ROMES
DRIVE TEST SOFTWARE

Mobile coverage and QoS measurements in mobile networks

Product Brochure
Version 31.00

ROHDE&SCHWARZ
Make ideas real

CONTENTS

Your local Rohde&Schwarz expert will help find the best solution for you.

Contact your local Rohde&Schwarz sales office for more information, www.sales.rohde-schwarz.com

ROMES with test devices.

AT A GLANCE

The ROMES drive test software, in combination with one of the unique Rohde&Schwarz drive test scanners and the R&S®ROMES4NPA network problem analyzer tool, provides an all-in-one solution for network analysis and optimization.

Universal software platform

ROMES is the universal software platform for network engineering and network optimization systems from Rohde&Schwarz. In combination with other test and measurement equipment such as wireless communications scanners and test mobile phones, it provides solutions for all essential tasks involved in coverage measurements, interference identification, performance measurements and quality analysis in mobile networks. In addition to measuring and displaying test parameters, data is processed instantly and statistics are calculated in real time.

Support of multiple protocols and standards

ROMES supports 5G NR (incl. RedCap), GSM/EDGE, WCDMA/HSPA+, CDMA2000® 1xEV-DO Rev. A, WLAN (IEEE 802.11a/b/g/n), WiMAX™ (IEEE 802.16e), LTE, NB-IoT/Cat NB1, LTE-M and TETRA. Standard-compliant RF level measurements can be time and route-triggered over a very wide frequency range up to 53 GHz with the downconverter. Due to its highly modular structure, the platform can be expanded at any time for new technologies. The test software runs on a Windows 10 or Windows 11 (64 bit) PC.

Combination with an R&S®TSMx scanner

When ROMES is combined with an R&S®TSMx drive test scanner, the measurements help typical users (such as network operators, regulatory authorities, service providers, chipset manufacturers and government authorities) complete their work quickly and easily. This combination also allows special measurements to be performed, such as time of arrival, time-gated and electromagnetic field strength (EMF) measurements.

For reliable mission critical (MCX) communications

Coverage and interference measurements in mission critical (MCX) networks are another safety-relevant use case for mobile network testing. Fire brigades, police departments and other first responders use MCX networks for their maximum coverage and reliability. R&S®TSMx scanners support TETRA/TETRA DMO and P25 Phase 1 and 2 networks. TETRA/TETRA DMO supports demodulation of system information. Future railway mobile communication system (FRMCS) are also a growing market. FRMCS is a 5G NR based communications standard optimized for railway voice and data communications on narrowband carriers. R&S®TSMx scanners can perform RF measurements on these carriers and decode layer 3/SIB information.

ROMES running on a tablet with an R&S®TSMA6B scanner.

KEY FACTS

- One software for all technologies from a single source
- Flexible software licenses that meet user requirements reduce startup costs
- Analysis of R&S®TSME6 and R&S®TSMA6B 5G NR scanner measurements and 5G Qualcomm and Samsung (Exynos) based user equipment (UE) measurements
- Mission critical (MCX) scanner measurements on TETRA, P25 and FRMCS networks
- Parallel measurements with up to eight mobile devices per license save time, allowing more effective utilization of existing resources and saving operating expenses (OPEX)
- High-precision, fast RF test and measurement equipment (Rohde&Schwarz scanners) delivers a large quantity of reliable measurements and results
- Automated analysis at the end of the measurement using the integrated replay function or the network problem analyzer (NPA) considerably reduces OPEX
- Unique scanner for 5G NR (incl. RedCap), GSM, WCDMA, CDMA2000® 1xEV-DO, WiMAX™, LTE, NB-IoT/Cat NB1 and TETRA in all bands and decoding of broadcast information

Straightforward ROMES drive test software user interface.

EASY OPERATION AND HIGH FLEXIBILITY

Easy-to-use interface that adapts to the user's level of knowledge

Featuring different user levels, ROMES can adapt to the user's level of knowledge. The different levels make it possible to adjust the displayed views and signals to what is most important for the individual user. Experienced and novice users alike finish their work faster.

Ready to use in no time thanks to predefined workspaces and composite signals

Users can create a workspace in which to store all settings and loaded drivers. At the start of a new drive test, all they need to do is load this workspace and the test system is immediately ready to use. To further simplify and speed up this procedure, users can create a project. A project contains all the settings of a workspace and reduces the overall volume of the modules to be loaded when the software is started. The startup wizard makes it possible to fully automatically load and start a project, workspace or test file.

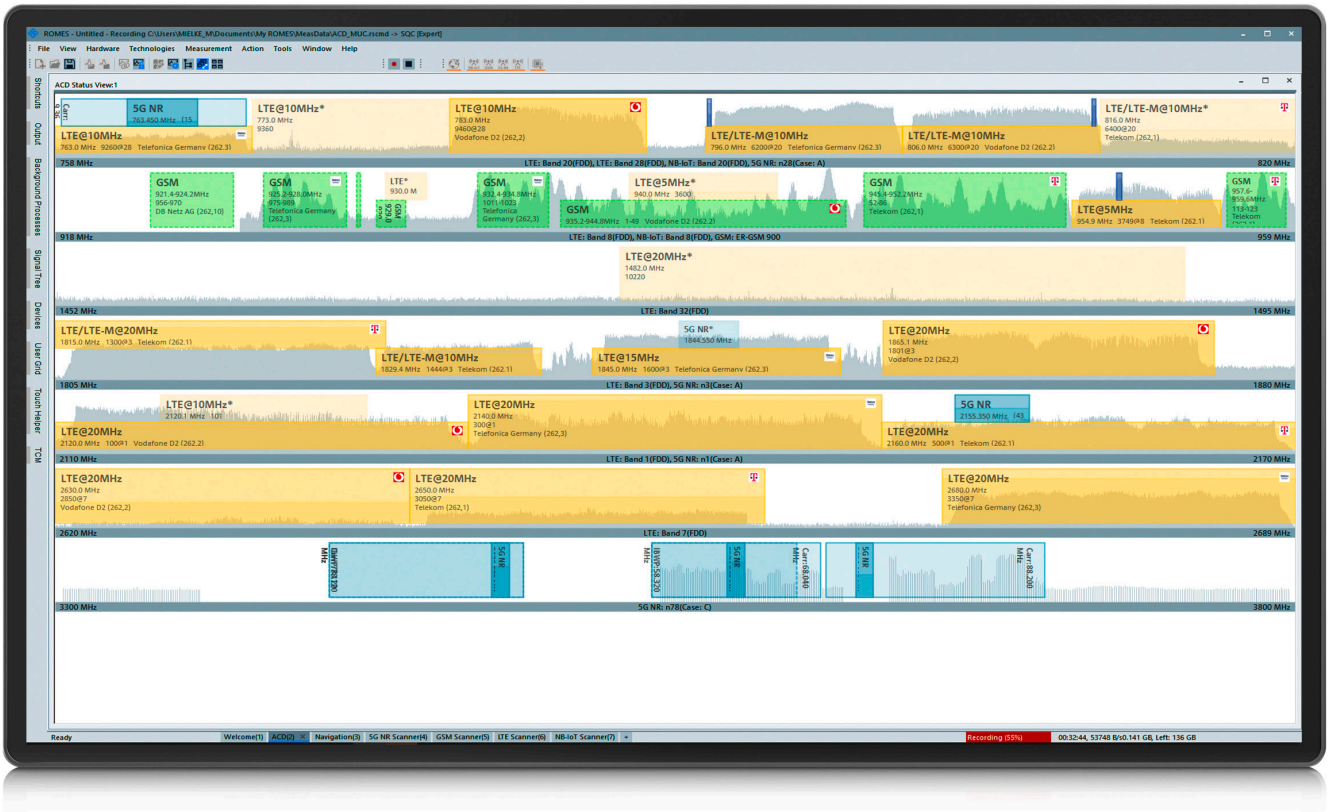
Easy system configuration with device manager and wizards

Multiple wizards help users configure a test mobile phone in order to perform application tests such as FTP or HTTP downloads. In just three quick steps, the user is ready to start testing. The device manager integrated in ROMES automatically finds and displays all connected test mobile phones and R&S®TSMx scanner options. With just three mouse clicks, the user can configure numerous application tests such as an FTP download. After successfully loading the drivers, ROMES automatically opens a selection of important windows that display measured data. The test can then be started.

Fast setup due to automatic channel detection

The R&S®ROMES4ACD automatic channel detection feature enables the R&S®TSMx drive test scanners to automatically detect active channels in a specified band. 5G NR (incl. RedCap), LTE, UMTS, CDMA2000® 1xEV-DO, TETRA and NB-IoT networks are supported. The feature can be optionally enhanced by a spectrum scan that significantly speeds up the detection process. This feature eliminates the need to set up channel lists prior to a measurement campaign.

Quick overview thanks to automatic channel detection.



The measurement system dynamically identifies new channels and adds them to the workspace during the drive. This is particularly relevant in networks deployed in a shared spectrum with other cellular standards, where channel frequency and channel bandwidth frequently change.

Support of numerous map data formats

In addition to the MapInfo map data format, ROMES also supports OpenStreetMap (OSM). Once downloaded, maps are also available offline. This is particularly important when testing data calls to ensure that measurement results are not affected by map downloads. Measurement results can be exported in ASCII format or converted to a Google Earth format. With the Google Earth format, a drive test can be displayed on a map with no additional effort.

Powerful analysis tools

When multiple, long drive tests need to be automatically evaluated for network errors and the cause for these errors determined, the R&S®ROMES4NPA network problem analyzer is the ideal tool. The base module for displaying ETSI key performance indicators (KPI) and providing an overview of the data in the measurement files is included with ROMES. Optional modules for dedicated error analysis of voice or data calls automatically evaluate and display the error causes. Other modules enable analysis of coverage test data and neighborhood relationships as well as delta and comparative analysis. LTE MIMO measurements can also be analyzed and evaluated (see page 33 for more details).

5G NR NETWORK TESTING

Requirements

- ROMES
- R&S®TSME6 or R&S®TSMA6B scanner with R&S®TSME6-K50/R&S®TSMA6-K50 option
- R&S®ROMES4T1E scanner driver
- For 5G NR mmWave measurements: R&S®TSME44DC/R&S®TSMS53DC ultracompact downconverter and R&S®ROMES4T30D downconverter hardware driver
- Appropriate Samsung or Qualcomm chipset drivers (for connecting devices to ROMES), depending on whether an unmodified device with external diagnostic ports or a fully integrated one is used

5G NR market share is growing rapidly. 5G radio access flexibility allows various use cases, such as high speed internet access, a massive number of connected devices and low latency connections.

Another essential building block of the 5G NR physical layer is the use of beamforming technology. It is the key to overcoming the issue of higher path loss due to operating on higher frequencies. Beamforming is even used for synchronization signals that UEs traditionally use to synchronize with the network. In 5G NR, synchronization signals are also used for channel quality estimations, which are the basis for establishing effective data transmissions.

Analysis of 5G scanner measurements on 5G NR synchronization signal blocks (SSB)

With the R&S®TSME6-K50 or R&S®TSMA6-K50 option, users can measure 5G NR synchronization signal blocks (SSB) and decode the PBCH/MIB content of each detected SSB. 5G NR SSB measurements help verify 5G NR coverage and the effect of beamforming, which is a very complex technology with several components involved. Each SSB can be transmitted on different beams (depending on the network configuration), which can be decoded by the scanner. With different SSBs and beams, the scanner results become three dimensional: power and signal-to-interference-plus-noise ratio (SINR) measurements for each PCI and SSB/beam index deliver a complete set of data to verify the transmission of each SSB/beam. 5G NR SSB measurements are supported for all SSB subcarrier spacings and transmission cases defined for sub-6 GHz bands (FR1) and mmWave bands (FR2) from 24 GHz to 53 GHz, where a downconverter is needed.

Validation of dynamic spectrum sharing (DSS) network functionality is also supported in combination with scanners, which are able to deliver accurate measurements of both LTE and 5G broadcast channels if the DSS feature is activated. Another scanner capability is verification of 5G TDD synchronization accuracy by delivering accurate time of arrival measurements.

5G Reduced Capability (RedCap) is the first 5G standard designed for the vast and growing internet of things (IoT). RedCap meets the IoT device requirements for smaller, less complex, lower-cost RF solutions, which have better battery life than existing 5G products. R&S®TSMx scanners let users verify RedCap network coverage or identify RedCap cells with its ACD feature.

Measurement setup (example) for 5G private network testing.

Measurements with a 5G NR UE

With UE-specific drivers, users are able to perform measurements for both non-standalone (NSA) and standalone (SA) mode. 5G NR UE NSA support provides LTE information related to 5G as well as the 5G specific NR serving cell information such as NR DL ARFCN, PCI and SSB index, L1 measurement values such as RSRP and RSRQ, L2 PDSCH and PUSCH information, L3 signaling together with services testing data, and CSI-RS or 5G carrier aggregation related metrics. In addition to complete layer 3 and NAS layer message decoding, an intelligent event view provides insight into specific 5G NSA/SA network events (such as RRC reconfigurations or SCG link failures).

5G SA and 5G NSA (4G/5G) dynamic spectrum sharing (DSS) measurements with the latest Qualcomm and Exynos based UE connected to ROMES are fully supported, sometimes even before UE hits the market. Fast time to market thanks to ROMES makes the software a perfect partner when engineering new 5G network features (e.g. VoNR). It is also easy to investigate various aspects of 5G SA network functionality (access procedure via layer 3 messages, mobility events, QoS/QoE), as well as DSS related parameters (DSS bands and frequencies, ratio of traffic carried over 4G to traffic carried over 5G).

Testing with an iPhone

ROMES supports voice and data on-device testing with suitable iPhone 13 and 14 devices. On-device testing is possible with the ROMES Probe application from Rohde&Schwarz, which is available in the App Store. ROMES controls the app, enables campaign definition with the controlling PC and can test the true user experience. Voice and data testing – HTTP DL/UL, iperf3 and ping – are currently possible, in addition to existing manual locking functions for the RAT and frequency band on the device itself. The ROMES and ROMES Probe combination provides extensive measurement capabilities, such as full Qualcomm chipset logging support, UL and DL layer 1 and layer 3 insights, as well as insights into the mobility procedures.

Testing of private 5G networks

Private 5G networks are gaining global importance in various industries. Their promise is to reduce operating costs and simplify operation of manufacturing lines. When building private 5G networks, it is crucial to ensure proper operation of devices connected over 5G networks (such as robots) through installation and maintenance tests.

The portable private network testing solution from Rohde&Schwarz, consisting of ROMES software (running on a PC or an R&S®TSMA6B scanner) and an unmodified Quectel RM500Q commercially available module, masters the above challenges, enabling users to extensively test and troubleshoot private 5G networks. The Quectel RM500Q module perfectly mimics real-life industry environments (e.g. such including connected robots). The Rohde&Schwarz testing solution offers capabilities to test and understand the performance of private 5G networks (e.g. speed, latency and reliability) based on various supported tests, including ping, interactivity and iperf3.

ROMES 5G NR GUI displaying the results measured with the R&S®TSME6 scanner.

The UE activity log view quickly identifies potential issues in the network.

UE Activity Log View:1 s23+[1] mi12pro[2]

	Time	Type	Message	Result
406	15:54:57.952	DQA	Session finished	
407	15:54:57.954	DQA	Pause: 2 s	
408	15:54:58.888	DQA	Thrpt: 11.923 Mbps	
409	15:54:59.892	DQA	Thrpt: 6.054 Mbps	
410	15:54:59.893	LTE MIB	MIB (Down)	
411	15:54:59.955	DQA	Cycle 3	
412	15:54:59.971	5G RACH	5G NR RACH Attempt (Up)	5G NR RACH: Success (1)
413	15:55:00.007	DQA	QualiPoc session 1-3 started!	
414	15:55:00.007	DQA	Session Name: Data Session 1	
415	15:55:00.009	DQA	Start Ping	
416	15:55:00.009	DQA	1. Test of Session	
417	15:55:00.009	DQA	Ping Serie started	
418	15:55:00.009	DQA	QualiPoc Test Name: Ping	
419	15:55:00.010	DQA	Host: 62.52.30.92	
420	15:55:00.015	DQA	Starting ping test with 10 requests	
421	15:55:00.093	DQA	62.52.30.92 replied in RTT:51.000 ms	
422	15:55:00.440	5G RACH	5G NR RACH Attempt (Up)	5G NR RACH: Success (1)
423	15:55:00.900	DQA	Thrpt: 6.092 Mbps	
424	15:55:01.659	LTE MIB	MIB (Down)	
425	15:55:01.737	LTE RRC	rrcConnectionReestablishmentRequest (Up)	
426	15:55:01.800	LTE RRC	rrcConnectionReestablishmentReject (Down)	
427	15:55:01.846	LTE NAS	EmmMsgServiceRequest (Up)	
428	15:55:01.846	LTE RRC	rrcConnectionSetup (Down)	
429	15:55:01.893	LTE RRC	rrcConnectionSetupComplete (Up)	
430	15:55:01.903	DQA	Thrpt: 5.568 Mbps	
431	15:55:02.053	DQA	62.52.30.92 replied in RTT:1010.000 ms	
432	15:55:02.143	DQA	62.52.30.92 replied in RTT:96.400 ms	
433	15:55:02.737	KPI	4G - IF Handover (LTE A5)	Success
434	15:55:02.905	DQA	Thrpt: 11.136 Mbps	
435	15:55:03.908	DQA	Thrpt: 12.151 Mbps	
436	15:55:03.956	LTE MIB	MIB (Down)	
437	15:55:04.003	LTE RRC	rrcConnectionReestablishmentRequest (Up)	
438	15:55:04.003	LTE RRC	rrcConnectionReestablishment (Down)	
439	15:55:04.018	LTE RRC	rrcConnectionReestablishmentComplete (Up)	
440	15:55:04.063	DQA	62.52.30.92 replied in RTT:1014.000 ms	
441	15:55:04.103	DQA	62.52.30.92 replied in RTT:40.500 ms	
442	15:55:04.912	DQA	Thrpt: 6.086 Mbps	
443	15:55:05.909	LTE MIB	MIB (Down)	
444	15:55:05.909	LTE RRC	rrcConnectionReestablishmentRequest (Up)	
445	15:55:05.917	DQA	Thrpt: 5.567 Mbps	
446	15:55:05.940	LTE RRC	rrcConnectionReestablishment (Down)	
447	15:55:05.956	LTE RRC	rrcConnectionReestablishmentComplete (Up)	
448	15:55:05.967	DQA	62.52.30.92 replied in RTT:902.000 ms	
449	15:55:06.112	DQA	62.52.30.92 replied in RTT:47.500 ms	
450	15:55:06.659	LTE MIB	MIB (Down)	
451	15:55:06.802	DQA	Max. test duration reached	
452	15:55:06.813	DQA	Thrpt: 6.847 Mbps	
453	15:55:06.841	DQA	Wait duration: 5 s	
454	15:55:07.131	DQA	62.52.30.92 replied in RTT:64.800 ms	

CELLULAR V2X TESTING

Requirements

- ROMES
- R&S®TSME6 or R&S®TSMA6B scanner with R&S®TSME6-KAB and R&S®TSME6-K36 options
- R&S®ROMES4T1E scanner driver

Driver assistance systems

For several years, vehicle manufacturers and government agencies have sought ways to increase road safety, manage traffic efficiently and make driving more comfortable. Vehicle-to-everything (V2X) is a new generation of information and communications technology that connects vehicles to everything and can support these objectives. V2X is designed to offer low-latency vehicle-to-vehicle (V2V), vehicle-to-roadside infrastructure (V2I) and vehicle-to-pedestrian (V2P) communications to add a new dimension to future driver assistance systems.

Vehicle-to-network mode

Cellular V2X (C-V2X) is a communications standard defined by 3GPP Release 14. It uses LTE technology as the physical interface for communications. The standard describes two modes. The vehicle-to-network (V2N) mode with communications over the Uu interface uses traditional cellular links to allow road and traffic information for a given area to be distributed to vehicles and enables cloud services to be integrated into end-to-end solutions. The R&S®TSME6 ultracompact drive test scanner with the R&S®TSME6-K29 LTE scanning option is frequently used to validate and optimize the Uu interface in LTE networks.

Direct or sidelink mode

The second mode is referred to as direct or sidelink mode (V2V, V2I, V2P), where communications takes place over the PC5 interface. In that mode, C-V2X does not necessarily require network infrastructure. It can operate without a subscriber identity module (SIM) and without network assistance, and uses GNSS as its primary source for time synchronization.

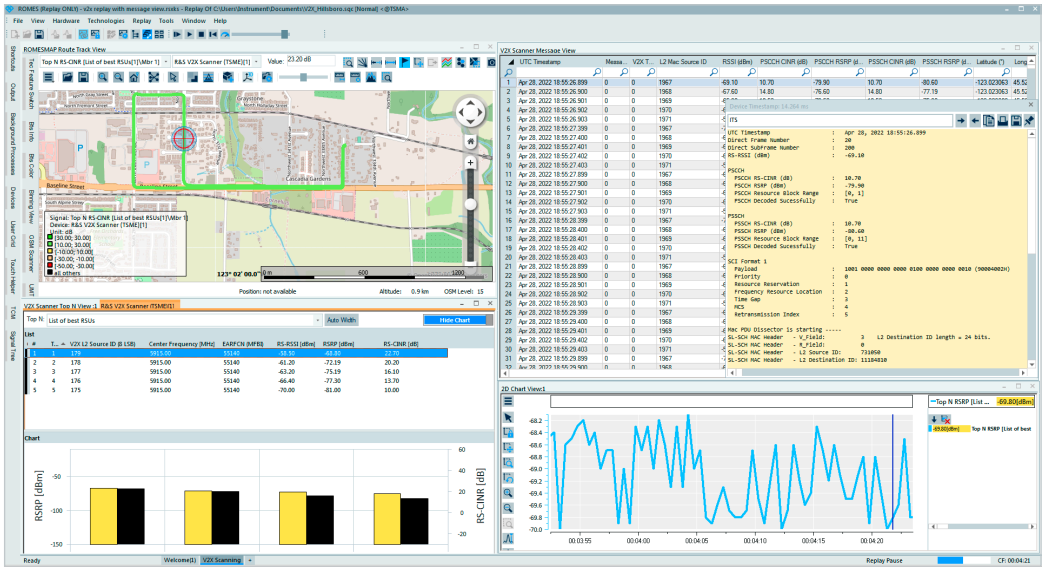
Coverage and quality measurements of direct communications between vehicles

Equipped with the R&S®TSME6-K36 C-V2X LTE scanning option, the R&S®TSME6 measures the coverage and quality of C-V2X direct communications between vehicles, infrastructure and vehicles, and vehicles and pedestrians. The scanner provides a neutral reference RF measurement that is independent of the suppliers of commercial C-V2X transmitters and receivers and serves as a baseline for the assessment of the system.

In addition, the scanner is able to decode ITS stack messages. This makes it possible to validate ITS system implementations and to verify ITS applications in the field.

The ROMES software (from Release 22.1, July 2022) supports C-V2X scanning for engineering use cases and provides a reference implementation.

ROMES supports C-V2X scanning.



NUMEROUS APPLICATION TESTS

Requirements

- ROMES
- Test mobile phone
- Appropriate Samsung or Qualcomm chipset drivers (for connecting devices to ROMES), depending on whether an unmodified device with external diagnostic ports or a fully integrated one is used

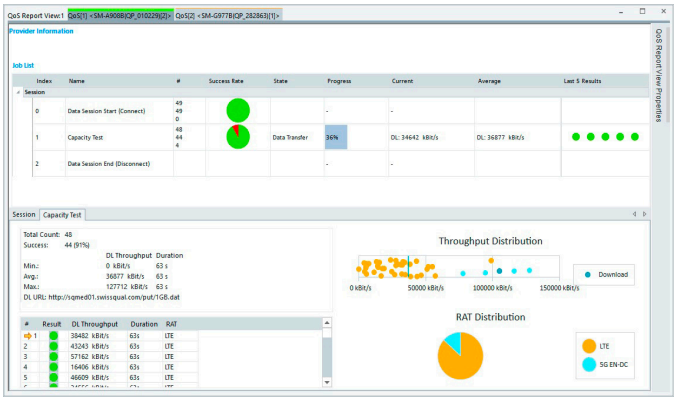
Creation of different application jobs

Mobile data calls are the standard today. It is therefore essential that data services be optimized with respect to quality and data throughput. This requires tools that can be used to configure, display and evaluate the different data measurements and packet-switched services. ROMES offers three different test solutions that are based on differing test concepts.

Data throughput measurement on a PC

The ROMES data quality analyzer (DQA) makes it possible to perform data tests using a commercially available mobile device (mobile phone, data stick), where the mobile device either acts as a modem or is connected via NDIS. The test is evaluated on a PC. This ensures that the latest devices are always used for testing and enables a fast response to new technologies such as LTE carrier aggregation or 5G NR testing. DQA jobs can be run in parallel so that users need just a few mouse clicks to generate the high data loads required for LTE CA and start testing. By appropriately linking parallel and sequential jobs, the behavior of internet users can be simulated. The ROMES data quality analyzer supports the following applications, which can be combined in an individual job list: SMS, email (POP3 and IMAP), ping, UDP, FTP, HTTP and video streaming.

The QoS report view reveals the status of data and voice tests.



Innovative on-device testing with a smartphone

When used together with a suitable QualiPoc Android phone, the R&S®ROMES4QP smartphone option sends all of the messages and analyses directly to the smartphone. This ensures an almost exact simulation of user behavior. ROMES GUI makes configuration easy and convenient. Up to six wired devices can be controlled in parallel. Depending on the device, voice quality analyses and VoLTE measurements can be performed in addition to data tests (incl. carrier aggregation). ROMES includes the following jobs, which can also be assigned to a job list: email, ping, FTP, HTTP, HTTP capacity test, iperf3, Call2AnyNumber, double-ended voice quality, MOC DL voice quality, network performance tests and application testing such as YouTube, OTT services, Facebook or WhatsApp.

The QualiPoc Android phone can also be used as a standalone device, for instance for indoor measurements. This increases the flexibility and saves costs, since only one device is needed.

Innovative on-device testing with commercial smartphones

Today's applications often call for very high-speed mobile data transfer, where a USB connection can be a limiting factor. To overcome that limitation, ROMES supports on-device testing for unmodified commercial or pre-commercial Android smartphones. Users can test data throughput directly on the device without the limitations imposed by a USB connection. For example, tests can be performed on precommercial devices during initial testing of new features (e.g. carrier aggregation [1)], license-assisted access (LAA) and 4x4 MIMO) in the lab or field. The ROMES data quality analyzer (DQA) supports on-device testing for devices with external diagnostic ports for various tests, such as FTP, HTTP, interactivity or capacity tests. Fully integrated QualiPoc devices provide additional possibilities, such as 5G technology forcing or voice testing.

Output of KPIs and the most important network parameters in a report

Automatic real-time analysis generates multiple reports containing key benchmark data. ETSI KPIs are calculated automatically.

1) Up to 8 aggregated carriers supported.

DRIVE TEST ANALYSIS IN A 3D ENVIRONMENT

Requirements
- ROMES
- R&S®ROMES43DM driver for 3D maps

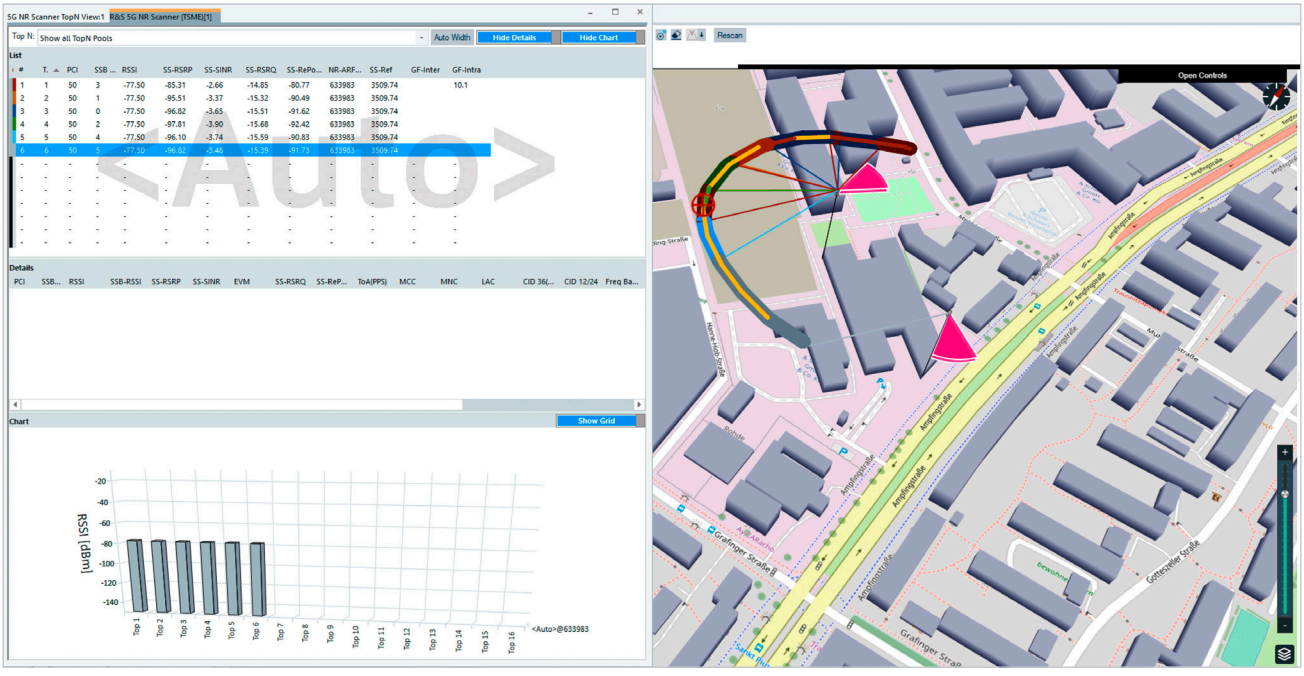
Complete 3D environment analysis capability

ROMES is capable of analyzing drive tests in 3D environments. Measured parameters or 5G NR beams, for example, can be displayed in the route track view on a 3D rendered map. The map with plotted parameters can be moved as desired, including pan, tilt and zoom capability. Base station lists can be imported with base transceiver station (BTS) heights and azimuth angles and displayed on the map. The best server lines for the measured route can be displayed to understand the beam coverage from available base stations. This capability provides users with a powerful tool to understand and evaluate the coverage and related attenuation in real networks.

Innovative testing capabilities

Drones are being used for mobile network testing in various innovative use cases. Whether addressing site survey related activities or more future oriented use cases such as package delivery with drones, analysis tools are facing a new requirement, i.e. they need to be able to handle the altitude component of mobile network coverage. ROMES offers complete capability to analyze those measurements. Drone based testing with scanners and smartphones is fully supported, including reading MAVLink protocol data for improved accuracy. If base stations with their heights and azimuth angles are imported, users get a complete overview of the coverage and quality up in the air, since the best server lines and best servers can also be displayed.

Drone based R&S®TSME6 scanner measurement in a 3D environment.



AUTOMATIC HANDOVER AND LTE/5G NR MOBILITY ANALYSIS

Requirements

- ROMES
- R&S®ROMES4HOA
- R&S®TSMx scanner
- R&S®ROMES4T1E scanner driver
- Test mobile phone
- Chipset drivers for connecting devices to ROMES

Automatic detection of missing neighboring cells during drive testing

Automatic neighborhood analysis is based on a base station list and the base station's broadcast signals that are decoded by the R&S®TSMx scanners. These system information blocks (UMTS and LTE) or system information types (GSM) include information that is normally used by test mobile phones to identify and monitor relevant neighboring cells. Reports containing the measured values of the neighboring channels are forwarded to the base station. If necessary, the base station can use this response to initiate a handover.

Improvement of network coverage

Unlike test mobile phones, the R&S®TSMx scanners see all signals. These signals can be allocated to the relevant neighboring cells. ROMES is thus able to automatically compare the measured data from the scanners and the test mobile phones against a base station list to identify any missing neighboring cells.

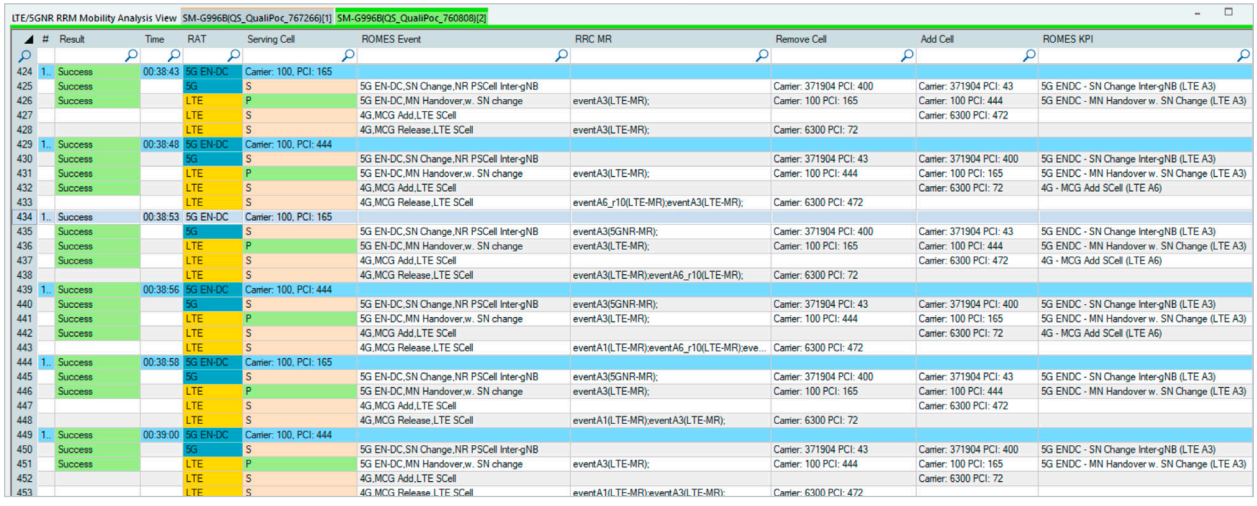
The issue of missing cells may result, for example, from cells not having been included in the base station list during network setup, and in the worst case can lead to call termination.

LTE/5G NR mobility analysis

The purpose of radio resource management (RRM) is to ensure the efficient use of available radio resources and to provide mechanisms that enable a radio network to meet radio resource related requirements. RRM encompasses a wide range of functionalities and procedures, but often the most important ones are those relating to link setup control, cell measurements and mobility. The introduction of 5G NR added an additional level of complexity to RRM procedures, so suitable tools are needed to help verifying their correct implementation and quickly identify potential issues.

The LTE/5G NR RRM Mobility Analysis View is a presentation window in ROMES where the network KPIs and the related events are arranged in a table, along with cell information about the cells involved. The columns focus on special RRM procedures that are of interest, and each column has a search function that helps users find desired content easily. With the help of this view, users can quickly identify mobility issues, plus they can synchronize to all other views. This saves time when resolving network issues.

Example of a handover analysis with secondary node change.


LTE/5GNR RRM Mobility Analysis View SM-G996B(QS_QualiPoc_767266)[1] SM-G996B(QS_QualiPoc_760808)[2]

#	Result	Time	RAT	Serving Cell	ROMES Event	RRC MR	Remove Cell	Add Cell	ROMES KPI
424	1.. Success	00:38:43	5G EN-DC	Carrier: 100, PCI: 165					
425	Success		5G	S	5G EN-DC,SN Change,NR PSCell Inter-gNB		Carrier: 371904 PCI: 400	Carrier: 371904 PCI: 43	5G ENDC - SN Change Inter-gNB (LTE A3)
426	Success		LTE	P	5G EN-DC,MN Handover,w. SN change	eventA3(LTE-MR);	Carrier: 100 PCI: 165	Carrier: 100 PCI: 444	5G ENDC - MN Handover w. SN Change (LTE A3)
427			LTE	S	4G,MCG Add,LTE SCell			Carrier: 6300 PCI: 472	
428			LTE	S	4G,MCG Release,LTE SCell	eventA3(LTE-MR);	Carrier: 6300 PCI: 72		
429	1.. Success	00:38:48	5G EN-DC	Carrier: 100, PCI: 444					
430	Success		5G	S	5G EN-DC,SN Change,NR PSCell Inter-gNB		Carrier: 371904 PCI: 43	Carrier: 371904 PCI: 400	5G ENDC - SN Change Inter-gNB (LTE A3)
431	Success		LTE	P	5G EN-DC,MN Handover,w. SN change	eventA3(LTE-MR);	Carrier: 100 PCI: 444	Carrier: 100 PCI: 165	5G ENDC - MN Handover w. SN Change (LTE A3)
432	Success		LTE	S	4G,MCG Add,LTE SCell			Carrier: 6300 PCI: 72	4G - MCG Add SCell (LTE A6)
433			LTE	S	4G,MCG Release,LTE SCell	eventA6_r10(LTE-MR);eventA3(LTE-MR);	Carrier: 6300 PCI: 472		
434	1.. Success	00:38:53	5G EN-DC	Carrier: 100, PCI: 165					
435	Success		5G	S	5G EN-DC,SN Change,NR PSCell Inter-gNB	eventA3(5GNR-MR);	Carrier: 371904 PCI: 400	Carrier: 371904 PCI: 43	5G ENDC - SN Change Inter-gNB (LTE A3)
436	Success		LTE	P	5G EN-DC,MN Handover,w. SN change	eventA3(LTE-MR);	Carrier: 100 PCI: 165	Carrier: 100 PCI: 444	5G ENDC - MN Handover w. SN Change (LTE A3)
437	Success		LTE	S	4G,MCG Add,LTE SCell			Carrier: 6300 PCI: 472	4G - MCG Add SCell (LTE A6)
438			LTE	S	4G,MCG Release,LTE SCell	eventA3(LTE-MR);eventA6_r10(LTE-MR);	Carrier: 6300 PCI: 72		
439	1.. Success	00:38:56	5G EN-DC	Carrier: 100, PCI: 444					
440	Success		5G	S	5G EN-DC,SN Change,NR PSCell Inter-gNB	eventA3(5GNR-MR);	Carrier: 371904 PCI: 43	Carrier: 371904 PCI: 400	5G ENDC - SN Change Inter-gNB (LTE A3)
441	Success		LTE	P	5G EN-DC,MN Handover,w. SN change	eventA3(LTE-MR);	Carrier: 100 PCI: 444	Carrier: 100 PCI: 165	5G ENDC - MN Handover w. SN Change (LTE A3)
442	Success		LTE	S	4G,MCG Add,LTE SCell			Carrier: 6300 PCI: 72	4G - MCG Add SCell (LTE A6)
443			LTE	S	4G,MCG Release,LTE SCell	eventA1(LTE-MR);eventA6_r10(LTE-MR);eve...	Carrier: 6300 PCI: 472		
444	1.. Success	00:38:58	5G EN-DC	Carrier: 100, PCI: 165					
445	Success		5G	S	5G EN-DC,SN Change,NR PSCell Inter-gNB	eventA3(5GNR-MR);	Carrier: 371904 PCI: 400	Carrier: 371904 PCI: 43	5G ENDC - SN Change Inter-gNB (LTE A3)
446	Success		LTE	P	5G EN-DC,MN Handover,w. SN change	eventA3(LTE-MR);	Carrier: 100 PCI: 165	Carrier: 100 PCI: 444	5G ENDC - MN Handover w. SN Change (LTE A3)
447			LTE	S	4G,MCG Add,LTE SCell			Carrier: 6300 PCI: 472	
448			LTE	S	4G,MCG Release,LTE SCell	eventA1(LTE-MR);eventA3(LTE-MR);	Carrier: 6300 PCI: 72		
449	1.. Success	00:39:00	5G EN-DC	Carrier: 100, PCI: 444					
450	Success		5G	S	5G EN-DC,SN Change,NR PSCell Inter-gNB		Carrier: 371904 PCI: 43	Carrier: 371904 PCI: 400	5G ENDC - SN Change Inter-gNB (LTE A3)
451	Success		LTE	P	5G EN-DC,MN Handover,w. SN change	eventA3(LTE-MR);	Carrier: 100 PCI: 444	Carrier: 100 PCI: 165	5G ENDC - MN Handover w. SN Change (LTE A3)
452			LTE	S	4G,MCG Add,LTE SCell			Carrier: 6300 PCI: 72	
453			LTE	S	4G,MCG Release,LTE SCell	eventA1(LTE-MR);eventA3(LTE-MR);	Carrier: 6300 PCI: 472		

TESTING VOICE QUALITY – INCL. VoLTE

Requirements
- ROMES
- R&S®ROMES4QP

User-friendly configuration for checking voice quality

Mobile networks face increasingly high quality demands. For testing voice quality, ROMES offers an innovative, full-featured, end-to-end solution that exactly simulates user behavior.

The test mobile phone is connected to the ROMES via USB and configured using a job list. A POLQA algorithm (ITU-T P.863) evaluates the voice quality directly on the phone. The results are displayed live in ROMES. The greater the difference between the transmitted voice signal and the reference signal, the poorer the voice quality. This is indicated by the usual mean opinion score (MOS) and can lie between 1 (poor) and 5 (very good).

Complete end-to-end measurement from the user perspective

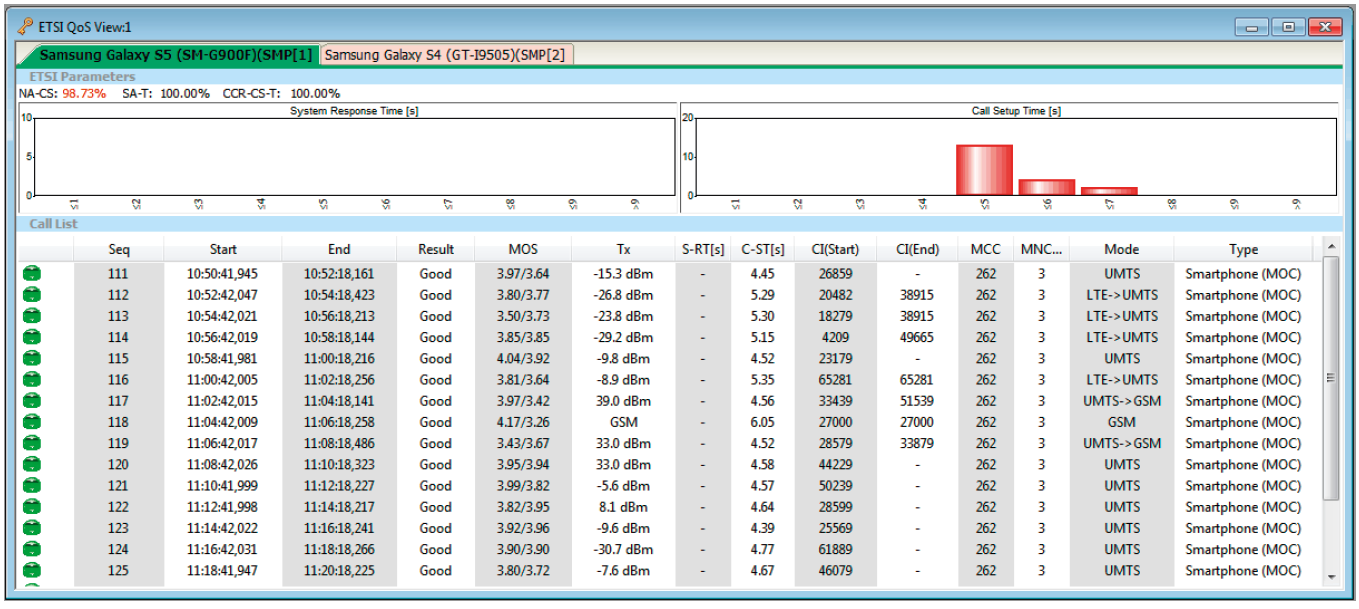
The measurements can be performed using a fixed-network station, usually a voice-quality server, or another mobile phone. The mobile phone reflects the quality as experienced by a mobile user and also permits HD voice measurements. In contrast, a fixed-network station serves as a reference, enabling the cause of a poor MOS to be found more quickly.

Based on POLQA standard

The R&S®ROMES4QP option and a suitable QualiPoc Android QA can be used to measure calls for the downlink and uplink. For the downlink, the server replays a reference voice signal, and the QualiPoc Android QA connected to ROMES evaluates this received signal. For the uplink, the ROMES test system replays a voice signal and the server uses a POLQA algorithm to evaluate it.

Following a drive test, the measured data can be merged so that the uplink and downlink measurements are available in one log file. The merge process can be skipped if two phones connected to ROMES call each other.

Voice quality measurement (MOS).



Seq	Start	End	Result	MOS	Tx	S-RT[s]	C-ST[s]	CI(Start)	CI(End)	MCC	MNC...	Mode	Type
111	10:50:41,945	10:52:18,161	Good	3.97/3.64	-15.3 dBm	-	4.45	26859	-	262	3	UMTS	Smartphone (MOC)
112	10:52:42,047	10:54:18,423	Good	3.80/3.77	-26.8 dBm	-	5.29	20482	38915	262	3	LTE->UMTS	Smartphone (MOC)
113	10:54:42,021	10:56:18,213	Good	3.50/3.73	-23.8 dBm	-	5.30	18279	38915	262	3	LTE->UMTS	Smartphone (MOC)
114	10:56:42,019	10:58:18,144	Good	3.85/3.85	-29.2 dBm	-	5.15	4209	49665	262	3	LTE->UMTS	Smartphone (MOC)
115	10:58:41,981	11:00:18,216	Good	4.04/3.92	-9.8 dBm	-	4.52	23179	-	262	3	UMTS	Smartphone (MOC)
116	11:00:42,005	11:02:18,256	Good	3.81/3.64	-8.9 dBm	-	5.35	65281	65281	262	3	LTE->UMTS	Smartphone (MOC)
117	11:02:42,015	11:04:18,141	Good	3.97/3.42	39.0 dBm	-	4.56	33439	51539	262	3	UMTS->GSM	Smartphone (MOC)
118	11:04:42,009	11:06:18,258	Good	4.17/3.26	GSM	-	6.05	27000	27000	262	3	GSM	Smartphone (MOC)
119	11:06:42,017	11:08:18,486	Good	3.43/3.67	33.0 dBm	-	4.52	28579	33879	262	3	UMTS->GSM	Smartphone (MOC)
120	11:08:42,026	11:10:18,323	Good	3.95/3.94	33.0 dBm	-	4.58	44229	-	262	3	UMTS	Smartphone (MOC)
121	11:10:41,999	11:12:18,227	Good	3.99/3.82	-5.6 dBm	-	4.57	50239	-	262	3	UMTS	Smartphone (MOC)
122	11:12:41,998	11:14:18,217	Good	3.82/3.95	8.1 dBm	-	4.64	28599	-	262	3	UMTS	Smartphone (MOC)
123	11:14:42,022	11:16:18,241	Good	3.92/3.96	-9.6 dBm	-	4.39	25569	-	262	3	UMTS	Smartphone (MOC)
124	11:16:42,031	11:18:18,266	Good	3.90/3.90	-30.7 dBm	-	4.77	61889	-	262	3	UMTS	Smartphone (MOC)
125	11:18:41,947	11:20:18,225	Good	3.80/3.72	-7.6 dBm	-	4.67	46079	-	262	3	UMTS	Smartphone (MOC)

LTE BROADCAST (eMBMS) NETWORK OPTIMIZATION

Requirements

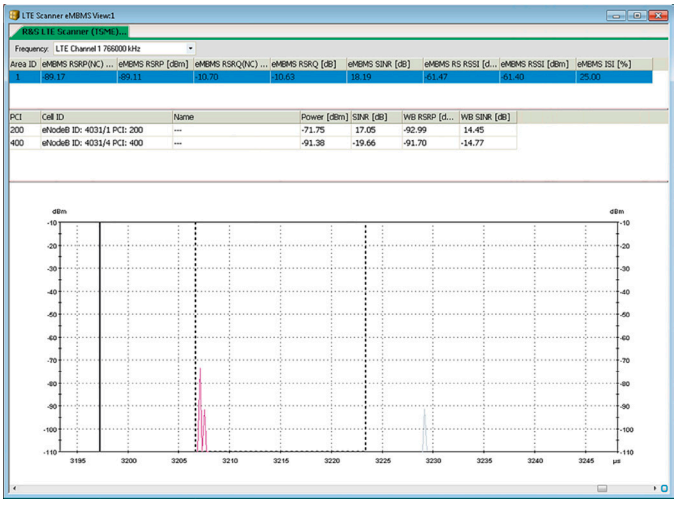
- ROMES
- R&S®TSME6 scanner with R&S®TSME6-K29 and R&S®TSME6-K32
- R&S®ROMES4T1E scanner driver
- Chipset drivers for connecting devices to ROMES

ROMES in combination with a Rohde&Schwarz LTE scanner and an LTE eMBMS test mobile

LTE broadcast, using the evolved multimedia broadcast multicast service (eMBMS) feature of LTE, allows operators to more efficiently provide services to a large number of subscribers. Instead of transmitting video and data content separately to individual users, broadcast saves network resources, making it attractive for areas such as event venues where a multitude of subscribers request the same type of content.

Enabling broadcast in an LTE network poses challenges for the network operator. It is necessary to ensure continued high-quality unicast services and simultaneously provide high-performance broadcast services. The broadcast network consists of a virtual single frequency network (SFN) inside the LTE network, where a set of eNodeBs that are part of the same broadcast area transmit the same downlink signal at the same time. This requires accurate eNodeB synchronization, which is typically not the case in LTE-FDD networks. In addition, intersymbol interference becomes important in the SFN.

ROMES eMBMS scanner view with intersymbol interference analysis.



The eMBMS feature already makes use of the extended cyclic prefix, but when planning and commissioning the broadcast network, it is crucial to validate that the network footprint at the given operating frequency does not lead to intersymbol interference. ROMES in combination with an LTE scanner, such as R&S®TSME6 or R&S®TSMA6B, and an eMBMS capable test mobile is the ideal solution for optimizing such a network.

Network planning

With the scanner, the LTE network can be baselined in the planning phase, and the network synchronization can be checked against GPS. This allows the network planner to predict potential areas of intersymbol interference and allows planning of the MBSFN area IDs, similar to PCI planning in an LTE unicast network.

Network rollout

During the network rollout and tuning of the broadcast network, the scanner can measure the power (RSRP) and quality (SINR) of each MBSFN area. The engineer can then check the validity of the network planning by comparing it to the results from the field.

Intersymbol interference detection

The scanner can also be used to detect intersymbol interference. Due to the impulse response measurement per PCI, it can also detect which eNodeB is causing this interference, allowing the engineer to take corrective measures.

Network configuration check

The scanner decodes the SIB2 and SIB13 broadcast messages that include information on the eMBMS configuration in the network, such as MBSFN subframe configuration from SIB2 and MCCH configuration per MBSFN area from SIB13. Engineers can check that the network is configured correctly in the field.

Network performance validation

While the scanner allows optimization of the RF environment, it is also crucial to validate the network performance with a test mobile. ROMES supports eMBMS test mobiles with a Qualcomm chipset, so the engineer can test the connection to the eMBMS network, view layer 3 and flute messages, capture the IP trace and analyze problems in the broadcast network. While testing eMBMS, it is important to continue testing the unicast services (data and VoLTE) to ensure that service quality stays at a high level when introducing the eMBMS feature.

NB-IoT (Cat NB1/NB2) AND LTE-M MEASUREMENTS

Requirements

- ROMES
- R&S®TSME6 scanner with R&S®TSME6-K29 and R&S®TSME6-K34/R&S®TSME6-K35, or R&S®TSMA6B scanner with R&S®TSMA6-K29 and R&S®TSMA6-K34/R&S®TSMA6-K35
- R&S®ROMES4T1E scanner driver
- R&S®ROMES4NBQ for Qualcomm NB-IoT UE support
- R&S®ROMES4NBN for Neul NB-IoT UE support

IoT measurements in combination with a Rohde&Schwarz scanner

In combination with an R&S®TSME6 or R&S®TSMA6B scanner, ROMES enables IoT measurements in both NB-IoT and LTE-M networks. NB-IoT (Cat NB1/NB2) and LTE-M are 3GPP standards for connecting a huge number of things such as smart meters to thei (IoT).

While traditional LTE standards are mainly aimed at increasing throughput and network capacity, NB-IoT and LTE-M focus on low power consumption for IoT devices and highest availability of the connecting links, especially indoors. Indoor measurements require lightweight, ultra-compact scanners with low power consumption.

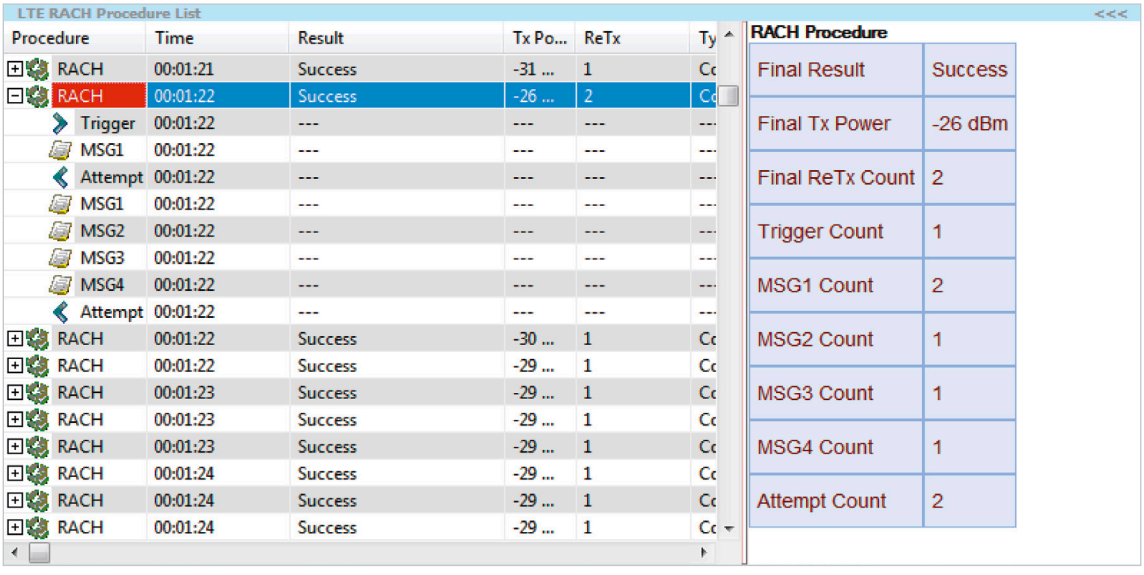
For coverage validation, troubleshooting and optimization, ROMES in combination with a Rohde&Schwarz scanner delivers signal power, signal quality, and carrier to interference and noise ratio (CINR) measurements for each available physical cell ID.

Support of all operating modes defined in NB-IoT

The NB-IoT standard defines three operating modes to integrate NB-IoT carriers efficiently into the available spectrum. ROMES supports all three modes. The LTE in-band mode makes the most efficient use of the available spectrum. In this mode, one NB-IoT carrier uses the spectrum of one LTE PRB. The other operating modes – guard-band and standalone – allow NB-IoT deployments independently of the LTE spectrum.

Simultaneous measurements for NB-IoT and other technologies

NB-IoT measurements can be performed with both Cat NB1 and Cat NB2 modules and simultaneously with measurements for other technologies such as GSM, LTE or (W)CDMA. During network optimization or troubleshooting, the impact of the NB-IoT spectrum on adjacent GSM/LTE/(W)CDMA spectra and vice versa can be validated.



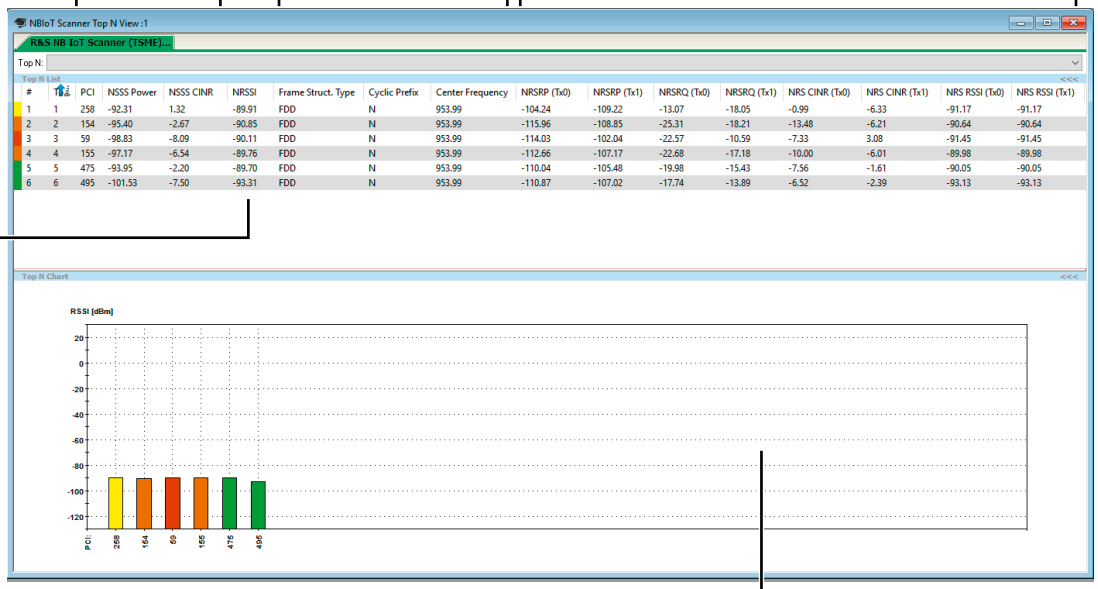
NB-IoT RACH retransmission.

NB-IoT scanner TopN view

PCI, power and carrier to interference and noise ratio (CINR) based on S-SYNC

Frame structure type, cyclic prefix information and NB-IoT carrier center frequency

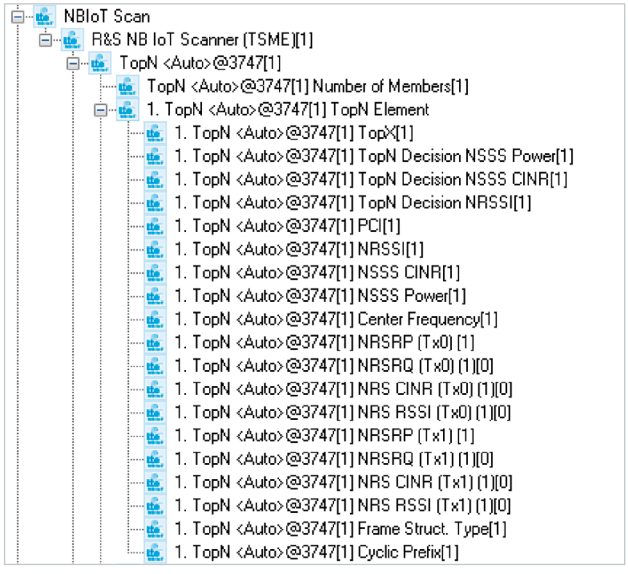
Power, quality, CINR and RSSI based on reference signal measurements for both eNodeB antenna ports (TX0, TX1)



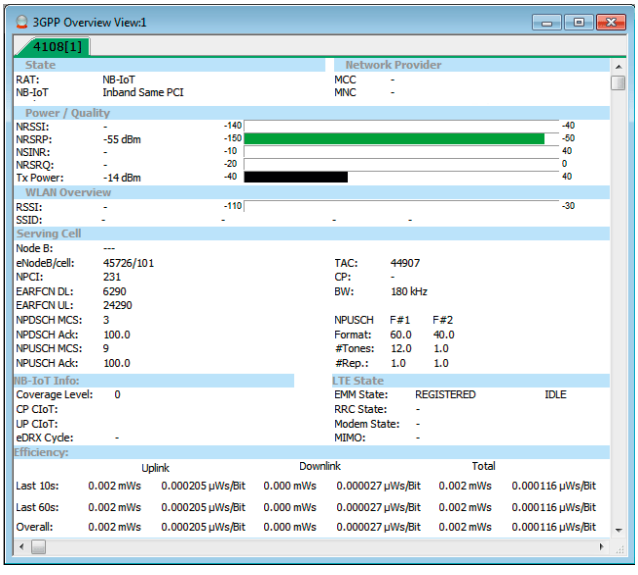
Total power received inside the NB-IoT carrier band-width (received signal strength indicator, RSSI)

TopN chart, received power bar for each PCI

NB-IoT scanner TopN signals.



NB-IoT UE overview view.



Layer 3 decoding

The NB-IoT scanner supports layer 3 BCH demodulation (MIB/SIB1). Layer 3 BCH data offers deep network configuration insight and helps optimize troubleshooting. Demodulation is performed on the fly during standard NB-IoT synchronization and reference signal measurements.

BCH/broadcast messages include master information block (MIB) and system information block (SIB) messages. They are demodulated for each cell/PCI and displayed in a tree structure in the NB-IoT scanner BCH view.

IoT measurements in combination with an NB-IoT UE

In combination with an NB-IoT (Cat NB1/NB2) UE, ROMES enables network performance and service quality measurements in NB-IoT networks. This setup permits traditional mobile network testing measurements such as RF conditions (including serving cell allocation and identity, downlink (DL) and uplink (UL) channel performance), random access channel (RACH) procedure, and various jobs executed directly on the NB-IoT stick (e.g. FTP jobs executed on the device).

It additionally provides information about NB-IoT specific features such as cellular IoT (CIoT), coverage enhancement levels (CE) and eDRX. Dedicated NB efficiency KPIs offer analysis of the used energy and transmission efficiency as power consumption is a key NB-IoT metric.

LTE-M (Cat M1/eMTC) support

LTE-M is fully compatible with existing LTE networks. ROMES supports LTE-M measurements in combination with both a scanner and an LTE-M device. LTE-M is standardized for the LTE in-band mode only. By performing subband measurements with a Rohde&Schwarz scanner, it is possible to evaluate the RF conditions for each LTE-M narrowband or identify e.g. the best narrowband for LTE-M data transmission. In combination with an LTE-M device, ROMES can deliver traditional UE based mobile network measurements (UL/DL RF conditions, UE state, operator information, serving cell information, RACH procedure). LTE-M specific measurements supported by ROMES include, for example, decoding eDRX, power save mode and coverage enhancement (CE) mode parameters.

NB-IoT measurements with ROMES and the R&S®TSMA6B autonomous mobile network scanner.

FULL OVERVIEW OF LAYER 1 AND LAYER 3

Requirements

- ROMES
- Test mobile phone
- Chipset driver for connecting devices to ROMES

Display of mobile phone activities in layers 1 and 3

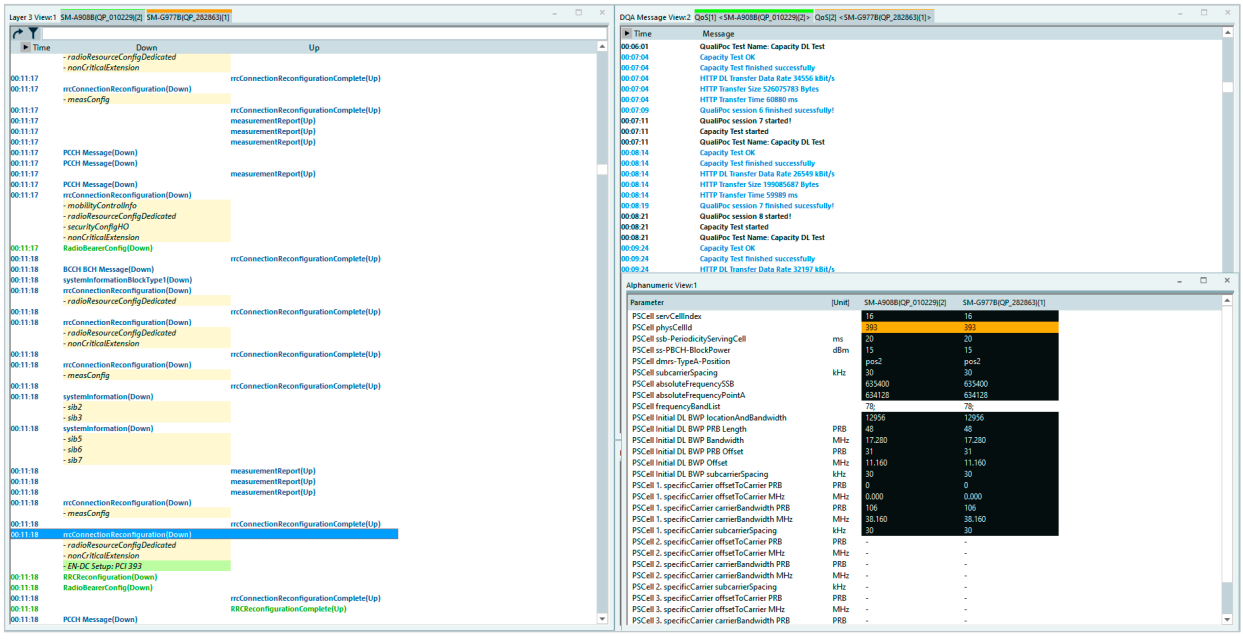
The basic functionality of ROMES in combination with the required test mobile phone drivers provides a large amount of information from layers 1 and 3. Users can investigate various procedures executed in 5G and other technologies at a glance. An important functionality for 5G – NAS layer message decoding – is also fully supported and enables comprehensive investigation of 5G SA procedures.

If at the same time measurements are taken by a scanner, the scanner's measured data is displayed in the same window, allowing a direct comparison. Layer 3 View displays all layer 3 protocol messages, sorted by uplink and downlink. Each message is decoded and can be opened if necessary.

Fast analysis of interrupted connections

In addition to protocol messages, interrupted/blocked and successful connections are also displayed. When jumping to a trouble spot, all views will show measurements taken at this point in time. This makes it considerably easier to find the cause of a problem. In addition, a filter function in Layer 3 View enables users to evaluate only specific messages.

EN-DC layer 3 protocol messages and RRC parameters.



PARALLEL SPECTRUM MEASUREMENT

Requirements

- ROMES
- R&S®TSMx scanner with R&S®TSMx-K27 RF power scan
- R&S®ROMES4T1E scanner driver

Broadband spectrum measurement

In combination with an R&S®TSME6 or R&S®TSMA6B scanner, ROMES can be used to perform a spectrum scan. The frequency range is not limited. ROMES offers different display options, e.g. envelope spectrum measurement, RMS, peak or a predefined channel mask. In this case, the power per channel is displayed.

Marker functions make it easy to precisely measure dedicated frequencies and detect changes. A marker can also be defined as a reference and compared against the maximum value.

Detection of broadband interferers, neighborhood interference and uplink activities

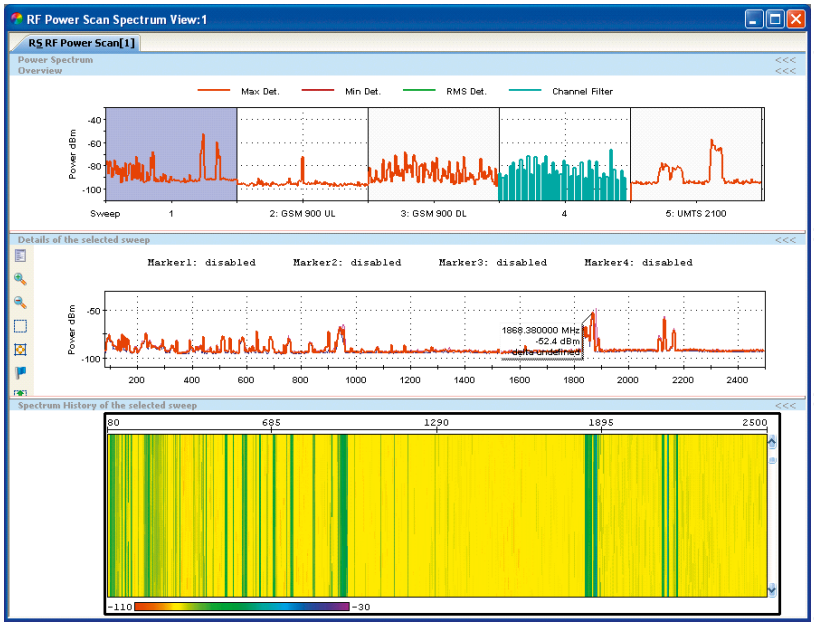
The waterfall diagram gives the user a general idea of the air interface and its history. This makes it very easy to locate broadband interferers or external interference. All the user needs to do is move the mouse pointer over the waterfall diagram. At any desired spot, timestamp and frequency are displayed, enabling the user to find the center frequency of an unknown signal faster.

The spectrum function is based on FFT analysis. Various FFT sizes allow users to set measurement bandwidths down to min. 140 Hz. The smaller the measurement bandwidth, the greater the measurement accuracy. This permits very fast spectrum measurements without the usual sweep time of a normal spectrum analyzer. Fast measurements are especially important during drive tests in order to obtain a sufficiently high density of results during the drive.

A special threshold value is provided for monitoring the spectrum. Spectra that do not show any test points above this threshold value are not displayed. Any data that is not of interest is not recorded.

Frequency markers and the entire spectrum can be exported in the ASCII format.

Spectrum measurement



Five user-selectable frequency ranges for spectrum measurements

Zoom display of one of the five ranges (here the first range "0" from 80 MHz to 2.5 GHz)

Waterfall display of selected range

LOCATION ESTIMATION OF 2G/3G/ LTE/5G AND NB-IoT BASE STATIONS

Requirements

- ROMES
- R&S®ROMES4LOC driver
- R&S®TSMx scanner
- R&S®ROMES4T1E scanner driver

Creation of a base station list during a drive test

The R&S®TSME6 and R&S®TSMA6B scanners enable users to estimate the geographic position of base stations. This can even be done for 5G, LTE, WCDMA, GSM, WiMAX™, CDMA2000® 1xEV-DO and NB-IoT sectors and base stations in parallel.

Requires only scanners and GPS

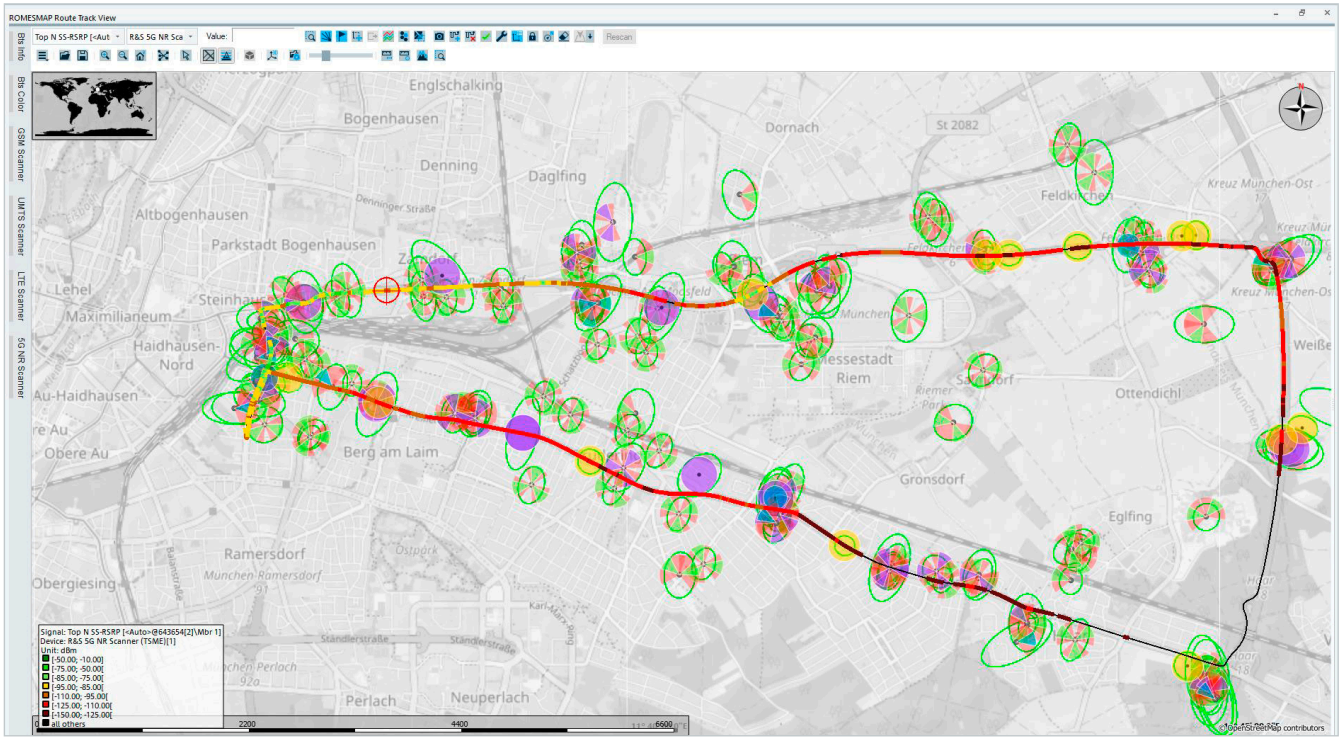
For the calculation algorithm, all that is needed are the measurement parameters from a highly accurate GPS receiver with output of the PPS time reference signal (pre-installed in the R&S®TSME6 and R&S®TSMA6B) and from the scanner.

The ROMES software and the R&S®ROMES4LOC driver allow the scanners not only to detect the main levels of the BTS (2G: RxLev, 3G: RSCP, 4G/5G: RSRP) but also to demodulate the broadcast channels (BCH). This delivers important time information as well as details of the transmitting BTS.

The maximum likelihood method is used to calculate the geographic position of the individual BTS from the measured data provided by the GPS receiver, the BCH time information and level changes during the drive test. A recent improvement of the algorithm enables location estimation also for the sectors of a BTS.

Following the drive test, the calculation results are exported to a base station list and the located base stations are displayed on a street map. The estimated location of each BTS sector lies within an error ellipse with a user-defined range (meters) and can be exported. Base stations can be filtered based on the accuracy of location estimation.

Results of the measured geographic positions of base stations using the ROMES software and the R&S®ROMES4LOC driver.



INDOOR MEASUREMENTS

Requirements

- ROMES
- R&S®ROMES4IND
- Test mobile phone and/or scanner
- Chipset driver for connecting devices to ROMES

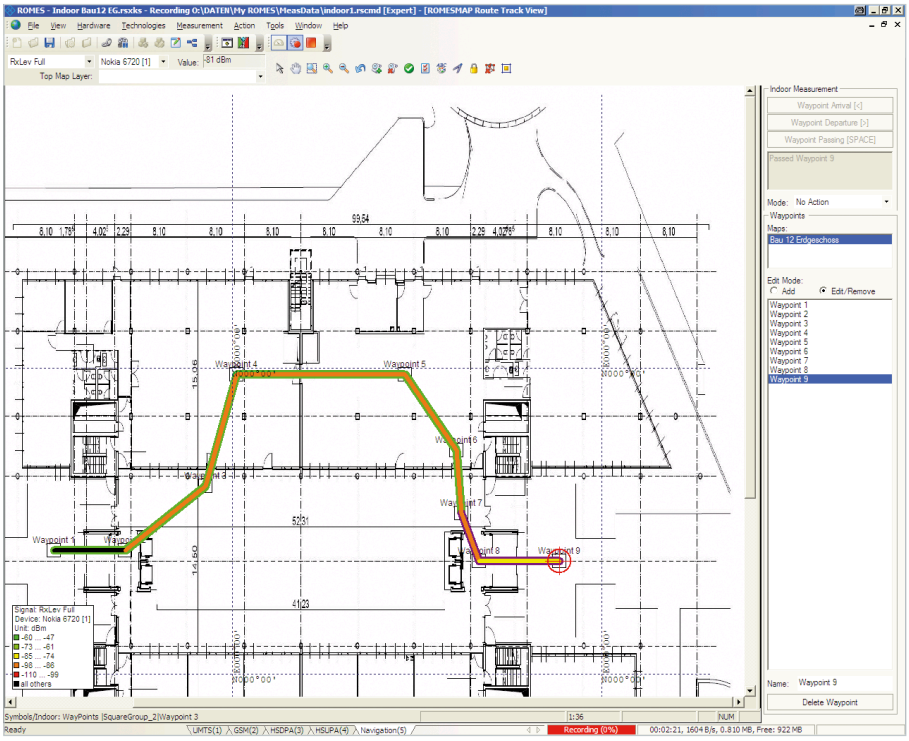
Stationary or moving measurements indoors without a GPS signal

High-quality wireless communications coverage inside buildings, e.g. at airports, shopping malls and exhibition halls, is gaining in significance, especially with respect to data traffic. Since GPS reception indoors is limited or nonexistent, ROMES offers an alternative to conventional navigation display (GPS data on a map).

Combined indoor/outdoor measurements

The R&S®ROMES4IND indoor driver option provides a separate means of navigation that makes it possible to display positions on a floor plan. Measurements can be taken at specific points (hot spots, e.g. in conference rooms) or along a specific path (continuous, e.g. in a corridor). Combined DUTs (comprising buildings and outdoor areas such as company premises) can be optimally measured and georeferenced. The software also displays a smooth transition to areas covered by GPS. Measurements of multi-floor buildings are easily handled by displaying the various floors as multiple layers on the map. The wide support of georeferenced and non-georeferenced map formats (tab, jpg, tif, bmp, png) and included import functionalities for iBwave ibwc and AutoCAD DXF files simplifies and speeds up daily work. The layer that corresponds to the floor where the user is located is visible on the map. The complete integration of the indoor functionality into the ROMES map display allows intuitive operation.

Display of a floor plan in hot spot mode.



ROMES INSIGHTS: ANALYZING 4G AND 5G NETWORK PROBLEMS

Requirements

- ROMES
- R&S®ROMES4INS driver

Increasing network complexity

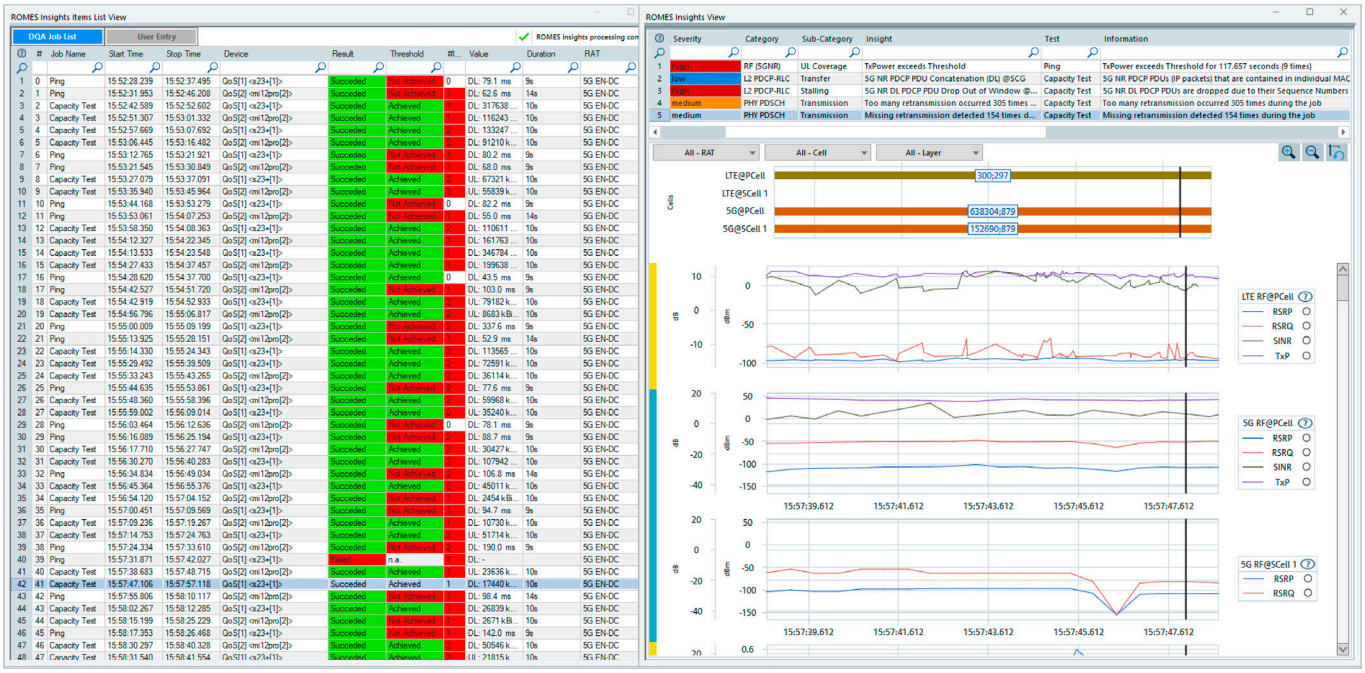
Newer mobile networks are more complex and have more configuration options. The networks can flexibly support various use cases, which also makes data collection more complex. Since many parameters can be configured and measured, users need to do more than collect data and display measured parameters to figure out an issue. The tool itself is expected to explain why network performance has degraded and find the source of the issue.

Automatic identification of LTE and 5G network problems

ROMES Insights lets the software autonomously identify why LTE and 5G performance has declined and finds the reasons. The QoS report view identifies and marks results where the application layer test results fail to meet the specified test threshold. Starting from a job of interest in the QoS report view, all other views (in layer 3, 2D charts or ROMESMAP views) will synchronize with and highlight the selected job duration. Users can focus on the specific test execution time span during analysis.

An additional Insights tab automatically generates a list of high level and detailed information. ROMES Insights combines detailed trace and TTI level data and delivers insights from all protocol layers about potential problems, such as PDU session info, RRC connection control and mobility, PDCP/RLC configuration, IP details, DRB PDCP analysis, RACH failures, PHY PDSCH/PUSCH analysis, resources/link adaptation/transmission and RF analysis (coverage, interference, time of arrival).

Display of results from ROMES Insights.



R&S®ROMES4NPA: ANALYSIS OF PROBLEMS IN TETRA NETWORKS

Requirements

- R&S®ROMES4NPA (included in ROMES or standalone)
- R&S®ROMES4N11
- R&S®ROMES4N15
- R&S®ROMES4N17
- R&S®ROMES4N18

Automatic detection, analysis and documentation of trouble spots

The sheer volume of recorded data makes individual and manual analysis impossible. The R&S®ROMES4NPA network problem analyzer automatically evaluates the data collected during drive tests and generates a list of all detected trouble spots and displays them on OpenStreetMap (OSM) or a user-defined map. R&S®ROMES4NPA also provides information about the source of a problem.

Sophisticated algorithms to support users

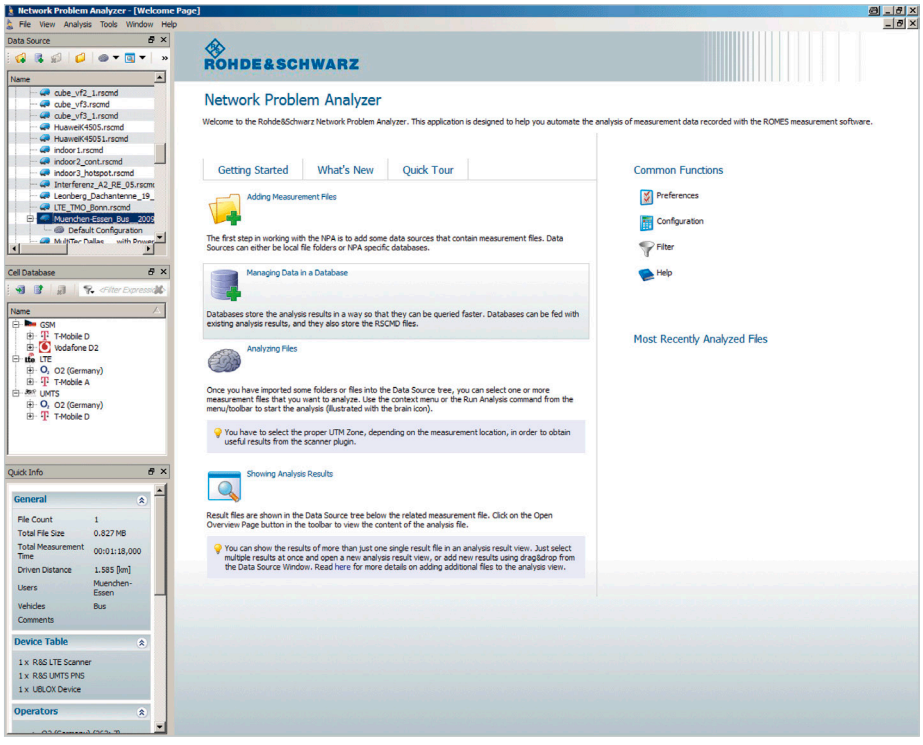
The easy-to-use interface guides the user through the process, from reading in the measured data (from one or more drive tests) and selecting the analysis criteria to retrieving the automatically generated list of trouble spots.

Right-clicking a problem automatically opens ROMES and positions the replay of the measurement file just ahead of the trouble spot in question so that the user can perform a detailed check if required. The result is displayed in HTML in a clear report that can be printed. An export to Excel allows easy data processing.

The measurement data is analyzed according to specific criteria that depend on the modules selected. In all modules, the analysis criteria can be adapted to user-specific limit values and settings.

The R&S®ROMES4NPA base package includes the following modules:

- NQA (network quality analyzer) for voice calls, base module including KPIs
- DQA (data quality analyzer) for PS data connections, base module including KPIs



Start screen of R&S®ROMES4NPA.

Broad range of optional add-on modules for voice quality and data tests as well as coverage and neighborhood analysis

R&S®ROMES4N11

NQA for TETRA voice calls, expansion for problem spot detection

This module enables analysis of voice calls for network problems, which can be selected from more than 140 different problem categories, and delivers a list of the problem spots including the type and cause of problem.

R&S®ROMES4N15

Coverage module with display of coverage data on a raster map

Coverage data measured with Rohde&Schwarz scanners is rasterized and displayed on a map using OpenStreetMap (OSM). This makes it easy to generate coverage plots and create and visualize overshooting problems. Optimizations can be checked using a before-and-after comparison.

R&S®ROMES4N17

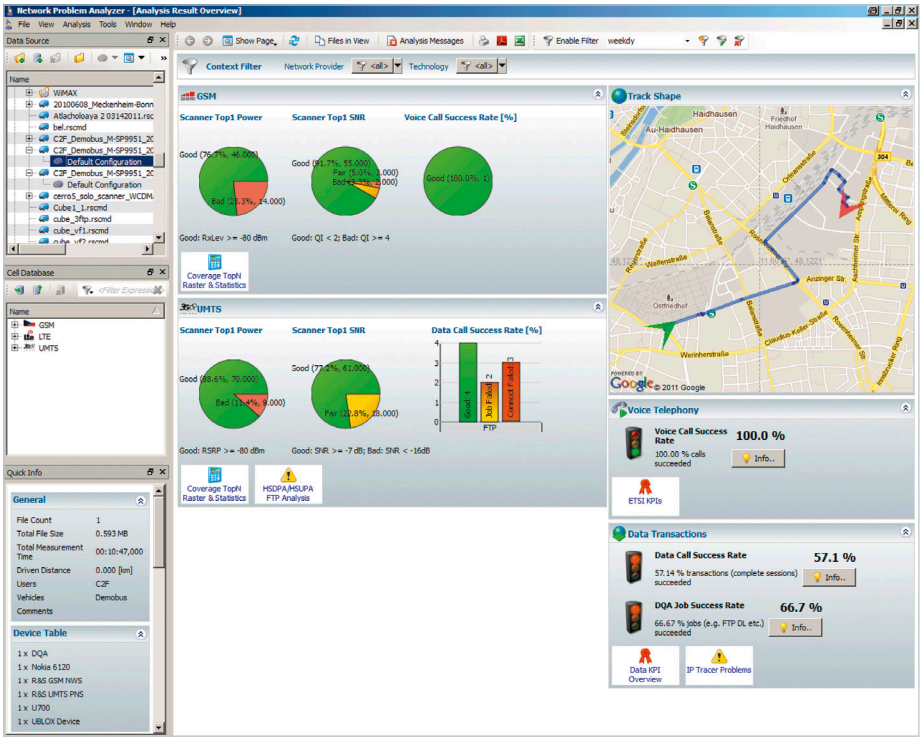
Neighborhood analysis module for automatic classification of neighborhood relationships into one of the following categories

- (Potentially) missing neighbor: a cell with high signal strength and good quality (both thresholds can be set) has been measured but is not contained in the currently defined neighbors
- Unused neighbor: a cell is configured as a neighbor but has not been detected during measurement
- Approved neighbor: a cell has been classified as a (potentially) missing neighbor and is contained in the neighbor list

R&S®ROMES4N18

Spectrum analysis module for automatic detection of strong transmitters in a spectrum thought to be empty

- Easy verification that a purchased spectrum is clear and that no other emitter still occupies part of that band
- Fast confirmation that part of a spectrum can be used for refarming purposes
- Reliable observation of power scan measurements, similar to a spectrum analyzer
- Automated and configurable (bandwidth, duration, power) analysis from potential narrowband and wideband interferers
- Detailed analysis by drilling down to the corresponding measurement file



Initial overview of scanner measurement content.

SYSTEM CONFIGURATIONS FOR VARIOUS APPLICATION SCENARIOS

Freerider CORE with mounted mobile phones and scanner.

Freerider backpack system generation 4

The Freerider backpack system generation 4 is a compact, lightweight backpack for walk test and drive test campaigns. Supporting for up to 12 test mobile phones and high-performance scanner measurements (including 5G mmWave and LTE 4x4 MIMO), it is ideal for network optimization, benchmarking and cellular network analysis. Its benefits include the following:

Well thought-out product design

Flexible design

The backpack can be operated from a tablet or laptop via Wi-Fi® to control the measurement application running on a built-in PC (R&S®NCM2) or an R&S®TSMA6B scanner. A cabled LAN or USB connection is also possible via the integrated LAN switch or optional USB hub. With the Freerider backpack system generation 4, a complete and compact drive test system can be temporarily installed in a rental car, significantly reducing the setup time for measurement campaigns. The sturdy construction is shock and vibration proof in line with automotive standards and can be used in any vehicle type.

Wi-Fi® is a registered trademark of Wi-Fi Alliance®.

User-specific cabling.

Maximum flexibility and future readiness

Extensive test mobile support

The Freerider backpack system generation 4 supports up to 12 test mobile phones, which can be charged via the optional, integrated USB hub.

Scanner and technology support

The Freerider backpack system generation 4 fully supports the R&S®TSMx scanner family as well as GSM, WCDMA, CDMA2000® 1xEV-DO, WiMAX™, LTE, NB-IoT, LTE-M, PowerScan RF, CW channel power scan and 5G NR. For the 5G NR mmWave bands, it offers a measurement bandwidth of up to 100 MHz. LTE MIMO measurements support up to 4x4 MIMO.

Designed for the toughest environmental conditions

The system has been designed for indoor and outdoor use. Active ventilation with silent fans allows operation in hot climates. The coating protects the backpack against splash water ingress in rainy conditions, and the light color of the coating minimizes the impact of solar radiation.

ROMES configurations

ROMES and the connected measuring equipment (test mobile phones, R&S®TSMx scanners, etc.) can also be used and on request delivered in the following configurations:

- With user-specific cabling
- Installed in a turnkey test vehicle
- As a TETRA backpack solution based on the R&S®MNT-CORE2

Freerider backpack system generation 4, with external tablet.

Turnkey test vehicle.

Specifications in brief of the Freerider backpack system generation 4		
Environmental conditions		
Temperature	operating temperature range	0 °C to +50 °C
	permissible temperature range	–10 °C to +55 °C [1]
	storage temperature range	–40 °C to +55 °C
Damp heat		+25 °C/+55 °C, < 95 % relative humidity, cyclic, non-condensing, in line with EN 60068-2-14
Connectors		► power in ► 5 × LAN ► 16 × USB (optional)
Power rating		
Supply voltage, DC		10 V to 19 V
Power consumption during operation	equipped with R&S®NCM2; 2 R&S®TSME6, 8 UEs performing a real measuring task	90 W (typ.)
Maximum inrush current		11 A at 19 V
Product conformity		
Electromagnetic compatibility	EU: in line with EMC directive 2004/108/EC	applied harmonized standards: ► EN 55032: 2012/EN 61326-1: 2006 (home location, class B) ► EN 55024: 2010 ► EN 61000-6-2: 2005/EN 61326 (industrial location, class B)
Electrical safety	EU: in line with directive 2014/35/EU	EN 61010-1
	USA	UL 61010-1
Dimensions	Freerider CORE (layer 1 and 2)	485 mm × 356 mm × 146 mm (19.1 in × 14.0 in × 5.7 in)
	Freerider CORE plus extension kit (layer 1 to 3)	485 mm × 356 mm × 191 mm (19.1 in × 14.0 in × 7.5 in)
Weight	depends on installed devices	
	without devices/batteries, layer 1 and 2	approx. 3.2 kg (7.1 lb)
	without devices/batteries, layer 1 to 3	approx. 4.0 kg (8.8 lb)
	typical weight (1 × R&S®TSMA6B and 4 × test mobiles)	7.9 kg (17.4 lb)
Freerider backpack system generation 4 is optimized for the software applications ROMES, SmartBenchmarker and R&S®NESTOR. Only one of them can be installed.		

[1] The maximum operating temperature may be lowered by the maximum stable operating temperature of the installed UEs and devices.

SYSTEM COMPONENTS

Technology	Qualcomm/Samsung Exynos Driver (devices with external diag port)	TETRA driver for devices	Qualcomm IoT driver, Neul IoT driver	R&S®TSMA6B driver, R&S®TSME6 driver
GSM/GPRS	•			•
EDGE	•			•
WCDMA Rel. 99	•			•
HSPA+	•			•
CDMA2000® 1xEV-DO				•
WiMAX™ IEEE 802.16e				•
LTE	•			•
Spectrum				•
TETRA		•		•
NB-IoT			•	•
5G	•			•

A list of test mobile phones supported by ROMES is available separately.

SYSTEM REQUIREMENTS

Minimum

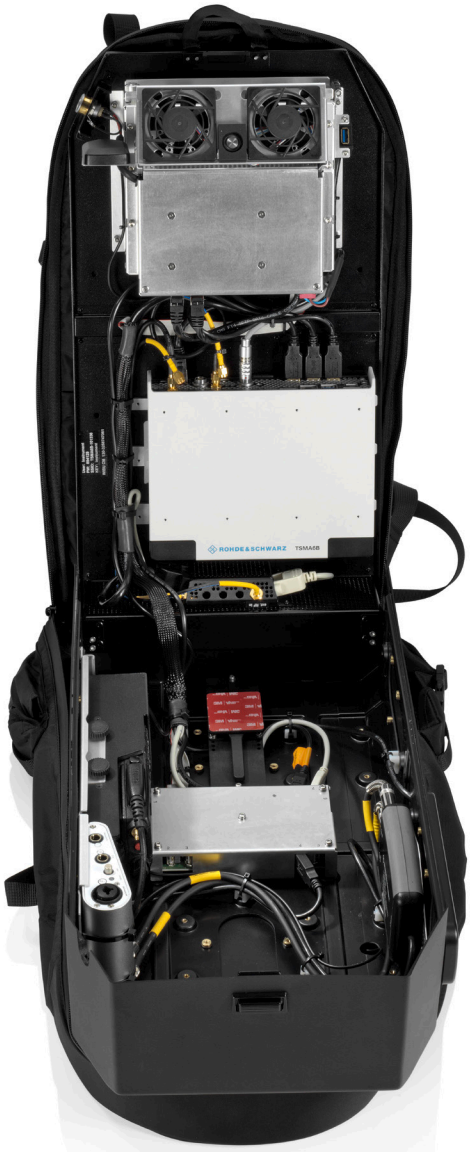
- Current generation Intel® Core™ i7 CPU
- 16 Gbyte RAM
- 512 Gbyte SSD
- USB 3.0 and LAN ports
- Windows 10 or Windows 11 (64 bit)

APPLICATION: TETRA

Requirements

- R&S®TSMx scanner
- R&S®TSMx-K26 TETRA option for scanner
- ROMES
- R&S®ROMES4T1E scanner driver
- R&S®ROMES4TET
- R&S®ROMES4SQA

The R&S®TSMA6B scanner, TETRA radio and other accessories controlled by ROMES in a backpack for active and passive testing.



ROMES is the software platform for measurements on the TETRA air interface. Statistics, analyses, troubleshooting for coverage, quality of service and handover behavior give network operators a complete overview of the network state and help them keep it in the best possible state.

The R&S®TSME6 or R&S®TSMA6B scanner, TETRA radios and other accessories are controlled by ROMES. For such tasks, the following capabilities are indispensable:

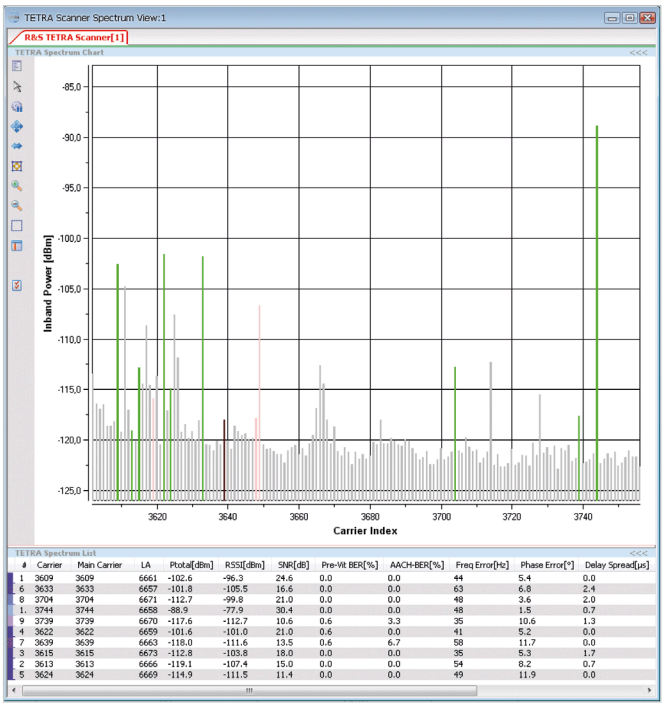
- Mobility and speed – use in vehicles, helicopters and on foot
- Highly accurate coverage measurements on TETRA networks using a passive RF scanner
- Spectrum analysis for identifying interferers
- Measurement and identification of TETRA base stations
- Subsequent problem analysis – uncovers problems in the TETRA network and analyzes them based on the test data obtained with ROMES
- In the downlink, measurements performed using the scanner in the D-CT and D-CTT operating modes include the following:
- 100 MHz to 1000 MHz frequency range, with parallel measurements of all channels in a 10 MHz block
- 25 kHz channel resolution (with QPSK)
- Automatic detection of the broadcast synchronization channel (BSCH)
- Up to 20 Hz measurement rate for carrier measurements of up to 2 × 600 channels simultaneously (10 MHz block, QPSK) with
  - Channel number and frequency
  - Power of each base station
  - MCC, MNC, TN, FN, MFN
  - BER before Viterbi
  - AACH BER
  - Frequency error and phase error
  - SNR
  - Delay spread
  - In-band spectrum
  - Constellation diagram
  - BCH demodulation, incl. decoding of neighboring cells
  - Measurement of co-channel interference
  - Channel impulse response (channel sounder)

ASIO COMPATIBLE

ASIO is a registered trademark of Steinberg Media Technologies GmbH

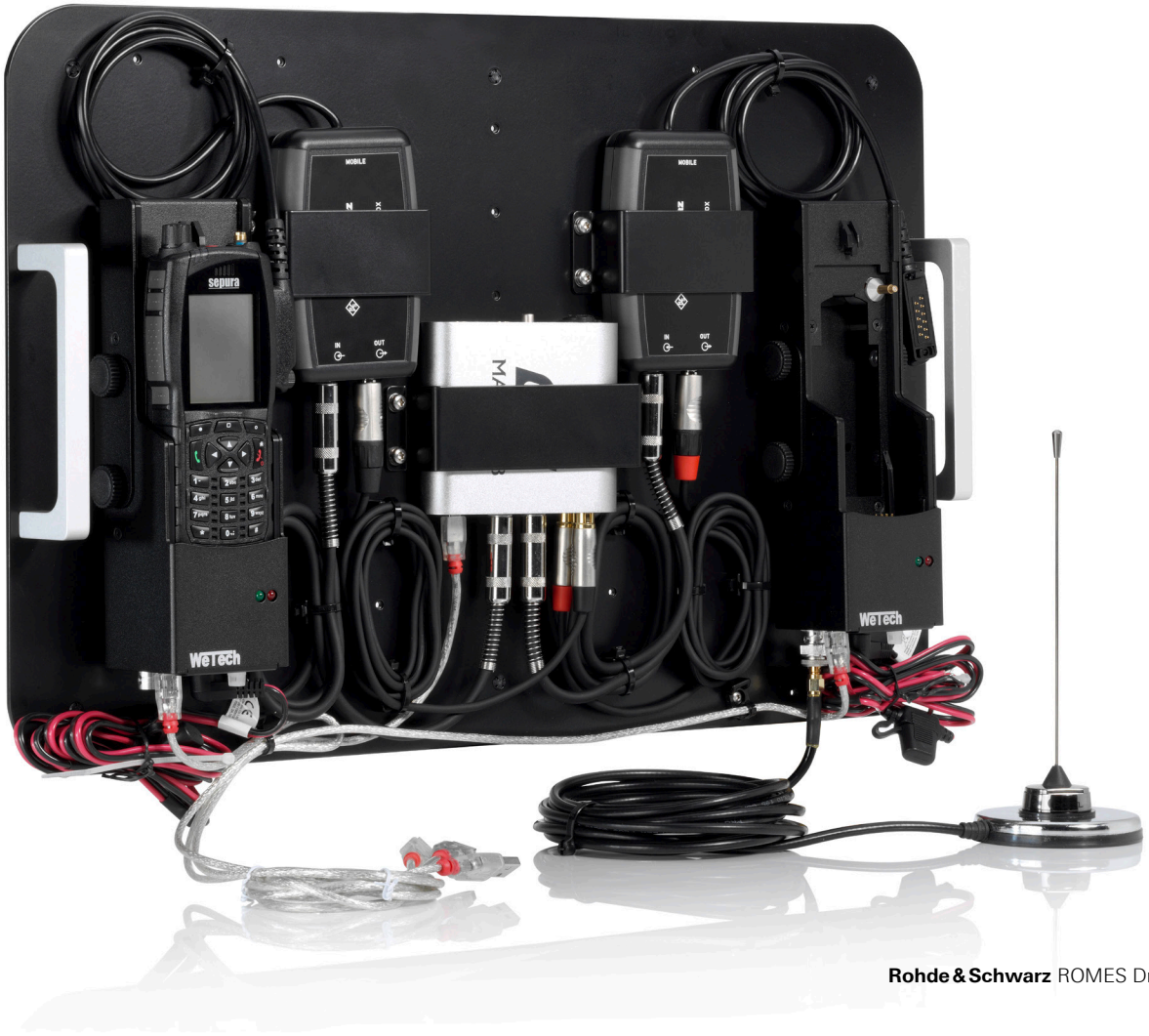
The R&S®ROMES4TET software option controls Sepura (latest Sepura SC20 and SC21 also supported), EADS and Motorola radios via the standardized PEI interface to control calls and transfer data in order to emulate user behavior in the network and provide additional status information. This software option also provides layer 3 information for calculating KPIs of QoS measurements, including handover and neighborhood analysis.

The R&S®ROMES4NPA network problem analyzer completely supports analysis of TETRA QoS using R&S®ROMES4N11 and R&S®ROMES4N15 for coverage and interference and R&S®ROMES4N17 for handover and neighborhoods.



The TETRA spectrum scan displays all channels in a 10 MHz band.

Stationary measurement system with TETRA devices.



APPLICATION: LTE

Requirements
- ROMES
- Chipset driver for connecting devices to ROMES
- R&S®TSMx scanner
- R&S®ROMES4T1E scanner driver

Coverage analysis with Rohde&Schwarz scanners

This essential analysis determines whether an LTE signal of sufficient strength is available at the test site. ROMES and TopN View can be used to clearly display the results and plot them on a map. For signal strength, the R&S®TSME6 and R&S®TSMA6B scanners deliver the RSRP value or the power of the P-SYNC/S-SYNC signals. In addition to signal strength, the reference signal received quality (RSRQ) and the signal to interference plus noise ratio (RS-SINR) for each cell as well as the SINR for the SYNC signals are displayed. If one of these values is too low, this indicates interference, intermodulation or other types of disturbance. In this case, the R&S®TSME6/R&S®TSMA6B and ROMES offer a more detailed cause analysis.

Data throughput measurements with an LTE test mobile phone

ROMES collects scanner data and measurement data from a Qualcomm or Samsung LTE test mobile phone. One of the most important parameters is data throughput. If it is too low, the cause may be a low-order modulation format such as QPSK or the use of SISO rather than MIMO. A comparison with the scanner data permits further conclusions about possible causes. Interference, multipath propagation, handover failures or even weak network coverage might be the cause of error.

In addition to measuring data throughput, measurement data of layer 1 and layer 3 messages is recorded. Qualcomm or Samsung chipset based LTE mobile phones or data sticks display detailed information about individual data packages so that often a quick glance is enough to detect possible causes of error.

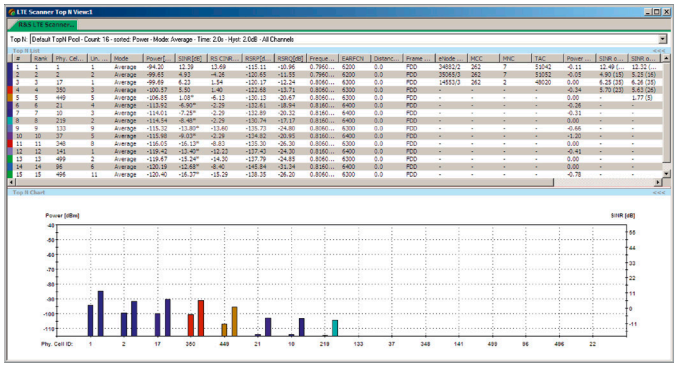
VoLTE measurements

LTE is also increasingly used for voice transmission. IP-based telephony via VoLTE places higher demands on network quality because users have less tolerance for poor voice call quality, such as dropped calls, than they do for data calls. In addition to the normal chipset trace data, ROMES also supports output of the SIP signaling used for VoLTE. This makes it possible to collect voice KPIs for VoLTE and identify the cause of errors.

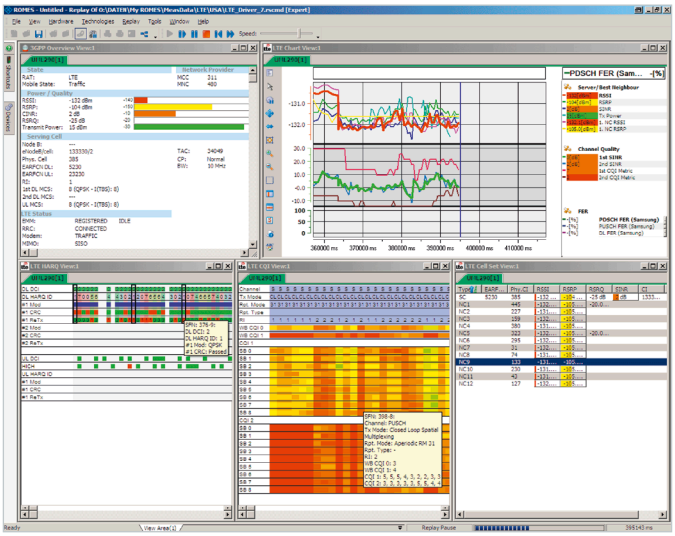
Interference analysis

LTE is a single frequency network (SFN) that is identified by a reuse factor of 1. This means that neighboring cells use the same frequency ranges. Interference is therefore especially frequent and must be analyzed to the greatest possible extent to avoid capacity losses. This is a special challenge for T&M equipment because the interference can also affect the T&M equipment itself. The scanner was developed specially for this task and features an impressive C/I value of –20 dB. Even signals that are 20 dB weaker than the strongest noise can be measured, making it possible to identify interferers and reduce interference. The scanner can also distinguish between signals that have the same physical cell ID but come from different eNodeBs. It makes no difference whether the measurement is performed in the FDD mode or in the TDD mode.

TopN View shows eNodeB signals sorted by strength.



Display of measurement data from a Qualcomm chipset based LTE data stick.



Cyclic prefix analysis

A special feature of the Rohde&Schwarz LTE drive test solution based on the R&S®TSME6 and R&S®TSMA6B is the channel impulse response (CIR) measurement. This involves a channel measurement performed over a period of time. ROMES displays the multipath propagation of the signals – also referred to as echoes – in a power versus time diagram. As an OFDM standard, LTE has a defined frame length and a fixed guard interval, also referred to as a cyclic prefix. This value is necessary in order to wait for echoes in the receiver. A cyclic prefix that is too short or an echo that is too long can cause problems in the subsequent frames. This is referred to as intersymbol interference (ISI). The effect manifests itself in a low SINR. ROMES can measure the length of the cyclic prefix and match it against the multipath propagation. This enables the user to draw conclusions about how often multipath propagation disturbs the subsequent symbol, whether a longer cyclic prefix would be better and whether the network needs to be optimized, e.g. by adding eNodeBs.

Demodulation of eNodeB broadcast information

The R&S®TSME6 and R&S®TSMA6B can scan LTE signals and demodulate broadcast signals. The broadcast information from previously detected eNodeBs is demodulated (MIB and SIBs) to learn more about the base station. Based on this information, the user knows the country, the network and the cell from which the received signal originates. Neighborhood relationships (intra-RAT and inter-RAT) and handover thresholds are also visible. All these values make it easier to classify the signals and detect problem spots.

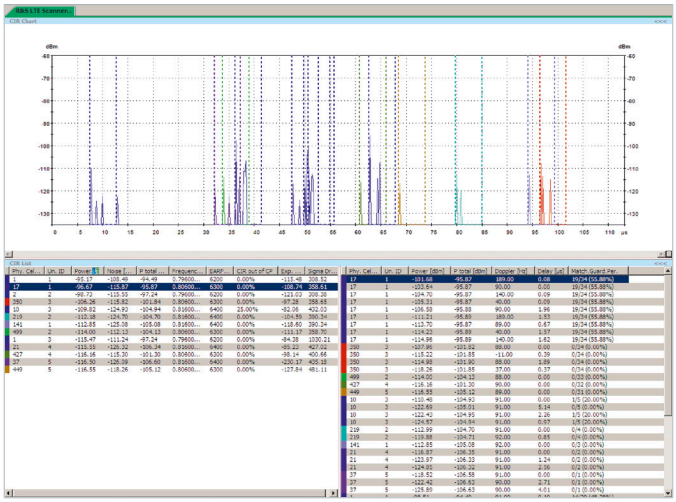
Subband measurements

The LTE wireless communications standard permits channel bandwidths of 1.4 MHz to 20 GHz. While the synchronization and broadcast information is contained within a bandwidth of approximately 1 MHz in the center of the LTE carrier, useful data is transmitted over the entire bandwidth. Narrowband interference outside the center of the carrier can be detected through subband measurements performed on the LTE scanner. The SINR of the reference signals is determined for every resource block (12 subcarriers corresponding to 180 kHz). ROMES graphically displays these values in a waterfall diagram. Interferers are visible as vertical lines in the diagram.

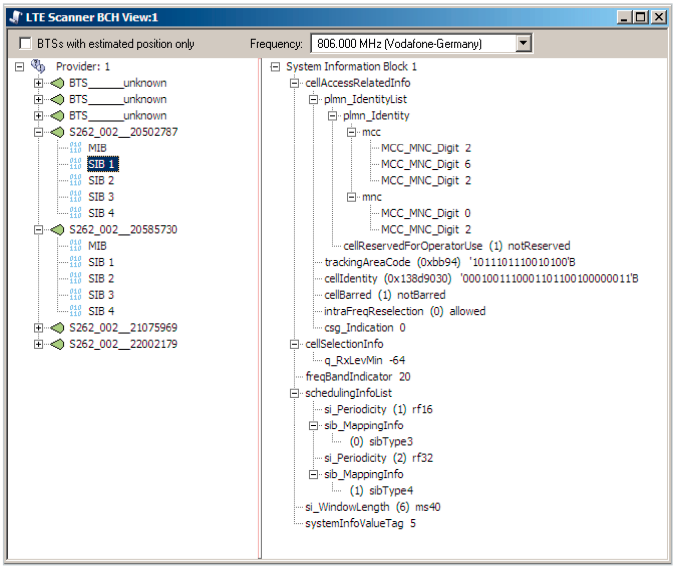
MIMO measurements

MIMO plays an essential role in achieving high data rates in LTE networks. Ideally, using 2x2 MIMO will double the data rate and 4x4 MIMO will quadruple the data rate. Whether this is possible in each specific case depends on the characteristics of the radio channel. The characteristics can be measured using the scanner for 2x2 MIMO or a set of R&S®TSME6 for 2x2 MIMO and 4x4 MIMO together with the R&S®TSME6-K30 MIMO option. The scanner receives the eNodeB reference signals from all transmit antennas at its independent frontends. These signals are then used to determine the transmission matrix for the radio channel and the condition number. The condition number describes how effectively MIMO can be used. If the condition number is low, the radio channel is suited for MIMO. The MIMO and SINR measurements can be used to explain the data rates achieved with the test mobile phone.

CIR View shows the channel impulse response (CIR) and all parts of the multipath propagation (echoes) together with a cell's cyclic prefix.



Decoding LTE BCH information with the scanner.



RELATED PRODUCTS

MOBILE NETWORK SCANNERS

- Simultaneous multiband, multitechnology measurements with no limitations in 3GPP frequency bands (including 5G NR) up to 6 GHz, with SIB/layer 3 (SIB/L3) decoding support
- Lightweight design
- Integrated high-performance Intel® Core™ i7 CPU (8th generation quad core)

R&S®TSMA6B autonomous mobile network scanner

Compact and lightweight design with customized mechanical concept for cascading multiple scanners

The compact R&S®TSMA6B autonomous mobile network scanner is an integrated solution for efficient drive and walk testing. It contains a powerful, integrated CPU and offers maximum performance, autonomy and connectivity to comply with the latest requirements for state-of-the-art mobile network testing.

- Multiband support from 350 MHz to 6 GHz
- 5G NR, GSM, WCDMA, LTE FDD, LTE TDD, CDMA2000® 1xEV-DO, TETRA, WiMAX™, NB-IoT and spectrum analysis simultaneously in one scanner

R&S®TSME6 ultracompact drive test scanner

All bands, all technologies simultaneously, including 5G NR

The R&S®TSME6 is designed for efficient drive and walk testing with a maximum degree of freedom and upgradability. Its ultracompact design, multiband and multitechnology support and support for 5G NR make the R&S®TSME6 a state-of-the-art T&M instrument.

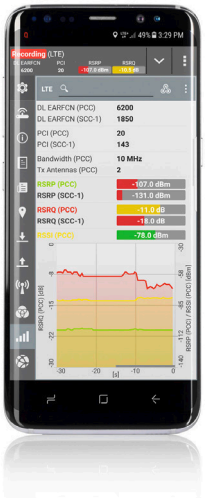
Parallel mmWave and sub-6 GHz measurements with a single scanner

R&S®TSME44DC and R&S®TSMS53DC ultracompact downconverters

Ultra broadband RF frequency range for downconversion (up to 53 GHz)

Downconverters are designed to easily upgrade the R&S®TSMx scanners to measure 5G NR signals in the mmWave frequency range. They perfectly extend the latest generation mobile network scanner family and provide all the features required for easy drive and walk testing. They are fully controlled by the R&S®TSMx and the corresponding software layers, which allows seamless, unattended operation.

TEST MOBILE



Rich set of service tests for voice quality, data, messaging and video quality to reflect the real end user experience.

QualiPoc Android

Smartphone based product for optimizing mobile networks

QualiPoc Android is based on the latest commercial Android smartphones. It supports all mobile network technologies used worldwide, and covers multiple protocol layers as well as the IP stack in realtime. QualiPoc Android provides extensive test functions for voice, including MOS, data, video streaming and messaging tests to assess and reflect the real end user experience (QoS/QoE) within a mobile network.

Service at Rohde&Schwarz
You're in great hands

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

Rohde&Schwarz

The Rohde&Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test&measurement, technology systems and networks&cybersecurity. Founded 90 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

www.rohde-schwarz.com

Mobile network testing

The company's broad and diverse product portfolio for mobile network testing addresses every test scenario in the network lifecycle – from base station installation to network acceptance and network benchmarking, from optimization and troubleshooting to interference hunting and spectrum analysis, from IP application awareness to QoS and QoE of voice, data, video and app based services.

www.rohde-schwarz.com/mnt

Rohde&Schwarz training

www.training.rohde-schwarz.com

Rohde&Schwarz customer support

www.rohde-schwarz.com/support

PD 5214.2062.12 | Version 31.00 | March 2024 (ch)
ROMES Drive Test Software
Data without tolerance limits is not binding | Subject to change

5214206212