5G DEVICE APPLICATION TESTING WITH THE R&S®CMX500 RADIO COMMUNICATION TESTER

Application Brochure
Version 01.00

ROHDE&SCHWARZ
Make ideas real

THE R&S®CMX500 RADIO COMMUNICATION TESTER CAN PERFORM 5G NR MEASUREMENTS FOR ALL 5G DEVICE TESTING USE CASES: RF TESTING, SIGNALING TESTING, E2E TESTING, CONFORMANCE TESTING AND CARRIER ACCEPTANCE TESTS.

THIS APPLICATION BROCHURE DESCRIBES KEY 5G DEVICE APPLICATION TESTING USE CASES FOR THE R&S®CMX500.

CONTENTS

AT A GLANCE

The R&S®CMX500 radio communication tester offers a unique and fully integrated solution for 5G mobile device application testing. Thanks to a pre-optimized IPv4/IPv6 test environment, the R&S®CMX500 ensures maximum reproducibility and stability. This dramatically shortens test setup preparation and configuration times for application and connectivity testing of the most common internet transport protocols.

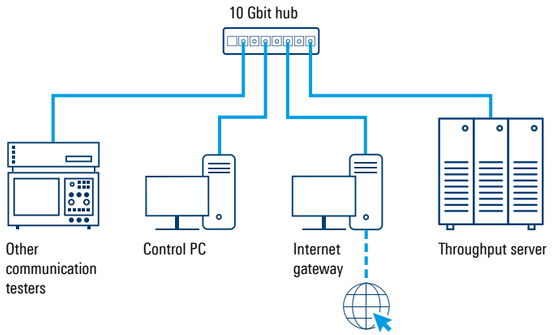
The challenge

Starting from the fourth generation (4G LTE/LTE-A), mobile networks use the internet protocol (IP) for all services. Additional infrastructure is required for traditional services such as voice communications and many other new applications and services. The introduction of 5G NR is triggering the evolution of new mobile internet use cases and applications, while creating new IP connectivity test requirements.

Mobile application testing includes testing device IP connectivity and the functionality and performance of applications. Security and usability also play an important role. This is part of the device development process for most common applications and services. The main focus is on IP and application layer testing since it is crucial for mobile device vendors to provide optimal service and top end user experience.

Testing is typically performed in a signaling connection with IPv4/IPv6 connectivity and requires a server infrastructure and tools to test common internet services and protocols. Repeatability, stability and comparability aspects mean these tests cannot be performed in a live network but require a mobile network emulator based test environment.

In the past



Traditional test environment

Standard end-to-end test setups consist of a communication tester connected to several external PCs for throughput generation, remote control or to set up an internet connection. Various other components are involved, which makes it a difficult setup to handle.

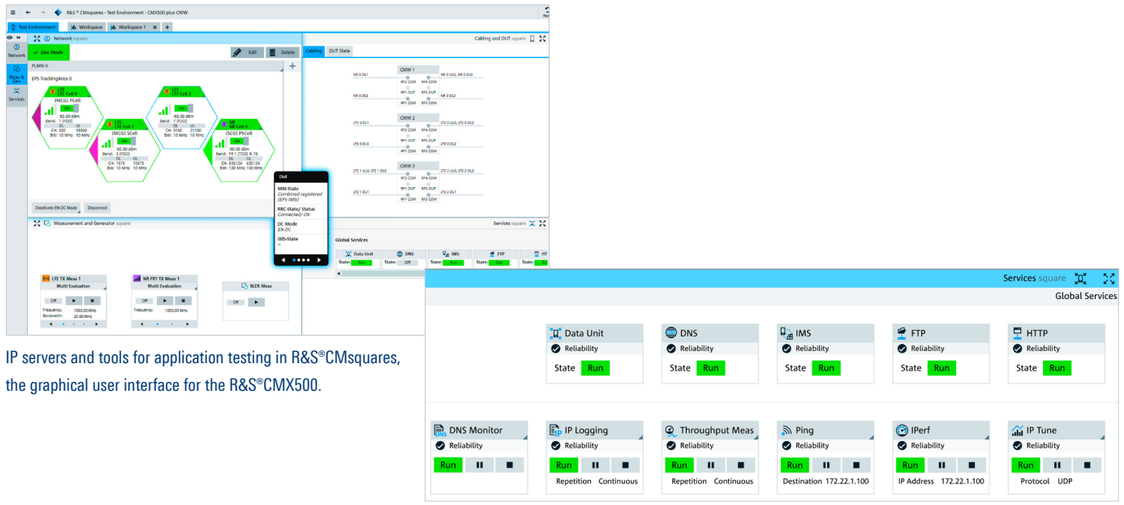
In addition to its bulky size, this unwieldy setup has many potential error sources, especially because of the high data rates and flexible design required for 5G. Using the wrong hardware in this setup could cause a dramatic reduction in IP throughput rates. Incorrect IP network settings can block communications and Windows firewalls can affect communications and measurement results.

A new era in mobile application testing

The R&S®CMX500 radio communication tester offers a fully integrated IP end-to-end test environment and toolchain to ensure optimum quality of service (QoS) and user experience for most common 5G FR1 and FR2 IP services. A throughput optimized IPv4/IPv6 environment with comprehensive tools e.g. for IP throughput measurements with state-of-the-art iPerf and immediately available web, FTP, DNS and IMS servers enables expansive out-of-the-box device testing at the IP and applications level.

Rohde&Schwarz uses this approach to create an accurate, reliable and uniform IP data test environment for 5G mobile devices that simplifies the test setup and keeps components to a minimum by delivering truly reproducible results. Test condition reproducibility reduces test times and effectively supports delivery of the desired quality of service for 5G mobile applications. Mobile device vendors and network operators can identify error sources early on by accurately measuring IP performance under specific and controlled network conditions. Designed for extreme high data throughput in the 20 Gbps range, the R&S®CMX500 can test even the most demanding 5G applications.

The services are integrated in R&S®CMsquares, the unique graphical user interface for the R&S®CMX500, which makes the test environment very easy and comfortable to use. Servers and measurements can be manually operated in workspaces or used in test sequences in the integrated R&S®CMsequencer graphical scripting interface. Users benefit from customized test routines which can be developed using Python based XLAPI and SCPI remote interfaces.



IP servers and tools for application testing in R&S®CMsquares, the graphical user interface for the R&S®CMX500.

Ready for the future of 5G mobile device testing

BENEFITS

Simplify your test setup – unique integrated 5G mobile application testing solution

The introduction of new 5G NR is triggering an evolution in IP connectivity and application test requirements. The R&S®CMX500 simplifies the test setup required for IP application tests and keeps the required components to a minimum.

Designed to meet 5G data rate expectations of 20 Gbps and more

The R&S®CMX500 offers a pretested, optimized test environment for maximum throughput testing. Powerful IP tools such as the throughput wizard enable maximum data rates in just a few clicks.

Preconfigured servers – ready for testing right away

Ready-to-use application servers for testing common internet services such as file transfer, web browsing, IMS services, media streaming and more.

5G NR connection for over-the-top (OTT) application testing and communications monitoring

The R&S®CMX500 can also act as a gateway to the internet. In a controllable 5G NR connection, the R&S®CMX500 monitors security aspects. The integrated IP analysis measurement detects, analyzes and classifies IP data traffic to the internet from the device in real time.

Easy IP setup configuration and measurement handling in the R&S®CMsquares user interface

A single common graphical user interface makes handling simple and clear, even in complex test scenarios. Dedicated IP measurements provide a comprehensive overview of the traffic in the different layers.

Automated test sequences for IP application tests using R&S®CMsequencer

Benchmarking 5G IP data throughput performance in a fully automated environment or audio and battery life tests are extremely important for 5G device manufacturers. R&S®CMsequencer offers blocks and functions to fulfill all testing challenges and automatically verify KPIs.

XLAPI Python or SCPI remote interface for writing customized repeatable test routines

IP application test routines can be easily remotely controlled via XLAPI and SCPI interfaces.

Best reproducibility and stability wherever you need it

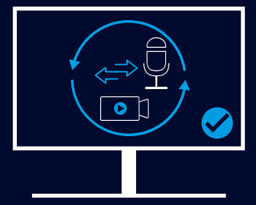
The R&S®CMX500 ensures reproducible test results around the globe with its fully integrated application test solution

TESTING USE CASES

5G innovations in virtual reality, online gaming, live event streaming as well as critical low latency and ultra-reliable applications transform user experience and industries. But also, traditional services such as voice telephony still account for a significant revenue share and cannot be neglected. Verification of high level KPIs such as E2E IP throughput, audio tests or battery life tests are extremely important to ensure optimum quality of service (QoS) and user experience for 5G FR1 and FR2 IP services.

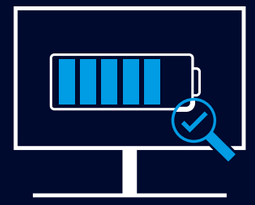
IP THROUGHPUT TESTING

The R&S®CMX500 allows traffic generation and monitoring of 5G high data rates along with the different layers, including the physical and IP layers.



IMS AUDIO AND VIDEO TESTING

The integrated IMS server enables voice, video and SMS testing over NR and LTE.



BATTERY LIFE TESTING

The seamless integration of power consumption measurements for unique insights together with RF, protocol and application tests.

WLAN OFFLOADING AND VoWLAN

5G and WLAN are expected to seamlessly intermingle in future networks. WLAN offloading is vital to ubiquitous network availability.

IP TRAFFIC AND SECURITY ANALYSIS

IP traffic analysis for a detailed look at data traffic from 5G mobile devices.

R&S®CMX500 ONE-BOX TEST SETUP FOR APPLICATION TESTING

Rohde&Schwarz revolutionized application testing with the R&S®CMX500.
For a consolidated solution, we moved the entire setup of external servers and PCs into the tester. The advantage offered by the R&S®CMX500 is a preconfigured setup – ready for testing right away and same test conditions wherever you need it.

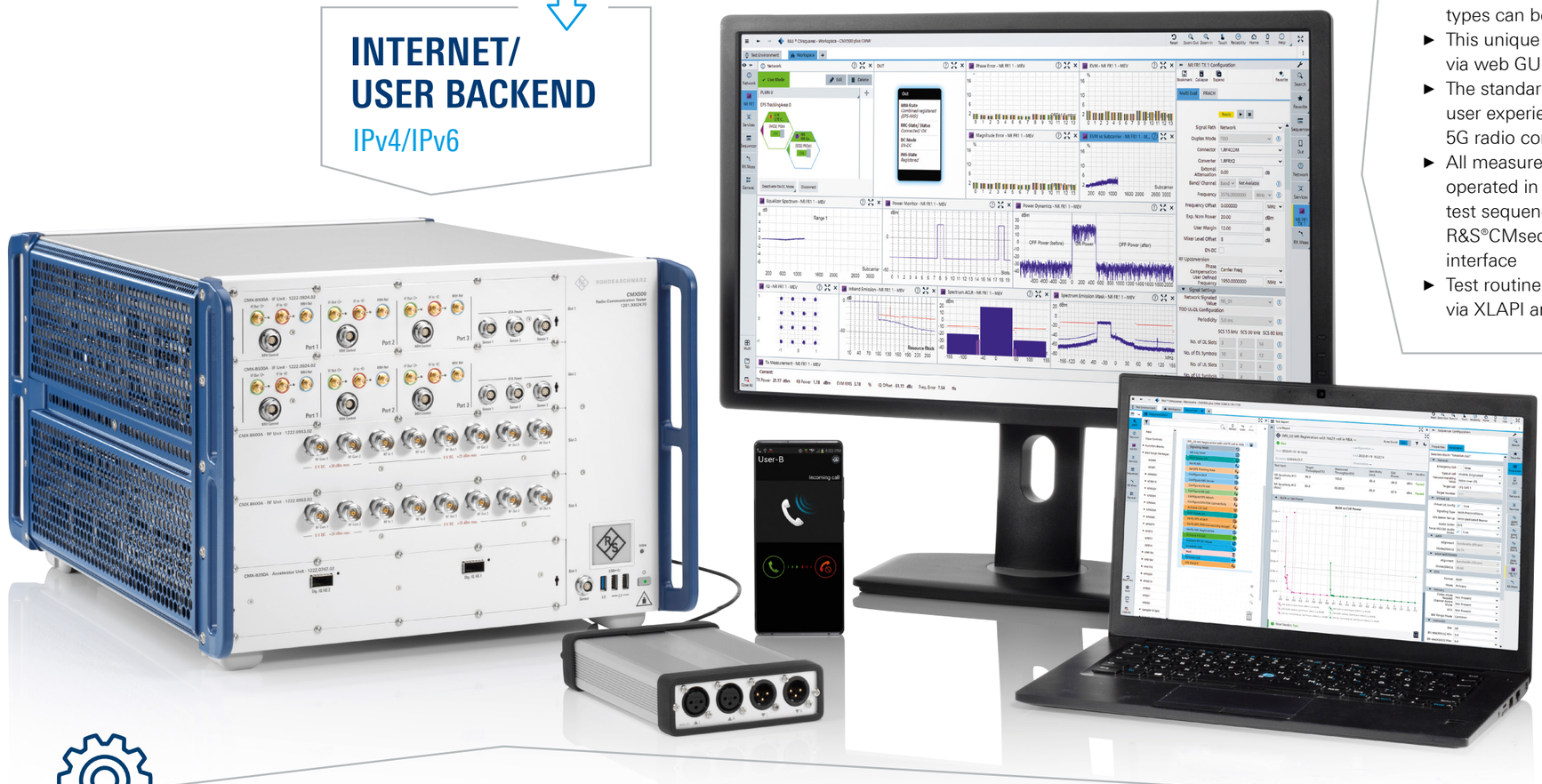
INTERNET/ USER BACKEND

IPv4/IPv6

SERVER FUNCTIONALITY

Integrated web services

- DNS
- FTP
- IMS
- ePDG
- HTTP
- Video



APPLICATIONS

Measurements and tools

- Iperf
- Ping
- IP tune
- IP analysis
- IP logging
- DNS monitor
- QoS

COMMON GRAPHICAL USER INTERFACE

R&S®CMsquares

- All R&S®CMX500 services are integrated in R&S®CMsquares, the common graphical user interface
- It has a dashboard where all application types can be accessed
- This unique user interface is controlled via web GUI
- The standardized GUI provides a uniform user experience for all Rohde&Schwarz 5G radio communication testers
- All measurements can be manually operated in workspaces or built as test sequences in the integrated R&S®CMsequencer graphical scripting interface
- Test routines can be remotely controlled via XLAPI and SCPI interfaces

IP THROUGHPUT TESTING

The R&S®CMX500 application test environment provides 5G device vendors easy-to-handle analysis and tuning tools for maximum IP throughput tests of UE transmitters and receivers.

Complex test scenarios

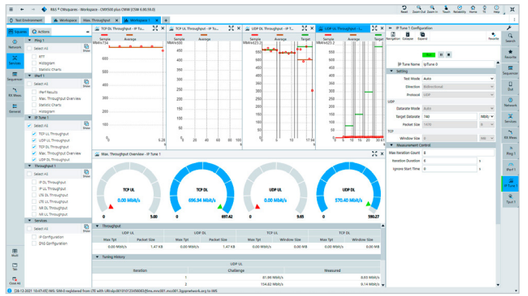
Network operators rely on 5G to accelerate networks and satisfy smartphone users and other vertical markets. Complex test scenarios are required to meet data rate expectations. Maximum throughput testing in 5G is more challenging than in the past. The reasons include new numerology and newly available radio resources with more bandwidth and extensive carrier aggregation scenarios. Designed for over 20 Gbps data performance in combination with a comprehensive toolchain, the R&S®CMX500 offers a unique test environment for simpler IP throughput tests.

Powerful tools

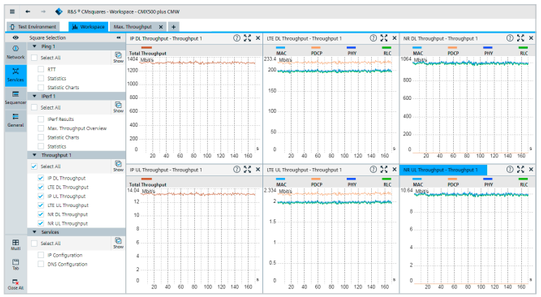
Powerful tools such as the **maximum throughput wizard** help users create a test scenario to reach the maximum data rates in just a few clicks. The wizard automatically opens a workspace which enables to users to immediately start measuring.

A perfect team – the unique **IP tune** service, in combination with the **Rohde&Schwarz Throughput App 2**, automatically optimizes the throughput performance via IP and stack parameter configurations.

A **multilayer throughput graph** provides a comprehensive overview of the throughput values along the different layers and relevant radio access technologies (RAT). Traffic bottlenecks can be immediately identified and addressed.



IP tune workspace for tuning IP parameters.



5G throughput measurements over multiple layers.

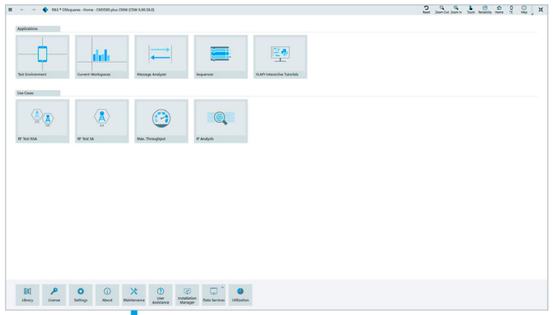
Test automation with R&S®CMsequencer

For automated throughput testing, R&S®CMsequencer offers exhaustive end-to-end IP level testing possibilities up to maximum throughput. R&S®CMsequencer is the tool of choice, especially for scenarios were multiple band and carrier aggregation scenarios need to be tested.

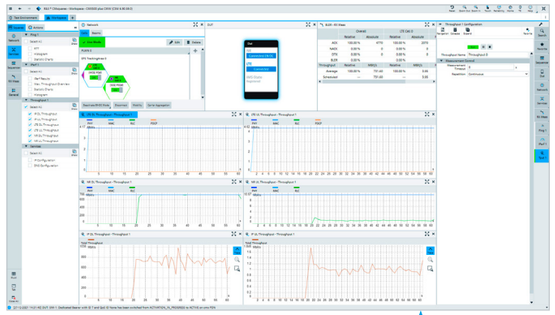
The R&S®CMsequencer Shuffler function easily performs an automatic iteration across the bands and band combinations reported by the DUT. This drastically reduces the time and effort needed to test the IP throughput performance for all supported combinations.

Maximum throughput wizard

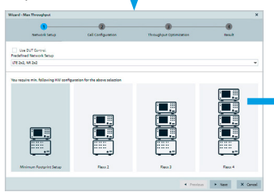
Wizard entry



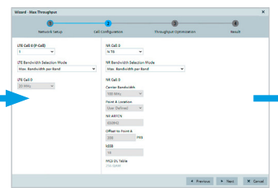
The workspace is created automatically and the user can start the measurement.



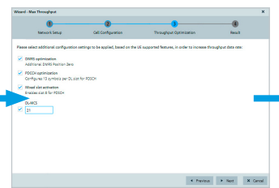
Step 1



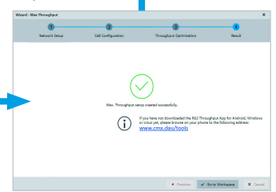
Step 2



Step 3

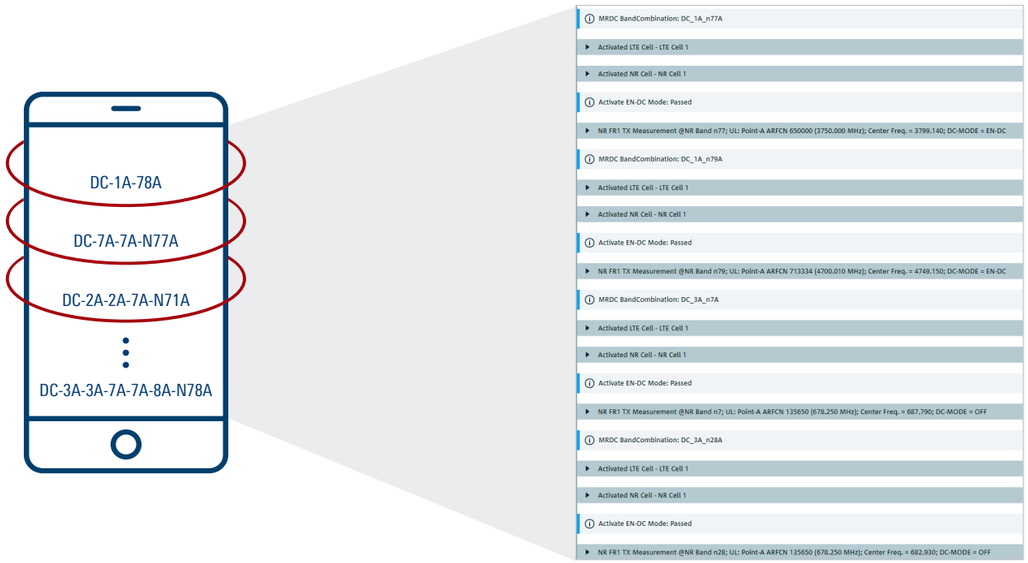


Step 4



R&S®CMsequencer Shuffler

The R&S®CMsequencer Shuffler iterates through device MRDC band combinations, providing fully automated DUT health checks.



IMS AUDIO AND VIDEO TESTING

The R&S®CMX500 supports device manufacturers and network operators by ensuring an optimized 5G voice experience early on and provides maximum flexibility with well-established solutions.

Mobile voice services

Mobile voice services are still important in 5G. More and more network operators have started to deploy 5G standalone (SA) networks, enabling high quality 5G voice over new radio (VoNR). The technology behind VoNR is similar to voice over LTE (VoLTE). The IP multimedia subsystem (IMS) is the 5G voice enabler using 5G core.

However, 5G voice services testing also includes VoLTE aspects for the non-standalone (NSA) and EPS fallback scenarios. These provide the handover from NR to LTE, or a RAT fallback during voice connection setups when 5G coverage is limited or mobile devices do not support VoNR.

Testing SA and NSA scenarios

The R&S®CMX500 provides out-of-the-box voice service testing for mobile devices. The solution supports LTE with EPC and 5G NR with 5G core testing for both SA and NSA scenarios. It also features an internal IMS server for device registration and setting up necessary bearers and QoS flows for voice services.

Internal IMS server

The internal IMS server emulates virtual user equipment (UE) for establishing mobile originated and mobile terminated end-to-end voice calls in loopback mode for fast and easy VoNR functional testing. Users can select the supported codecs, such as enhanced voice services (EVS) along with the adaptive multirate (AMR) wideband and narrowband codecs (AMR-WB, AMR-NB).

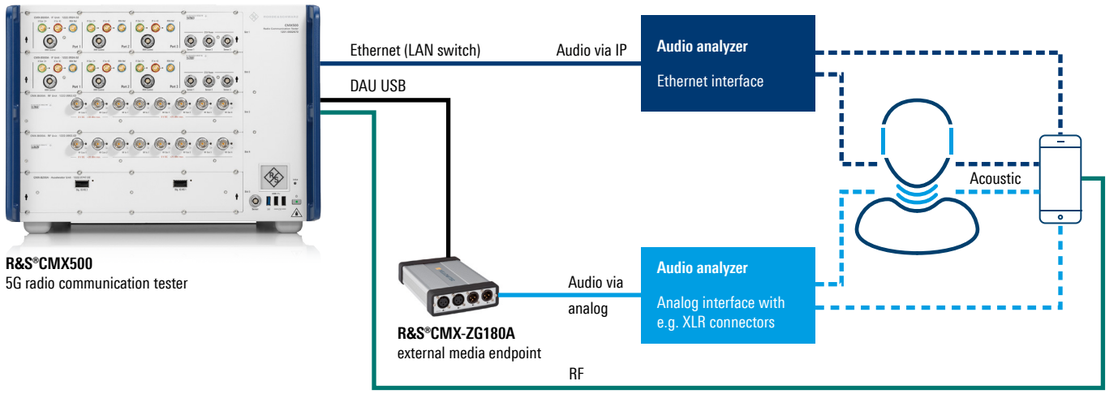
VoNR audio quality and audio performance tests

VoNR audio quality and audio performance tests are required for maximum voice performance and top user experience. Voice over 5G test systems must fulfill complex requirements and support the codecs mentioned above. Audio analyzer capabilities are required to test audio quality and performance during a call.

Audio quality analysis

The R&S®CMX500 setup can be expanded with an external media endpoint (R&S®CMX-ZG180A option) for connecting an analog audio analyzer and the DUT, as shown in the figure on page 12. For high-quality acoustic tests using a phantom head ear and mouth in line with 3GPP and ETSI, a second interface via IP connects to the Head Acoustics labCORE system.

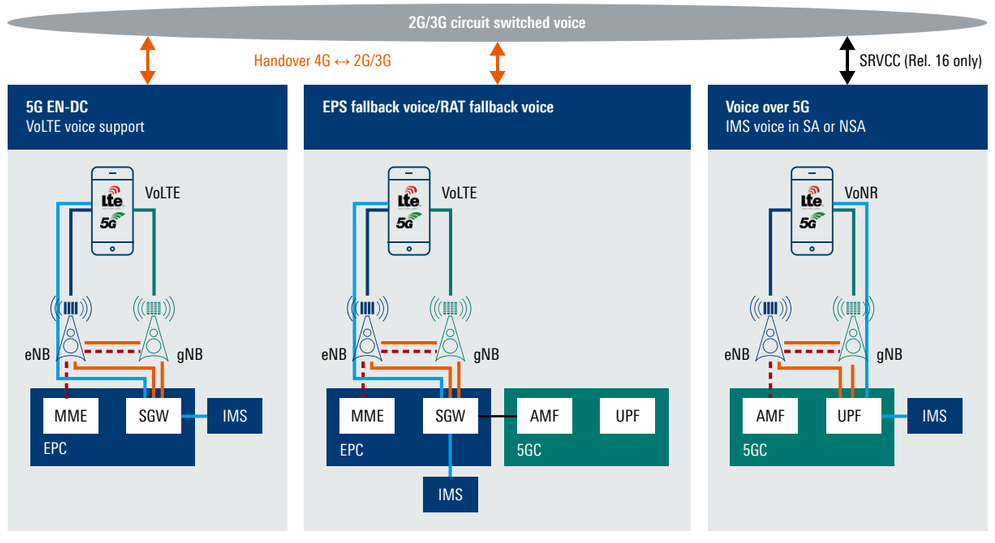
Maximum flexibility in 5G audio quality analysis



R&S®CMX500
5G radio communication tester

R&S®CMX-ZG180A
external media endpoint

Deployment scenarios supporting voice in 5G



Dual connectivity: VoLTE and 5G data
- ▶ UL coverage due to higher frequency 5G band
- ▶ Battery consumption

EPS fallback: VoLTE only
- ▶ Handover to EPC or E-UTRA during call setup

Voice over 5G NR
- ▶ Voice over NR and 5GC
- ▶ 5G coverage needed, risk of large number of handovers/call drop

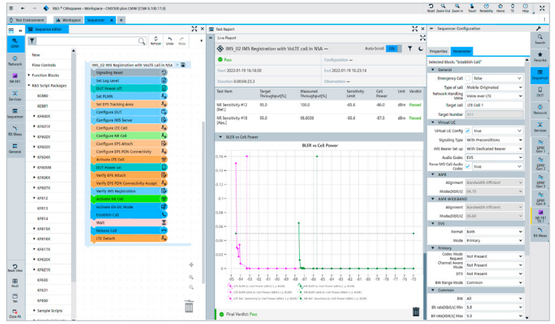
Voice
Data
Control

BATTERY LIFE TESTING

The R&S®CMX500 battery life testing solution offers seamless power consumption measurements parallel to RF measurements, protocol testing or application testing – and makes controlling and handling external equipment such as power supplies easy, saving time during development.

Power consumption challenges

5G enables new possibilities to end users and vertical markets, but it also brings big power consumption challenges. High performance, high throughput gaming and virtual reality applications put an enormous strain on batteries. From an RF perspective, NSA scenarios with two radiocommunications technologies running in parallel or carrier aggregation scenarios considerably increase device power consumption. Given battery life is important to end users, device manufacturers are working constantly to optimize energy consumption in idle or connected mode.



R&S®CMsequencer, well nested in web based R&S®CMsquares, brings the right balance of simplicity and flexibility to graphical scripting.

The R&S®CMX500 has settings to activate power saving techniques supported by the 5G NR standard. Combined with the integrated application test features, it is easy to simulate real-world scenarios such as voice calls or video streaming and monitor the current drain diagram in R&S®CMsquares.

Battery drain analysis

Meeting end user expectations for longer battery life in each successive generation makes analyzing battery consumption for different scenarios essential. These combine various power saving features for 5G networks such c-DRX, PDCCH WUS, etc.

The R&S®CMX500 makes it easy to control and handle external power supplies to test battery life. To seamlessly monitor the power consumption of a device simultaneously running different RF, protocol and application testing scenarios, the R&S®CMX500 integrates the R&S®CMX-KM110 battery life measurement option and displays the results collected from the R&S®NGM200 power supply series in R&S®CMsquares, performing all measurements in one place. R&S®CMsequencer also supports automated test sequences.

R&S®NGM200 6½ digit resolution in V/I metering: With a resolution of up to 6½ digits when measuring voltage, current and power, the R&S®NGM200 power supplies are perfect for characterizing devices that have low power consumption in standby mode and high current in full load operation. They are integrated into the R&S®CMX500 with the R&S®CMX-KM110 battery life measurement option.

The R&S®NGM200 power supply series is ideal for challenging applications, offering high speed FastLog functions to capture voltage and current measurement results.

WLAN OFFLOADING AND VoWLAN

VoWLAN and WLAN traffic offload are promising technologies that can significantly reduce the load on 5G mobile networks. The R&S®CMX500 and the R&S®CMW500 make it possible to realistically simulate these scenarios in a lab environment.

Traffic offload principle

Cellular networks ensure comprehensive mobile service coverage, but broadband WLAN can reduce their load. 5G and Wi-Fi are expected to intermingle seamlessly in future networks. Wi-Fi offloading is vital to maintaining network availability demands. The underlying technology is called WLAN traffic offload.

An important precondition for the acceptance of LTE to WLAN and 5G NR to WLAN traffic offload is uninterrupted rerouting between the cellular standards and WLAN. Instead of using the closest base station, the data packets are tunneled through the internet to a gateway provided by the network operator. To start, the evolved packet data gateway (ePDG) creates a link between the LTE/5G NR network and WLAN. Future 5G network extensions will need to work with untrusted non-3GPP networks such as WLAN and the 5G core network using the non-3GPP interworking function (N3IWF).

WLAN data traffic offloading tests

WLAN data traffic offloading tests focus mainly on mobile devices. These tests must establish a connection to the 5G NR core network gateway while also authenticating and switching IP service back and forth from 5G to WLAN, all while controlling the power of the relevant cells and WLAN access points.

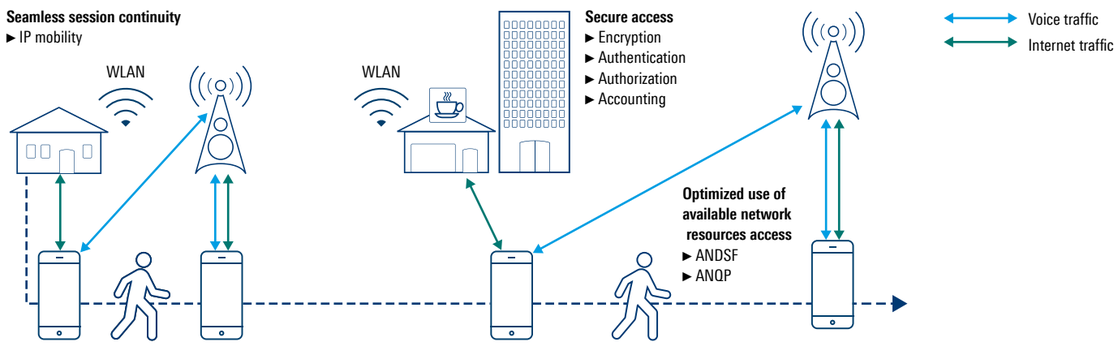
Voice over WLAN (VoWLAN) is a network operator driven technology that also uses SIP/IMS to route voice over WLAN access points. Instead of using the closest base station for a call, voice packets are tunneled through the internet to the gateway, establishing a link between the LTE/5G NR network and WLAN. This enables uninterrupted and high quality voice services for 5G wireless networks.

Test setup for 5G NR to WLAN traffic offload

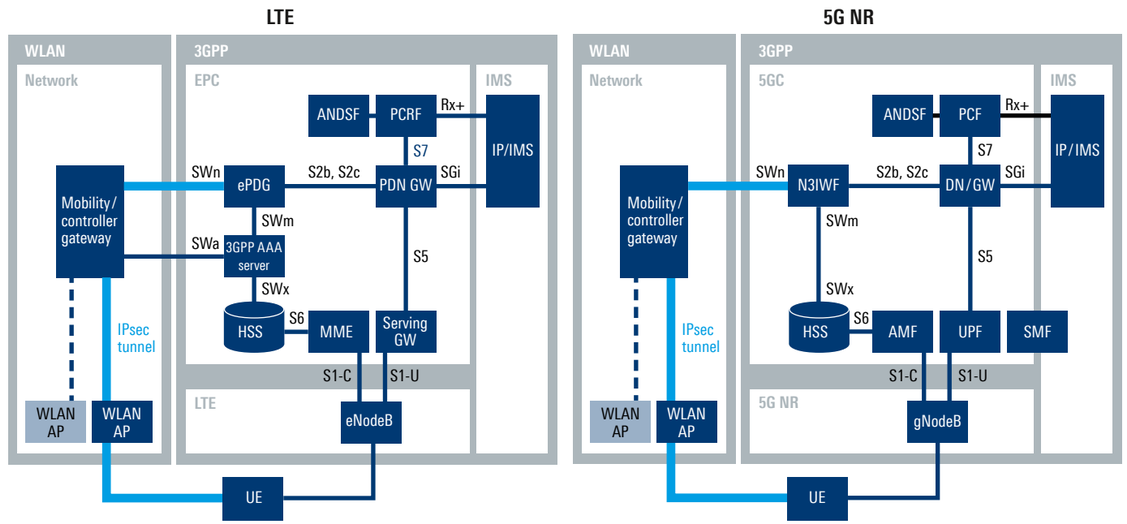
The test setup for 5G NR to WLAN traffic offload with ePDG includes the following core components to simulate the described scenarios:

- Emulated 5G NR base station, including SA or NSA scenarios and the related core network
- Emulated WLAN access point supporting IPsec communications
- ePDG during the offload from WLAN to the 5G NR core network and vice versa
- IMS and DNS server for implementing real-world scenarios such as video and voice telephony
- Message analyzer for recording all protocol messages between the DUT and the WLAN access point or LTE base station

Traffic offload principle

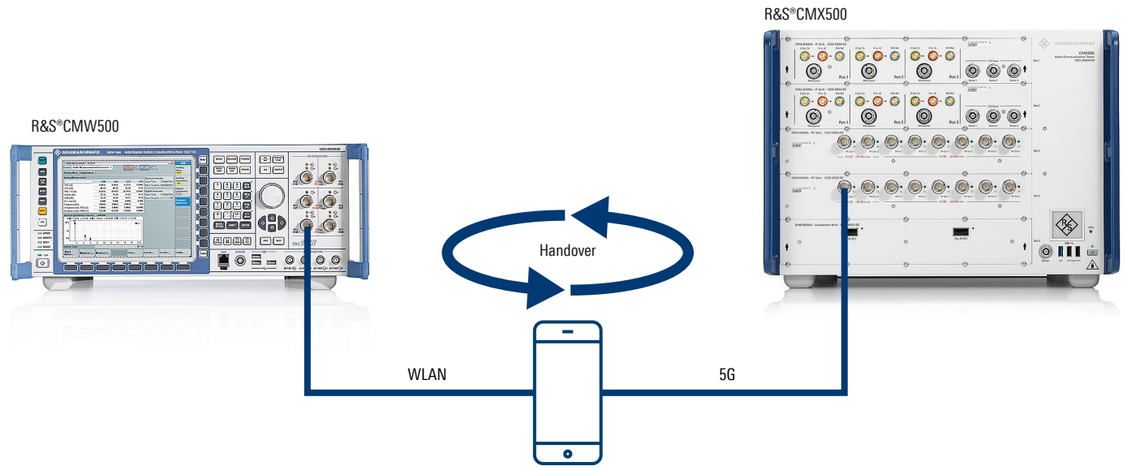


LTE WLAN data offload architecture evolving to 5G NR WLAN data offload architecture



3G, 4G, 5G: third, fourth, fifth generation of mobile telecommunications technology; 3GPP: 3rd Generation Partnership Project; 5GC: 5G core network; 5G NR; 5G New Radio; AAA: authentication, authorization and accounting server; AMF: access and mobility management function; ANDSF: access network discovery and selection function; AP: access point; DN: data network; EPC: evolved packet core; eNodeB: evolved node B; ePDG: evolved packet data gateway; gNodeB: NR base station; GW: gateway; HSS: home subscriber server; IP: internet protocol; IPsec: internet protocol security; IMS: IP multimedia subsystem; LAN: local area network; LTE: long-term evolution; MME: mobility management entity; N3IWF: non-3GPP interworking function; PCF: policy control function; PCRF: policy and charging rules function; PDN: packet data network; SMF: session management function; UE: user equipment (mobile device); UPF: user plane function; WLAN: wireless LAN

Test setup for WLAN data traffic offload testing



IP TRAFFIC AND SECURITY ANALYSIS

The R&S®CMX500 in combination with the R&S®CMX-KA150 IP traffic analysis option helps developers analyze the communications behavior of 5G devices with regard to data consumption and security at an early development stage.

Increasing data volume

New 5G applications such as virtual reality (VR) and artificial intelligence, applications for the internet of things (IoT) and other areas such as wearables and connected cars will keep data traffic growing steadily. Faulty application software on a mobile device or a misconfigured IoT device can lead to excessive IP traffic even if the devices are not actively used.

IP connection security is also important, particularly for devices that manage sensitive data or control systems. Developers need to focus on testing and identifying weak spots in their applications and mobile design early in the development process. IP connection security measurement solutions with full 5G control are rare, making it difficult to uncover weaknesses.

IP connection security analysis

Rohde&Schwarz is the first to offer a solution and has integrated IP connection security analysis in the innovative R&S®CMX500. The R&S®CMX-KA150 option detects and analyzes the IP data traffic in real time and is a powerful add-on for the R&S®CMX500. At the application layer, the R&S®CMX-KA150 option captures IP data packets sent or received by the mobile device. The IP data packets can be assigned to individual applications.

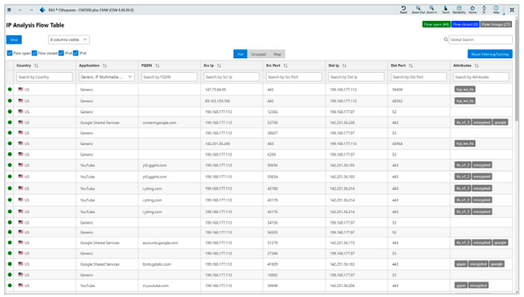
For the test, the R&S®CMX500 simulates the relevant 5G NSA or SA network (FR1 or FR2) including country and mobile network codes, establishes a device connection, acts as a gateway to the internet and connects to the required internet services.

The R&S®CMX-KA150 option captures and analyzes the data streams in established DUT IP connections and visualizes the data streams as well as relevant IP connection parameters. It is also possible to determine the location and domain name of the endpoint where communications are established.

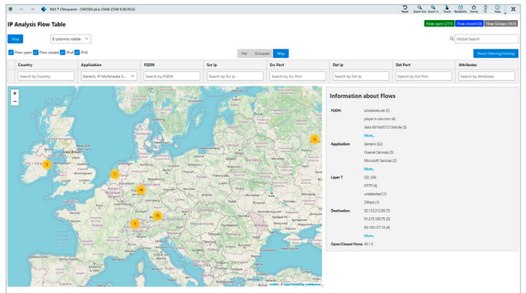
Various evaluation functions allow detailed, reliable analysis:

- List of active IP connections
- List of protocols used
- SSL/TLS protocol information
- Application detection
- Application-specific protocol information
- Endpoint geolocation (country)
- Endpoint domain name

IP analysis – flow table.



IP analysis – geolocation world map view.



ORDERING INFORMATION

Designation	Type	Order No.
Base unit		
Radio communication tester; instrument with following accessories: power cords, operating manual (getting started), R&S®CMX-B300B cables, R&S®CMX-PB70B cables	R&S®CMX500	1201.0002K70
Hardware options		
R&S®CMX500 basic assembly	R&S®CMX-PB70H	1222.0676.09
R&S®CMX500 accelerator unit	R&S®CMX-B200A	1222.0747.02
R&S®CMX500 processing unit	R&S®CMX-B300B	1222.0801.03
R&S®CMX500 IF unit	R&S®CMX-B500A	1222.0924.02
Software options		
NR signaling, NSA mode enabler Basic level, 2x2 MIMO and 4x4 DL (one CC only), 256QAM UL	R&S®CMX-KS600B	1222.1672.02
NR signaling, NSA mode enabler Medium level, 2x2 MIMO and 4x4 DL (one CC only), 256QAM UL	R&S®CMX-KS600M	1222.1650.02
NR signaling, NSA mode enabler Xpert level, 2x2 MIMO and 4x4 DL (one CC only), 256QAM UL	R&S®CMX-KS600X	1222.1695.02
NR signaling, SA mode enabler Basic level, 2x2 MIMO and 4x4 DL (one CC only), 256QAM UL	R&S®CMX-KS601B	1222.2327.02
NR signaling, SA mode enabler Medium level, 2x2 MIMO and 4x4 DL (one CC only), 256QAM UL	R&S®CMX-KS601M	1222.2333.02
NR SIG extension Basic, UL 2x2 MIMO, CA up to 8CC	R&S®CMX-KS610B	1222.3700.02
NR SIG extension Medium, UL 2x2 MIMO, CA up to 8CC	R&S®CMX-KS610M	1222.3717.02
NR SIG extension Xpert, UL 2x2 MIMO, CA up to 8CC	R&S®CMX-KS610X	1222.3723.02
Battery life measurement	R&S®CMX-KM110	Please contact your local Rohde&Schwarz sales office.
Application test options		
R&S®CMX500 application test feature set 1, IMS, IPv4/IPv6, ping, etc.	R&S®CMX-KA100	1222.1595.02
R&S®CMX500 application test feature set 2, Edge, QoS, etc.	R&S®CMX-KA110	1222.4142.02
R&S®CMX500 IP traffic analysis	R&S®CMX-KA150	1222.4159.02
R&S®CMX audio enabler	R&S®CMX-KA180	1222.4165.02
R&S®CMsequencer and XLAPI packages		
R&S®CMsequencer IMS, VoLTe, VoNR test package	R&S®CMX-KF613M	1222.4665.02
XLAPI standalone service access and voice call test scripts	R&S® CMX-KF606X	1222.4065.02
Application test accessories		
R&S®CMX external media endpoint	R&S®CMX-ZG180A	1222.4313.02
Headset cable set	R&S®CM-Z91	1212.3050.02
XLR/BNC adapter set (m/f)	R&S®CM-Z1MF	1212.3072.02
Remote radio heads (RRH)		
Remote radio head	R&S®CMXHEAD30	1201.0002K73
R&S®CMXHEAD30 hardware unit	R&S®CMXH-B73A	1430.9106.02
Remote radio head connection cable, length: 3 m	R&S®CM-Z30A	1212.1040.02
Extras		
5G NR UICC test SIM	R&S®CMX-Z01	1222.3917.02
Monitor mount	R&S®CMX-Z101A	1222.3098.02
R&S®CMX500 transport case	R&S®CMX-ZG501A	1222.3075.02
Software maintenance contracts		
Software maintenance for NR Basic and Medium level test scenarios	R&S®CMX-PU600	1222.4036.81
Software maintenance for NR Xpert level test scenarios and test cases	R&S®CMX-PU601	1222.4042.81
Software maintenance for NR signaling	R&S®CMX-PU610	1222.4059.81
Software maintenance for application tests	R&S®CMX-PU100	1222.5690.81

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