTA protocol and data throughput to see the data exchanged in real time, with full message decodes, giving you a real-time view of how handoffs between cells affect data transfer.
- Log, store, retrieve, and analyze previously captured message logs for troubleshooting handovers to ensure uninterrupted service even when crossing cell boundaries.

Functional KPI voice/video IMS

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

The UXM 5G Test Application includes an integrated IMS server for that purpose. It tests UE voice, video, and SMS services operating over an IMS core.

Full client and server implementation enables you to perform end-to-end functional testing.

Figure 11. Functional KPI voice/video IMS test setup

The functional test set is easily accessible from the IMS tab in the all-inclusive window. It provides an OTA network connection between the UE and the IMS-SIP infrastructure. It can emulate a range of network conditions so you can verify UE performance in a controlled laboratory environment:

- Autonomous setup 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 NSA networks and voice over NR (VoNR) for NR networks

Functional KPI protocol flexibility

The UXM 5G Test Application provides full protocol flexibility on the NR cell reconfiguration message via the ASN1.0 message edition, which you can overwrite in the Test Application Framework. You can edit the parameters not displayed with the PDU Editor option. Click on "launch and edit the ASN."

You can use your own radio resource control (RRC) reconfiguration message seed and overwrite the settings in the UI to exploit simple parameterization capabilities:

- Sweep by settings in the GUI using a user-customized ASN seed as a template
- Ease of use with the integrated PDU Editor

PDU Editor provides these capabilities:

- Modern, easy-to-use ASN1.0 editor with no direct XML use
- Ability to create and edit customized protocol messages
- Ability to tune RRC settings to enable interoperability at early stages (Figure 12)
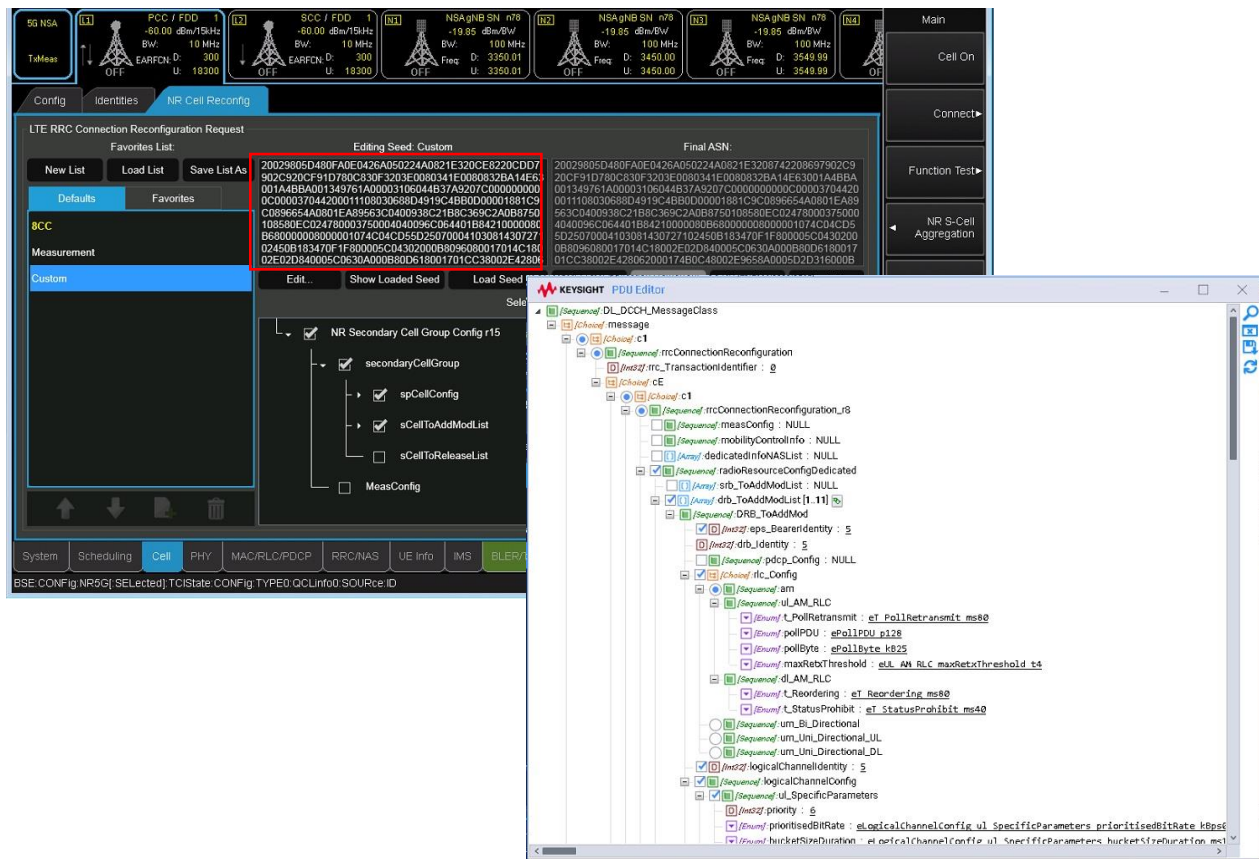- Access to any information element not exposed by the Test Application

Figure 12. Modifying the 5G NR RRC reconfiguration ASN using PDU Editor

Test Application Framework — 5G NR Beam Management Test

5G NR FR2 requires an OTA test environment (Figure 13), representing a major change from previous cabled test methodologies.

The UXM 5G Test Application enables you to fully test the beam management performance of your device (Figure 14). You can characterize mmWave beam acquisition, tracking, and management. This test mode emulates the signals as they reach the UE. You can test the following:

- Synchronization signal block (SSB) detection
- Beam acquisition
- Beam reporting and switching
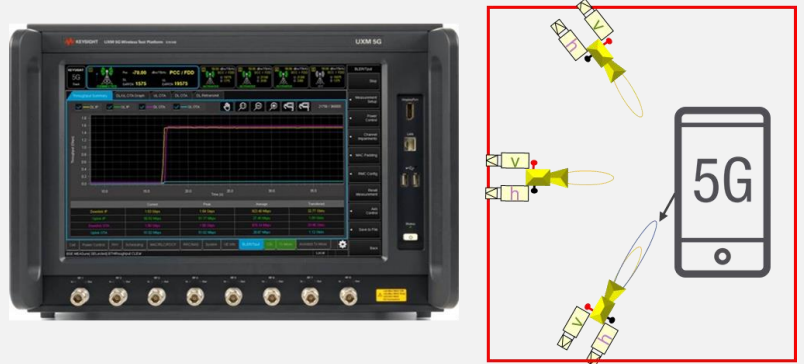
Figure 13. 5G NR beam management test setup

The beam management menu includes different tabs for definition (SSB beams, NZP CSI RSI for narrower 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 based on the UE reports.
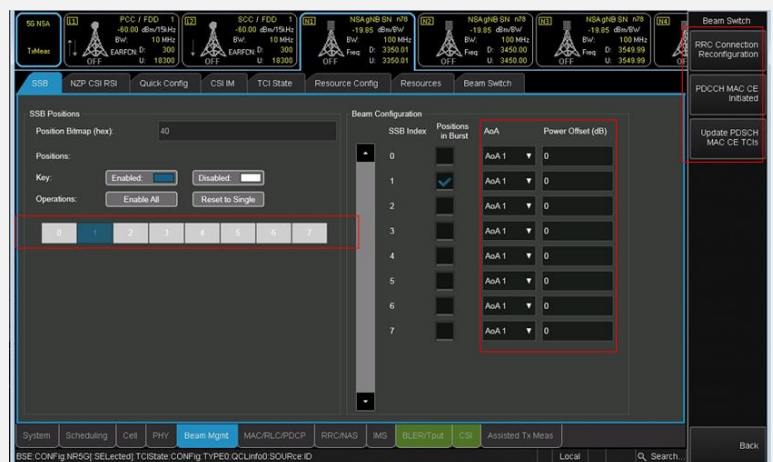

Figure 14. Flexible beam management setup

The Quick Config tool enables you to modify the parameters for a pool of items in the SSB or NZP resources.

Troubleshooting with Log Viewer

The UXM 5G Test Application generates test activity for each executed test, as well as diagnostic data saved to log files. You can view and analyze the data during or after the run of a test.

Log Viewer is a user-friendly GUI that displays several windows in one view. It is common across Keysight Network Emulation Solutions, including Keysight's RF/RRM DVT & Conformance Toolset, Functional KPI Toolset, and Protocol R&D Toolset.

The filtering functionality allows you to view the layers and test information of interest. You can use any of the default filters or create customized ones.

Bookmarks enable you to go back to any record in the log, facilitating troubleshooting (Figure 15). The Bookmarks tab displays all bookmarks you have created.

Log Viewer enables you to log the following records:

- LTE and NR protocol messages for all protocol layers (PHY, MAC, RLC, PDCP, and RRC)
- All information transmitted and received at the air interface, recorded at the MAC/PHY boundary
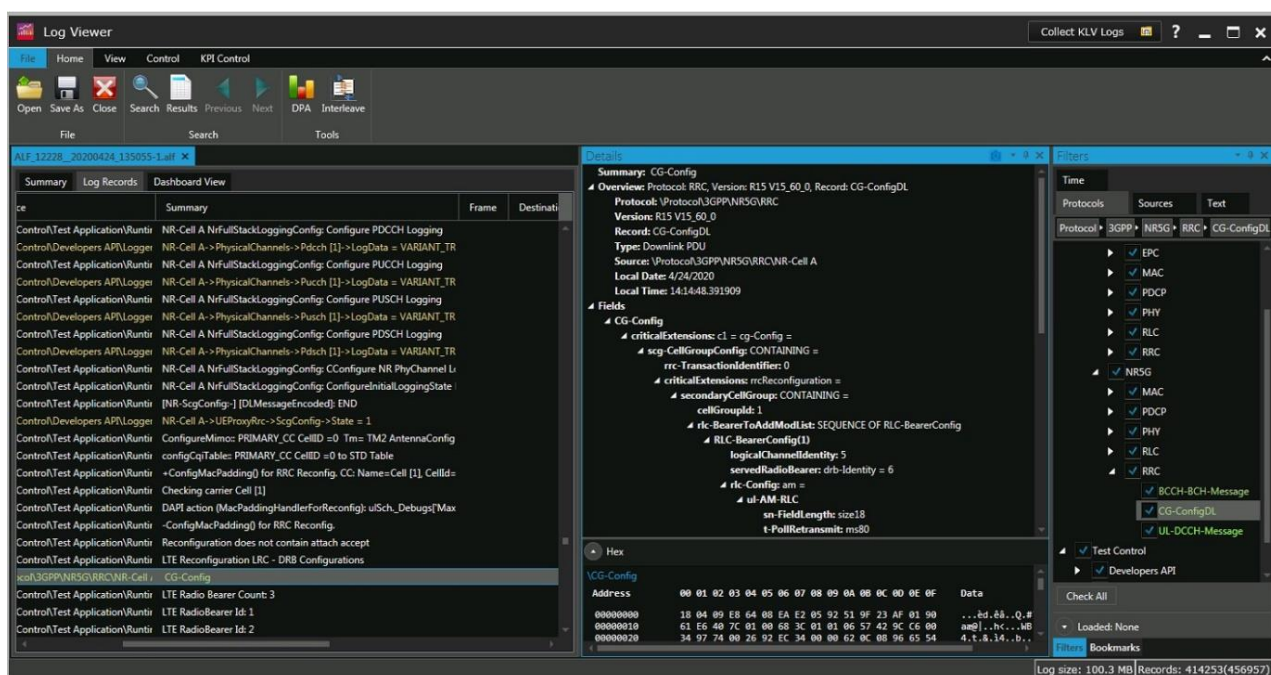- Control information such as the activation or deactivation of physical and transport channels

Figure 15. Debugging with Log Viewer

The Dashboard Viewer allows you to display predefined or customized graphs using a list of KPIs previously captured in Log Viewer. You can display graphs and data for different KPIs in the same view and create a dashboard (Figure 16). You can choose to display KPI data numerically or graphically with the style option. You can also select from different types of graphs such as histograms and time or scatter graphs. You have the option to launch the Dashboard Viewer during or after the test execution.
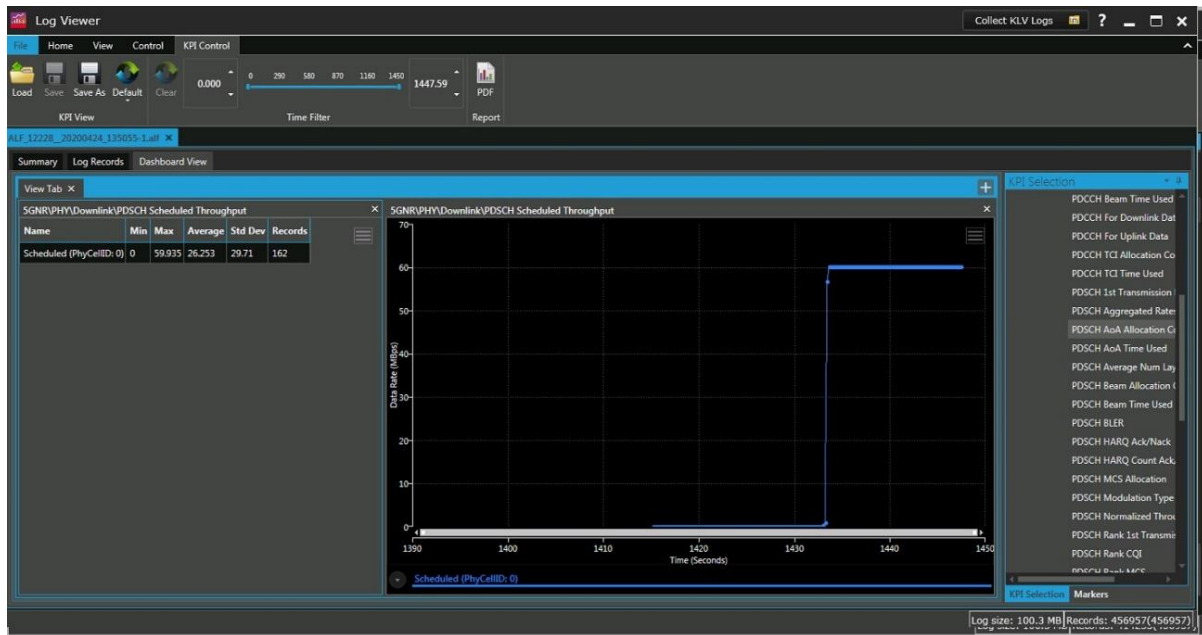
Figure 16. Dashboard Viewer shows graphical KPI data in one view

SCPI Commands for Automated Testing

Each operation the UXM 5G Test Application performs has an assigned SCPI command. For example, modifying a fading channel generates a SCPI command that appears at the bottom of the screen (Figure 17). Therefore, you can create an operational environment with automated testing campaigns.
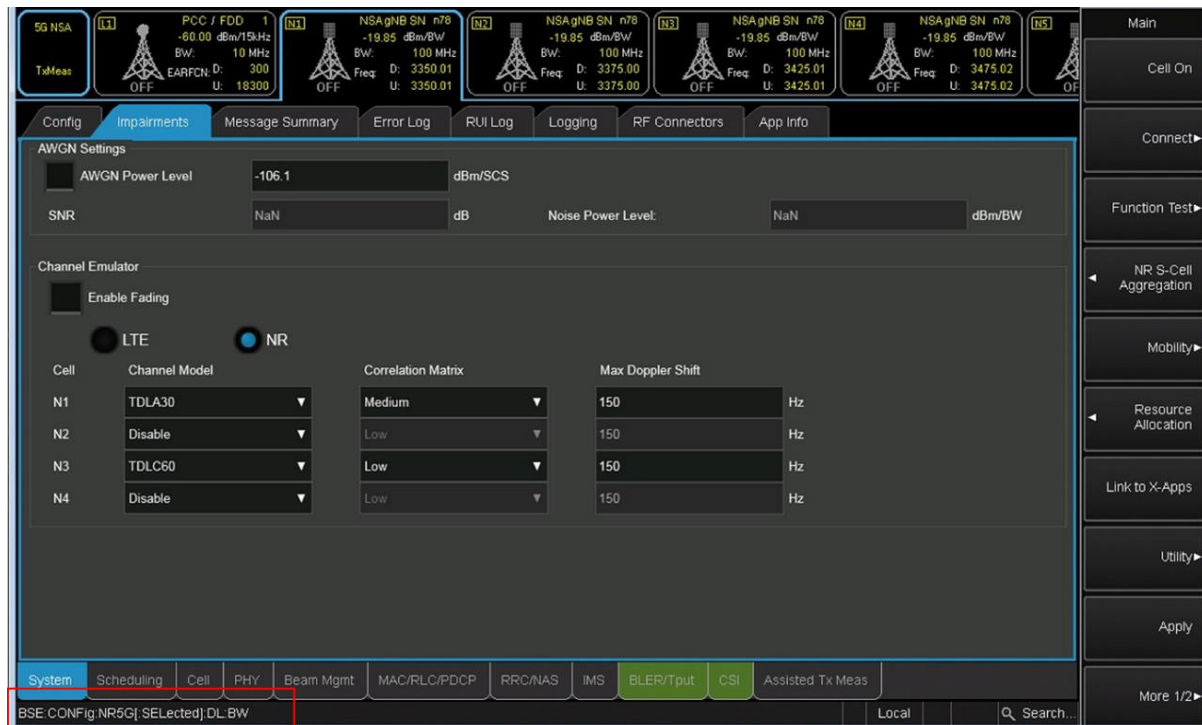

Figure 17. SCPI command at the bottom of the screen

Hardware Configurations

The configuration setup depends on the frequencies involved and the network requirements. Figure 18 provides the hardware components in an LTE 5G test setup:
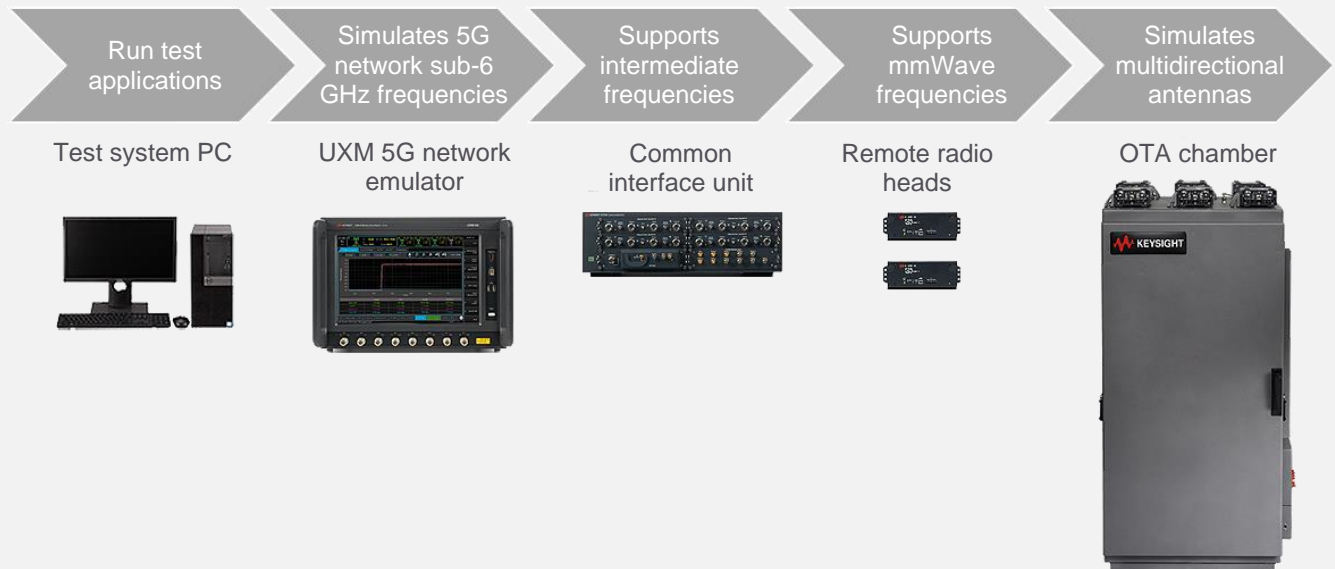

Run test applications	Simulates 5G network sub-6 GHz frequencies	Supports intermediate frequencies	Supports mmWave frequencies	Simulates multidirectional antennas
Test system PC	UXM 5G network emulator	Common interface unit	Remote radio heads	OTA chamber

Figure 18. LTE 5G test setup

Test setup for FR1 sub-6 GHz testing

For a typical test set such as sub-6 GHz in SA or NSA mode, the UXM 5G Test Application is embedded in the UXM 5G network emulator. You can also install it on a test system PC connected to the UXM 5G network emulator. The modular and scalable setup enables you to add a UXM 5G network emulator to increase system capability and test additional component carriers if required.

Test setup for FR2 mmWave testing

Devices that support mmWave frequencies are complex and have integrated antenna arrays, leading to the need for OTA testing. To address these challenges, you need a test setup with a UXM 5G network emulator, a common interface unit (CIU), and at least two remote radio heads (RRHs) to upconvert the sub-6 GHz frequencies to mmWave frequencies (Figure 19). You can connect up to eight RRHs to a CIU. You also have the option to include a CIU without the RRHs to generate 6–12 GHz for intermediate frequency (IF) testing.

Figure 19. 5G FR2 mmWave test setup

Accelerating 5G Chipset and Device Development

5G networks open doors to new business models and provide an edge for those who seize the opportunity. Keysight Technologies has designed the E7515B UXM 5G Wireless Test Platform to support a comprehensive portfolio of Network Emulation Solutions. These solutions help 5G NR device makers accelerate the development workflow, from initial design to acceptance, and increase confidence in hitting the target performance before market launch.

The UXM 5G Test Application enables you to set up and control Keysight's UXM 5G network emulator. It offers significant configuration and customization capabilities for R&D purposes and includes a comprehensive suite of tools for network emulation, RF parametric testing, and functional and application-level testing.

More Information

E7515B UXM 5G Wireless Test Platform
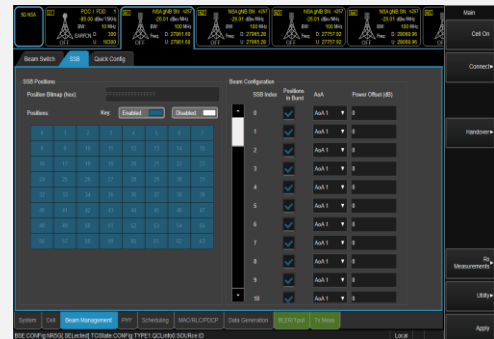
Learn more about Keysight's Network Emulation Solutions by visiting the following webpages:

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

You can also visit the following webpages to find out more about 5G challenges and solutions:

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

Learn more at: www.keysight.com

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