Driving tomorrow's mobility
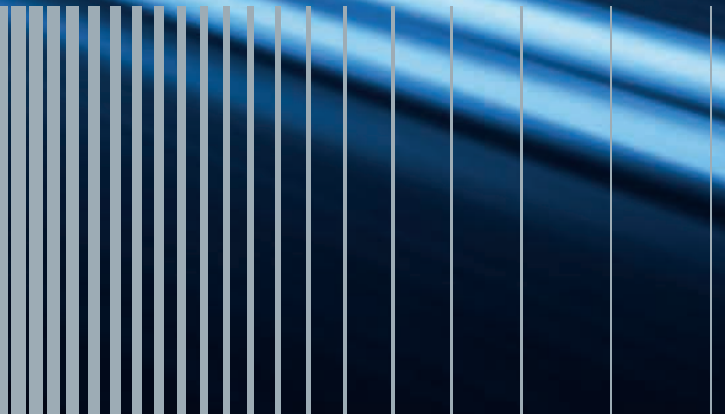
Test and measurement solutions
for the automotive industry

ROHDE&SCHWARZ

Automotive

Content

Test and measurement solutions for the automotive industry

The increasingly complex electronic systems and wireless applications in the automotive industry would be entirely unmanageable without specialized T&M solutions.
Rohde & Schwarz, a leading global manufacturer of wireless and RF T&M equipment and the market leader in EMC T&M solutions, can help.

As your partner, we provide the support you need to develop sophisticated electronic systems efficiently, on time and in line with specifications. We offer a broad range of T&M equipment and systems that cover the spectrum from audio frequencies to the millimeterwave range. We support you at all stages: chip/board/device/system development, prototype acceptance, production, quality assurance. As a global company with subsidiaries in over 70 countries, we offer individual consulting and service worldwide.

ADAS

Advanced driver assistant systems (ADAS) will play an increasingly important role in making driving safer and more comfortable. Such systems can help protect lives. However, a slight error can result in incorrect assessment of the situation.

Due to the complexity of the different methods, which include radar, V2X communications and eCall/ERA-Glonass, comprehensive testing is necessary to ensure correct functionality and maximum safety. Rohde & Schwarz offers test solutions that combine user-friendly, fully compliant systems with detection and analysis tools.

Automotive radar

Clear determination of both velocity and range
When using radar signals for automotive applications, engineers generally want to simultaneously determine the speed and distance of multiple objects within a single measurement cycle. This is possible with a linear frequency-modulated continuous-wave (LFMCW) signal. When developing radar sensors with LFMCW signals, any deviation from the ideal shape of the transmit signal causes errors in the determination of the velocity and range. Since this can have disastrous consequences in safety-relevant applications, key parameters such as the frequency linearity, length and long-term stability of a chirp need to be verified.

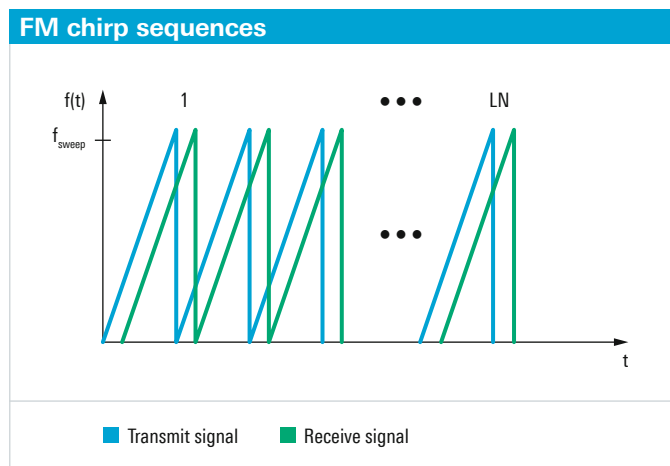**Automatic detection and analysis of chirp sequences**
Our diverse test solutions for automotive radar cover the entire eco chain, from chipset development to end-of-line testing of automotive radar modules. The R&S®FSW signal and spectrum analyzer's transient analysis option allows automatic detection and analysis of linear FM chirp sequences. Key radar signal parameters such as the chirp rate, chirp length and chirp rate deviation are displayed in a result table, eliminating the need for manual analysis with marker functions. The results can be displayed in graphical format, making the analysis process more efficient and providing a clearer presentation.

For characterization of FM chirps, the frequency (x-axis), time (y-axis) and the signal strength (color-coded) are presented. This provides a good overview of the signal behavior and allows assessment of the timing, even for brief signal impairments.

Comprehensive testing of every sensor and process
When performing high-resolution safety-relevant measure-ments on multiple targets, every sensor and every process is important. They have to be comprehensively tested to ensure reliable functionality. Realistic simulation in a special test environment offers the advantage of repeat-ability and significant time and costs savings compared with extensive drive tests over millions of kilometers (field to lab). Simulation lets you determine and modify the test conditions according to your specific needs.

Efficient: automatic detection and analysis

User friendly: all chirp parameters in a result table

Flexible: continuous extension of demodulation bandwidth

Radar signal analysis in frequency and time domain.

FM chirp sequences

Setup of radar sensor testing

Computer graphical user interface

Production test controller

Automotive radar sensor

Radar test simulation

LAN
RX IF
TX IF

Signal analysis in frequency domain

Power calibration

Signal analysis in time domain
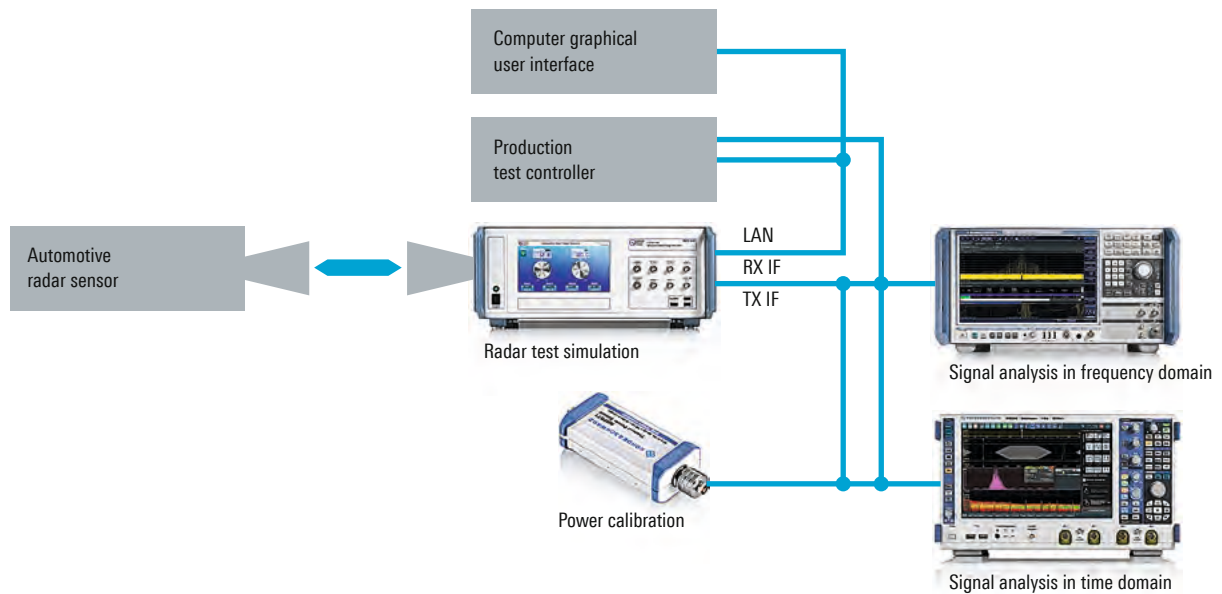
Fast and accurate phase noise measurements

Phase noise is one of the key performance-limiting parameters in automotive radar systems. To develop highly accurate automotive radars, the phase noise of oscillators and transmitters has to be minimized.

The R&S®FSWP phase noise analyzer's internal low-noise local oscillator makes it possible to precisely measure oscillators in automotive radar transceivers. The R&S®FSWP can be equipped with a second receive path for cross-correlation measurements, which can increase its sensitivity by up to 25 dB. Thanks to the analyzer's low-noise internal sources, often only a few correlations are needed to measure a high-quality oscillator. Faster, more accurate results shorten development and manufacturing times, helping you to be first to market with high-quality products.

Dynamic target simulation for the entire automotive spectrum

To perform measurements with different devices and sensors, the system has to be independent of a specific waveform or hardware supplier. Developed especially for the automotive industry, the ARTS9510 automotive radar test simulator is designed to be completely independent of the radar waveform. The flexible, future-ready architecture covers the entire range of radar technologies. Thanks to digital generation of the Doppler shift and range delay, the settings are highly precise, reproducible and stable. Baseband test ports allow you to use additional T&M equipment to monitor the characteristics of receive and transmit IF signals.

Further advantages of the ARTS9510 family include the ability to adapt the generated target list to your requirements and independently change the gain, range and Doppler shift of each of up to four targets. The simulator can be used with automation software. Linkable DLL/API libraries let you generate your own target scenarios. Additional benefits include waveform table programming and a direct programming mode for modifying scenarios in realtime. This is a vital prerequisite for hardware-in-the-loop (HIL) applications.

Comprehensive: test solutions from chipset development to end-of-line testing

Cost-effective: repeatability based on simulation

Flexible: completely radar waveform independent

Accurate: up to 2 GHz
baseband bandwidth

Flexible: generation of user-
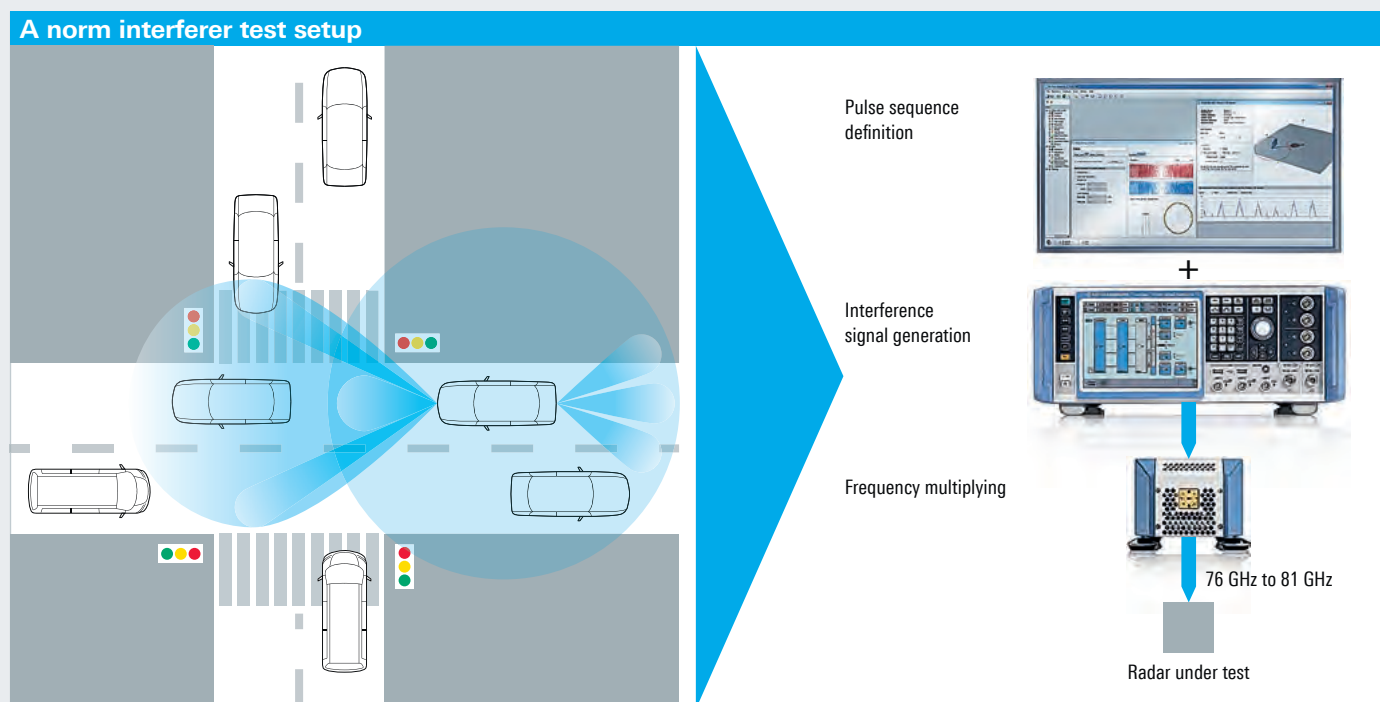defined interference signals

Upgradeable: extension
of RF into the E-band

Testing automotive radars against norm interferers

Regulations and standards on interference testing and mitigation are available for navigation radars, but not yet for automotive radars. In radar processing, the noise level of the measured frequency spectrum increases when interfered with by other RF signals operating in the same band. Such signals can easily reduce the probability of detection since the signal-to-noise level (SNR) of the echo signal decreases significantly. Objects with low radar cross sections, such as pedestrians, may not be detected or will be lost during tracking. This can lead to dangerous situations in city traffic. Testing automotive radars with a norm interferer helps verify their mitigation techniques and robustness against interference.

Flexible and user-friendly solution for research and development

The flexible and easy-to-use norm interferer solution from Rohde & Schwarz is an advanced approach for testing automotive radars – starting with the research and development chain through to final acceptance tests as well as during their operational lifetime.
The test setup consists of a powerful software program, a vector signal generator as the transmitter and a frequency multiplier. The R&S®Pulse Sequencer software can be used to generate any type of norm interferer with arbitrary modulation, position in space, antenna motion and antenna pattern.

A norm interferer test setup

Pulse sequence
definition

+

Interference
signal generation

Frequency multiplying

76 GHz to 81 GHz

Radar under test

Production testing on a small footprint

The increasingly widespread use of advanced driver assistance systems (ADAS) has promoted the development of radar-based sensor systems for automotive applications. All ADAS applications influence an automobile's steering and control algorithms and mechanisms. That means that every sensor and every process is safety-relevant and has to be comprehensively tested to ensure reliable functioning. The ideal test solution has a small footprint since space is limited in production.

Variety of individually tailored T&M solutions

Rohde & Schwarz offers a variety of T&M solutions individual tailored to production needs. The ARTS9510 automotive radar test simulator can be delivered in test chambers for production facilities. The monostatic transmit/receive horn antenna is located at the bottom of the ARTS9510. Tooling holes allow the test system to be precisely mounted, ensuring reproducible alignment. The internal transceiver module can be oriented for vertical or horizontal polarization. Shielded boxes are essential for reliable radiated emission testing. The ARTS9510 automotive radar test simulator system in combination with the R&S®TS7124 RF shielded box provides a highly reproducible environment in a very compact test setup. The R&S®TS7124 can be integrated into 19" racks. Its rugged design ensures a long lifetime. Manual and automatic modes are available. The LAN connection assures fast communications and control of the test system.
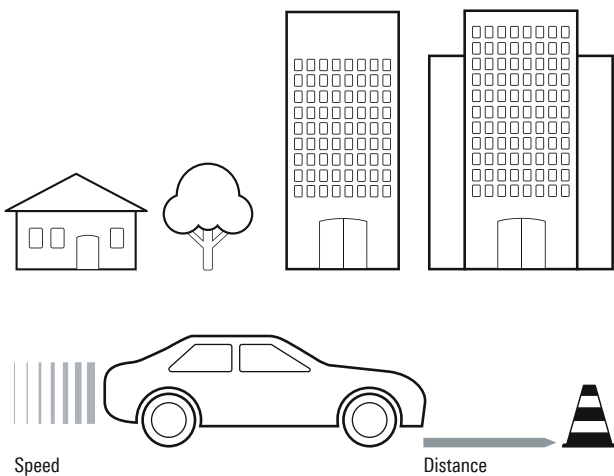
Customizable: from analog to digital solutions

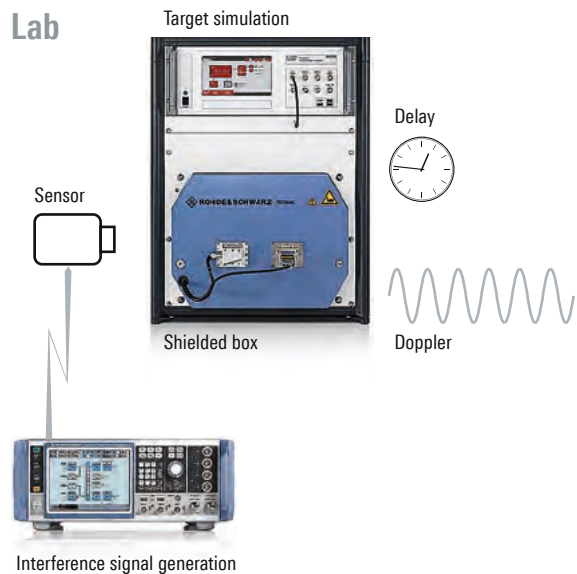Flexible: one-box calibration and functional testing

Simultaneous: optional tempered testing during production

Real-world automotive radar testing

Field

Speed

Distance

Lab

Target simulation

Sensor

Shielded box

Delay

Doppler

Interference signal generation

V2X communications

Fast: fully automatic tests
for reproducible test results

Complete: meets worldwide regulatory
test requirements

Flexible: intuitive and
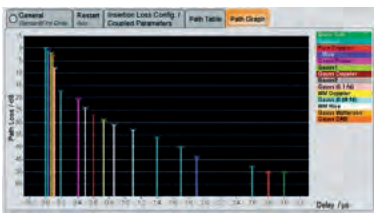configurable user interface

Crucial for autonomous driving

As automated driving becomes increasingly prevalent, vehicle-to-everything (V2X, V2V, V2I) communications will play a crucial role in achieving full autonomous driving.

Information will not only be received and displayed, it will be used to influence a car's driving behavior. Vehicles will communicate with one another as well as with the road infrastructure. For example, construction sites will alert drivers to their presence and traffic lights will transfer information about coordinated traffic signals to passing vehicles, allowing the driving assistance system to take this information directly into account.
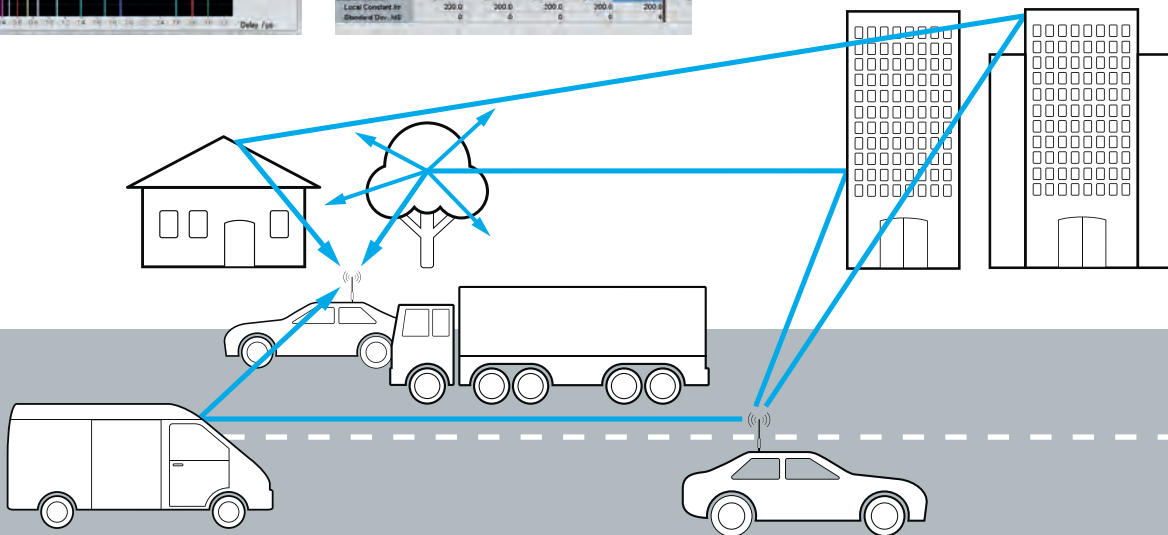
No interference with RF measurements

In order to minimize the safety risk arising from poor transmission conditions, the RF transmitters and receivers in the communications system's onboard units (OBU) and roadside units (RSU) must exhibit certain characteristics. Developers and users who want to integrate V2X components

Real-world V2X performance testing, including fading scenarios

into their systems can check these requirements with RF tests. For these tests, the two lower layers of the OSI model, i.e. the physical layer and the data link layer, are important because they are responsible for the physical transmission of the message. The RF module of the OBU must meet certain minimum requirements, for example with respect to power and frequency accuracy and the packet error rate (PER). These characteristics have to be checked with RF tests since any disturbances in the transmitted signal can enter the receiver via the OBU's RF module.

Flexible test environment

V2X communications, which includes both vehicle-to-vehicle (V2V) communications and vehicle-to-infrastructure (V2I) communications, is based on WLAN standard 802.11p. All IEEE 802.11p capable user equipment must demonstrate conformity with applicable regional standards, including special statutory regulations in Europe, USA and Japan. To verify performance under field-like conditions, the automotive industry has to define require-ments that go beyond these standards. Car manufacturers thus need a test environment that provides repeatable test results during design, verification and production.

Comprehensive analysis tools and user-friendly interface

The R&S®TS-ITS100 is an integrated test system for testing IEEE 802.11p conformity and the performance of user equipment. The R&S®CONTEST sequencer software supports these measurements and can be used to create fully automatic test procedures. It features comprehensive analysis capabilities to evaluate tests and summarizes test results in structured reports. The R&S®CONTEST graphic user interface's drag&drop function makes it easy to put together the desired test cases to create a test plan. The R&S®OSP-ITS switch matrix allows you to run tests without any manual interaction. Thanks to its compact size, the R&S®TS-ITS100 can be used throughout the entire value chain – from development to precompliance and compliance testing.

eCall/
ERA-Glonass

Ensure fast emergency response time

The European Union and the Russian Federation are working to introduce intelligent telematics-based vehicle safety systems to speed up emergency response times in order to save human lives. eCall and ERA-Glonass are electronic safety systems for cars. In the event of a serious road accident, such in-vehicle systems (IVS) automatically call the universal emergency call number 112 for local emergency medical services. Over the cellular network, they transfer a standardized minimum set of data (MSD) containing information such as the number of passengers as well as the time and GNSS coordinates of the accident. A voice connection is then established in case any car occupant(s) are able to speak. The ERA-Glonass system is harmonized with the European eCall standards but specifies some extensions to better support the Russian infrastructure. This includes additional SMS functionality for MSD transfer in case in-band data transmission fails. As a safety system, the in-band modems must be highly reliable and correctly transmit MSD.

This is particularly critical in cellular networks such as GSM and WCDMA that are optimized for voice transmissions. Testing eCall and ERA-Glonass system components can easily become time-consuming, costly and very challenging. And since environmental conditions can change, test results are hardly reproducible.

Faster testing with GNSS signal generation in realtime

Rohde & Schwarz offers a compact solution for reproducible end-to-end functional and standard-compliant conformance testing of eCall and ERA-Glonass modules. The R&S®CMW-KA094 eCall application software and the R&S®CMW-KA095 extension for ERA-Glonass simulate a PSAP and remotely control the R&S®CMW500 to emulate a cellular network in the lab. The software also controls the R&S®SMBV100A vector signal generator, which provides the GNSS coordinates required by the IVS to compile the MSD. This setup makes it possible, for example, to verify if the IVS modem is able to trigger an emergency call, send the correct raw MSD data and establish a voice connection with the PSAP – without having to use a real-world mobile network.

Simplify conformance and performance tests

The R&S®CMWrun sequencer software tool simplifies the extensive eCall/ERA-Glonass conformance tests. It provides ready-to-use test sequences for eCall and ERA-Glonass modules in line with CEN/TS 16454, GOST55530 and ETSI TS 103412.

R&S®CMWrun creates a complete test report with pass/fail indication for each IVS module. The ability to verify compliance with standards at an early design stage allows you to take corrective action and optimize an IVS module in a timely manner. The R&S®SMBV100A signal generator supports performance tests on GNSS receivers in line with the standard GOST55534. R&S®CMWrun can run these tests as well.

Time-saving: software tool with ready-to-use test sequences

Realistic: simulation of GNSS and mobile networks

Highly reliable: performance tests to verify all information

eCall/ERA-Glonass automatic transfer principle

Global navigation satellite systems (GNSS)

GSM/UMTS base station

Automatic emergency call

Voice   Data

Mimium set of vehicle data (MSD)

Data   Voice

In-vehicle system (IVS)

Crash

Public safety answering point (PSAP)
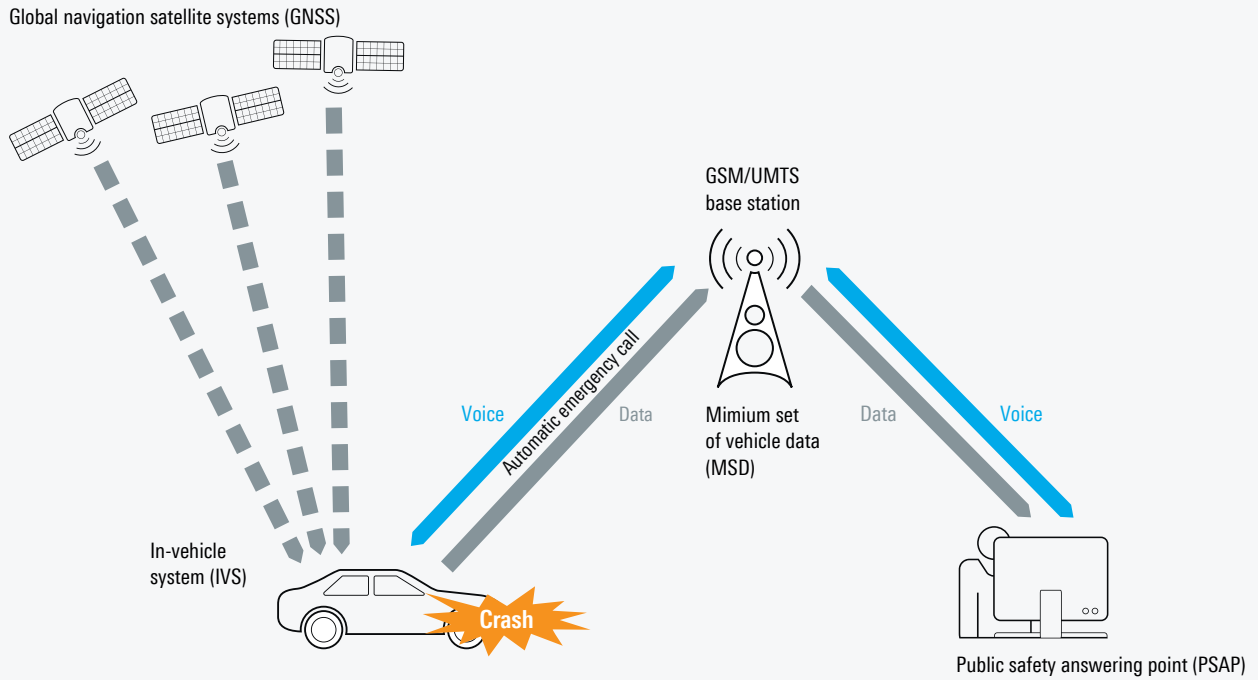
Automated eCall/ERA-Glonass conformance testing

Test case definition

Automated conformance tests

GNSS simulation

GNSS simulation

GNSS receiver

Position data

GSM/UMTS module

Voice

Data

PSAP simulation

Cellular network simulation

Module under test
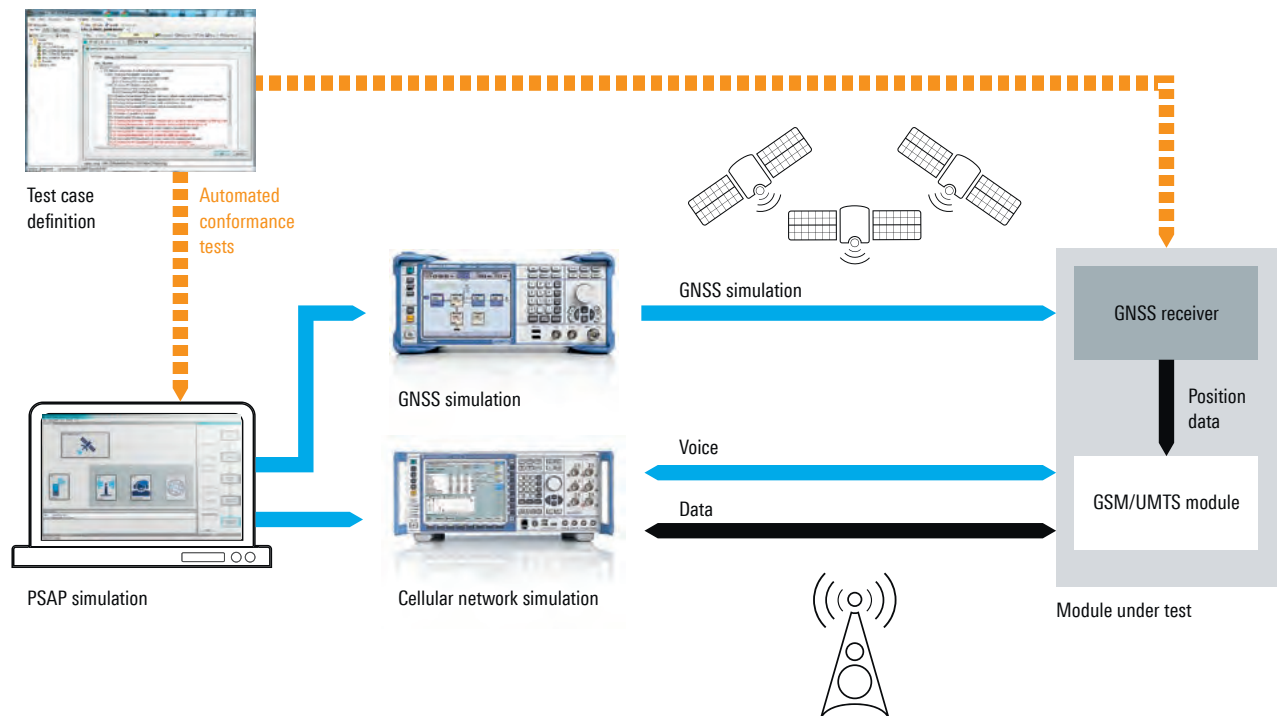
ADAS
product portfolio

Product families

R&S®SMW200A
Vector signal generator
Generate signals for automotive radar applications. With its 2 GHz bandwidth up to 40 GHz, it can generate and play back all kinds of waveforms (e.g. 5G, radar, GNSS).

R&S®SMBV100A
Vector signal generator
Generate signals for all automotive applications requiring realtime GNSS simulation. All current navigation standards (GPS, Glonass, Galileo and BeiDou) are covered in a single box that offers excellent RF performance.

R&S®FSW
Signal and spectrum analyzer
Ensure the purity and accuracy of the signals transmitted by automotive radar sensors.

R&S®FSV
Signal and spectrum analyzer
Analyze digitally modulated signals for the latest cellular and wireless standards with up to 160 MHz analysis bandwidth. Ideal for RF measurement tasks on the bench, in production and in the field.
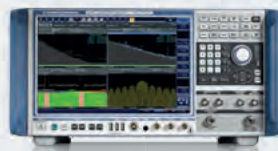
R&S®FSWP
Phase noise analyzer
Measure phase noise on highly stable sources.

R&S®SMZ
Frequency multiplier
Easy handling combined with precise output levels in the frequency range from 50 GHz to 170 GHz.

ARTS9510
Automotive radar simulator
Run functional tests during R&D and production. Excellent solution for car manufacturers who develop, manufacture, service or implement automotive radars.
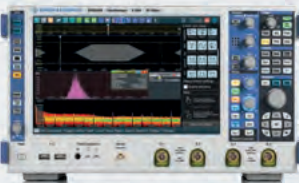
R&S®RTO
Digital oscilloscope
Directly measure the quality and content of measurement data transmitted on a bus thanks to outstanding trigger and decode functionality.

R&S®TS7124
RF shielded box
For reliable and reproducible measurements in the lab and in production. Rated for 1 million open/close cycles. Suitable for RF up to 110 GHz.

R&S®CMW500
Wideband radio communication tester
Test the air interface of automotive wireless devices. Covers all standards used for V2X communications (e.g. LTE, 802.11p).

R&S®CMW100
Communications manufacturing test set
Perform non-signaling tests in fully automated production lines to ensure the correct functionality of V2X modules in wireless devices.
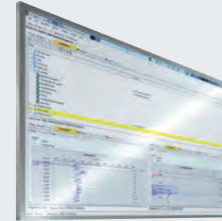
R&S®CONTEST
Sequencer software
Fully automatic test procedures and comprehensive analysis capabilities for evaluating tests and summarizing them in well-structured reports.

R&S®SMW-K300
Pulse sequencing
Create I/Q waveforms according to your requirements, e.g. for interference simulation or during the signal development process.

R&S®ATS1000
Antenna test system
Test 5G antennas up to mmWave frequencies. The portable shielded chamber is a customizable solution for OTA test requirements.

R&S®TS-ITS100
RF conformance test system
Verify the performance of user equipment under field-like conditions as specified in applicable regional standards, e.g. ETSI, IEEE 802.11p and ARIB.

R&S®NRPxxS/SN
Three-path diode power sensors
USB capability. Can also be controlled via LAN. This makes the R&S®NRP power meter portfolio unique in the industry.

Infotainment

Infotainment solutions in cars are becoming increasingly complex. Mobile Internet, traffic information, navigation, digital broadcast and streaming services are all combined in one system. Each service requires its own antennas.

Rohde & Schwarz offers a complete portfolio of test measurement solutions for multimedia, audio, antenna and navigation services to ensure that each part of the infotainment system functions correctly and to uncover the sources and effects of interference.

Multimedia

Identify error sources in a complex environment

As the number of audio and video formats in today's car infotainment systems increases, the number of possible error sources in the transmission path rises correspondingly. Mobile communications signals in neighboring frequency bands can impair car radios and entertainment systems that receive terrestrial TV and radio signals. This can cause quality problems or even complete failure. It is therefore vital to generate and replay video, audio and data content in realtime when developing and testing receivers and their components.

Create and simulate customized scenarios

Developers must include all broadcasting signals and interferer sources in any comprehensive test scenario. Rohde & Schwarz offers a diverse range of signal generators that meet the demands of creating such scenarios, ensuring complex simulation of all "on air" signals. Developers can simulate complex broadcast and cellular interferers, in-cabin interference and the diversity of audio/video reception based on the latest broadcast standards. They also have access to signals from local public networks and those from other countries required for a globally valid scenario.

User friendly: easily identify error sources

Complex: test all broadcasting signals and interferer sources

Highly diversified: simulate many different scenarios

EN 303345 compliance testing

Radio equipment directive (RED) testing

When a car drives through different areas, radio broadcast coverage often changes and is affected by challenging receiver conditions. The car radio and entertainment system should be able to receive transmitted broadcast programs in best quality even under poor conditions.

EN 303345 describes a number of relevant mandatory test cases on radio receivers. Typical EN 303345 scenarios include adjacent channel selectivity and blocking tests with AM, FM, digital audio broadcasting (DAB) and digital radio mondiale (DRM) signals as well as audio tests in line with CCIR 468. Wanted and unwanted broadcast signals as well as a CCIR weighted noise audio signal for AM and FM testing all need to be generated.

Generating compliance test scenarios

Such complex generation of audio broadcast signals can be performed with a single T&M instrument: the R&S®BTC broadcast test center. This easy-to-operate, high-end signal generator provides all necessary signals in realtime with highest signal quality.

It also analyzes audio and video signals, giving you all the capabilities you need in a single instrument. Adding the sequencer tool for semi-automatic or automatic operation makes the platform ideal not only for the lab but also for test houses working on compliance certifications.

Integrated: signal generator and A/V analyzer in one

Comprehensive: for all digital and analog audio receivers

Powerful: high signal purity for low-sensitivity tests

Diversity testing
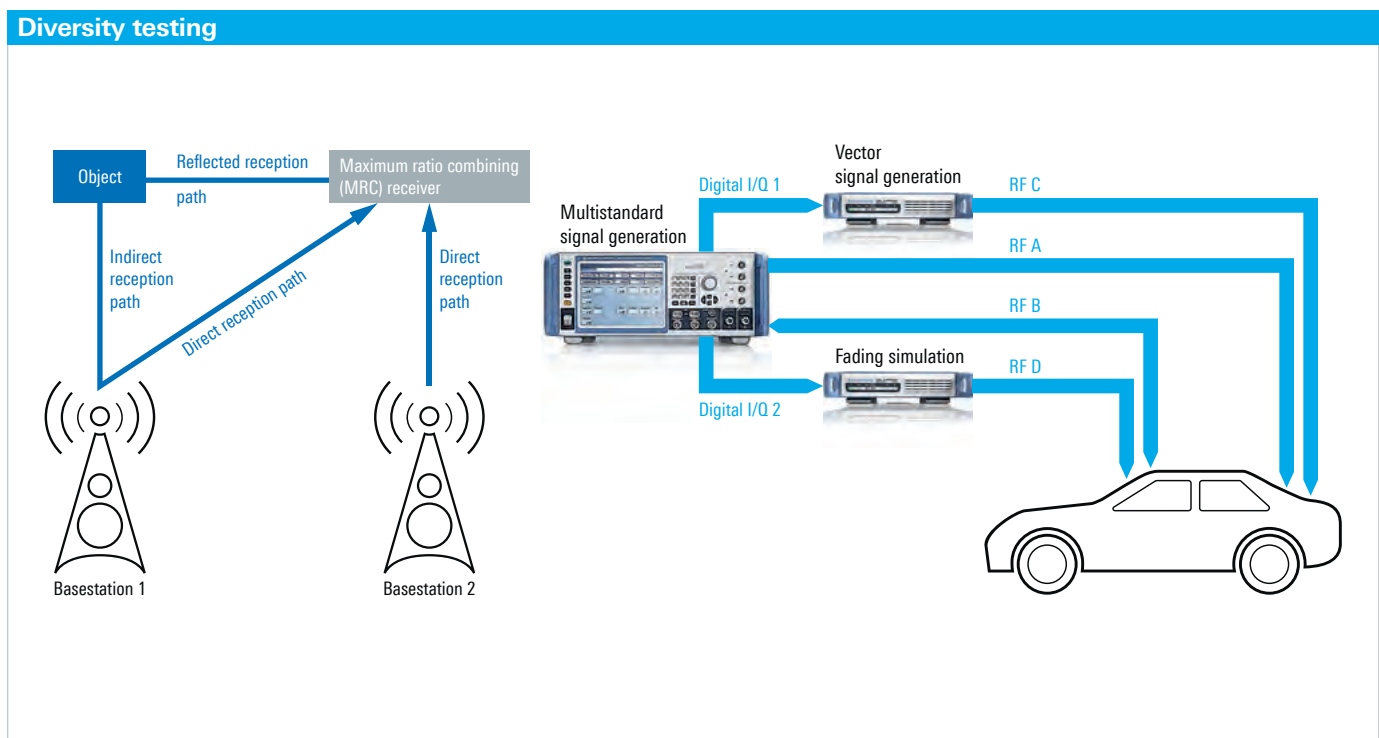
Comprehensive: for all digital and analog audio and video broadcast standards

Powerful: fading module helps you generate complex diversity scenarios

Integrated: signal and multimedia generation and transmission simulations

Improve car TV and radio receiver quality and reliability

In order to improve the quality and reliability of audio and video broadcasting in automotive applications, especially in areas where there is no clear line-of-sight (LOS) between the transmitter and the car antenna receiver, a diversity scheme of two or more antennas is often used. Today's diversity receivers use up to four RF tuners in flexible operating modes. A car might use up to three independent RF receivers for audio signal reception and up to four independent RF receivers for video signal reception. The field and drive tests used to test such receivers are typically affected by environmental conditions. Testing also requires the simulation of radio and mobile TV standards. Many complex test scenarios will need to be run.

Generate complex multichannel diversity test scenarios

The R&S®BTC offers an easy, yet powerful solution for simulating such scenarios using a single input signal source with a specific transmission technology, such as FM, DAB, DVB-T2 or other radio and video broadcast technologies. Its two RF output ports make it possible to run complex diversity scenarios from a single box. Adding the R&S®SGT100A increases the network simulation complexity to up to four independent RF transmission paths. In combination with the powerful fading simulators, the non-coherent, independent AWGN sources allow you to simulate different transmission conditions in each of the provided Gaussian channels. Predefined DVB and DAB fading profiles can be loaded to set up the multipath effects defined in relevant standards. The full flexibility of the R&S®BTC lets you test beyond these standards to ensure that your antenna diversity system offers the highest performance.

Audio analysis

Parallel measurement of different audio channels

Due to the difficult acoustic conditions and tight space conditions in a vehicle, manufacturers of modern car hi-fi systems split up the audio frequency range among several loudspeakers and control the speakers via separate amplifier channels. The use of DSP-controlled sound optimization circuits has helped perfect this technology. Switching to surround-sound technology can result in more than 16 loudspeakers and amplifier channels. To reduce test time, car manufacturers and their suppliers need to measure the different audio channels in parallel.

Optimal audio analyzer solutions

Rohde & Schwarz offers two solutions. The R&S®UPV audio analyzer handles all standard measurements – from frequency response to S/N ratio, distortion measurements and FFT analysis. Its multichannel interface card was specially developed to meet the requirements of surround-

Comprehensive: for all standard measurements

Expandable: simultaneous measurements on up to 48 loudspeakers

Cost-effective: harmonized solution for R&D and production

sound technology and the needs of the automotive sector. The compact cost-effective R&S®UPP audio analyzer is designed for system applications. By cascading multiple R&S®UPP audio analyzers, up to 48 channels can be simultaneously measured. Featuring the same operating philosophy and remote control, the R&S®UPV and R&S®UPP audio analyzers are a strong team. They provide the optimal solution for both R&D and production and harmonize well together.

Simultaneous testing of up to 48 loudspeakers

Multistandard signal generation

RF-modulated test signal, including ARI and RDS

Test system control

Analog or digital audio signals

Audio analysis

Navigation   Phone   Info

Audio   Settings   Weather

Infotainment system

Loudspeaker signals
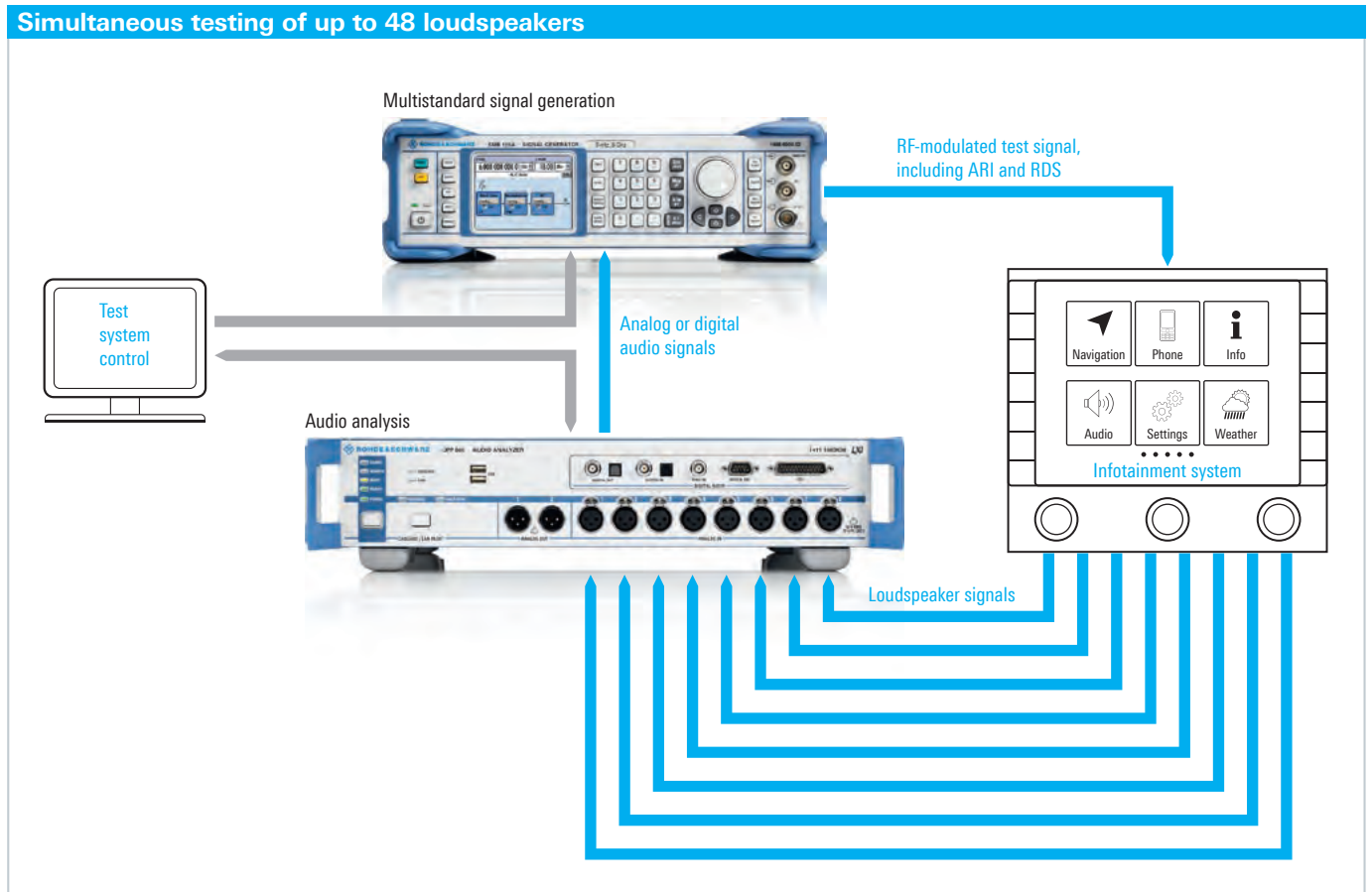
Navigation

Realistic: generation of dynamic scenarios in realtime

Versatile: real-world simulation

Time-saving: Assisted GNSS test scenarios

Simulation of satellite-based navigation systems

Developers must extensively test the receivers used in car navigation devices. In a real-word scenario, a moving GNSS receiver may not always receive the signal of all theoretically visible satellites for its current position. In rural or suburban areas, in tunnels or in parking structures, some satellites may be partly or completely obscured by a wall or other vertical plane. Receivers also experience the additional effects of signal reflections, e.g. due to ground or surrounding buildings. It is therefore necessary to simulate different obscuration and multipath effects in static and moving scenarios.

Faster testing with realtime GNSS signal generation

Equipped with the GNSS simulator option, the R&S®SMBV100A generates dynamic scenarios with up to 24 GPS/SBAS/QZSS, Galileo, Glonass and BeiDou satellite signals in realtime. This includes moving scenarios, multipath, dynamic power control and atmospheric modelling. You can simulate the effects of antenna patterns and a vehicle body mask in realtime with dynamic variation of the vehicle's attitude.

The R&S®SMBV100A can also easily simulate real-life user environments such as an urban canyon, rural area, tunnel or highway. Buildings, tunnels and bridges as well as reflections from concrete and glass surfaces affect the GNSS signal, regardless of whether the receiver is stationary or in motion.

Urban canyon simulation

Reflection only

Line-of sight (LOS) only

LOS and reflection
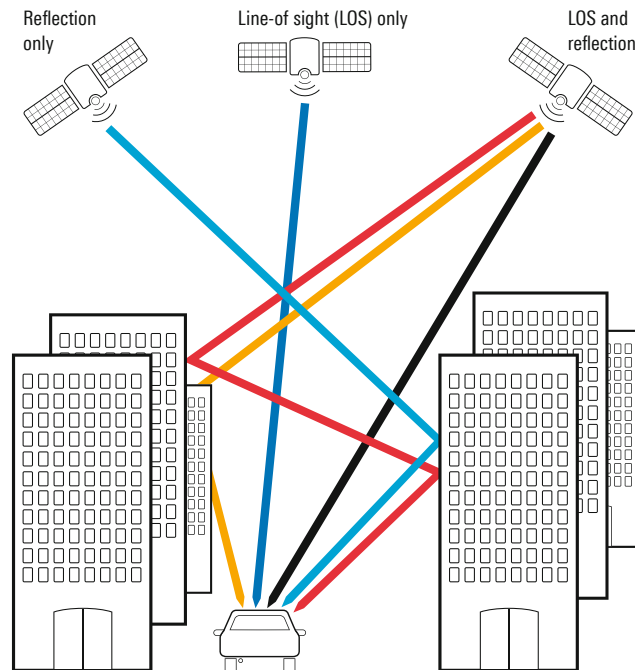
Production testing

Infotainment test system

Mass production requires a fully automatic test solution for manual or inline DUT handling with optimized through-put. The solution must cover electrical board tests such as in-circuit tests (ICT) and testing of digital and analog components. It has to support and simulate the large amount of technologies and interfaces: multiple displays and cameras, digital TV and audio broadcasting, LTE, Wi-Fi, Bluetooth®, GNSS, CAN, MOST, Ethernet, USB, SDARS. It needs to be full flexible to support future communications technologies. A small footprint is also important.

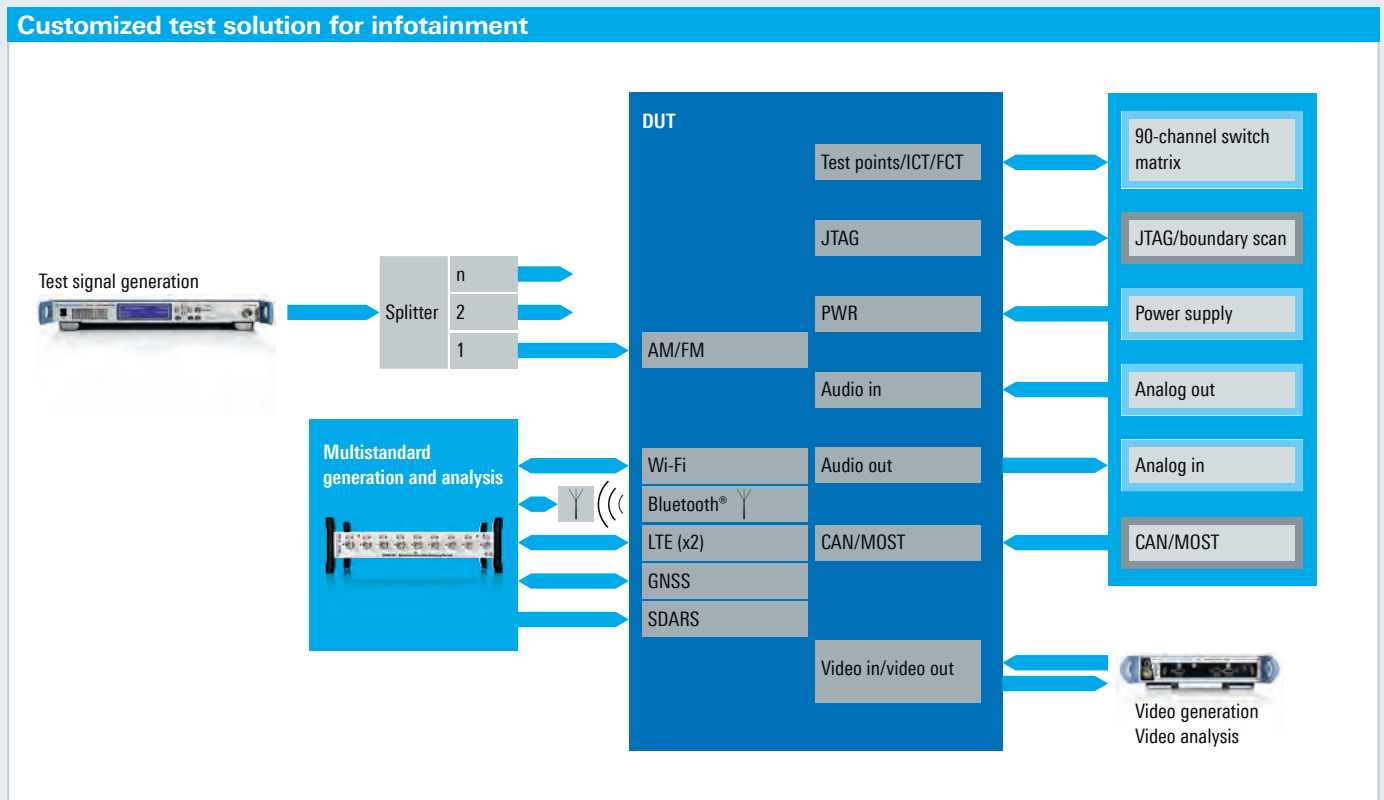## From test system solutions to turnkey projects

To achieve maximum throughput, all wireless technologies must be tested in non-signaling mode. The R&S®CMW platform provides the ideal test solution. It supports test codes for all major chipset manufacturers.

Even interfaces and technologies multichannel solutions are feasible on a small footprint. Shielded chambers can be used to ensure a controlled testing environment. The modular test platform supports all electrical analog and digital tests, including in-circuit tests and boundary scan.

Sustainable: support of all current and future wireless standards

Efficient: non-signaling test and chipset support

Space-saving: complete solution in one system

Customized test solution for infotainment

Test signal generation

Splitter — n, 2, 1

Multistandard generation and analysis

DUT
- Test points/ICT/FCT
- JTAG
- PWR
- AM/FM
- Audio in
- Wi-Fi
- Bluetooth®
- Audio out
- LTE (x2)
- CAN/MOST
- GNSS
- SDARS
- Video in/video out

- 90-channel switch matrix
- JTAG/boundary scan
- Power supply
- Analog out
- Analog in
- CAN/MOST

Video generation Video analysis

Infotainment product portfolio

R&S®BTC
Broadcast test center
Perform end-to-end tests in realtime. Reference signal generator featuring analysis functions and automated tests for audio, video and multimedia applications. Outstanding technical features, modular flexible design, supports latest transmission technologies.

R&S®SMBV100A
Vector signal generator
Simulate GNSS systems, including GPS, Glonass, Galileo and BeiDou. Offers excellent RF performance along with very high output level and short settling times.
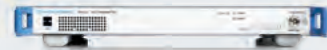
R&S®SFE100
Test transmitter
Generate modulated signals for various transmission standards in realtime. Realtime coding for broadcast signals. Supports all common digital and analog TV and a number of audio broadcasting standards.

R&S®SFC
Compact modulator
Generate test signals for production. Realtime coding for all conventional digital and analog TV and audio broadcasting standards.

R&S®UPV
Audio analyzer
Perform analog and digital audio measurements such as frequency response, total harmonic distortion (THD), spectrum analysis and analysis of digital interfaces.

R&S®UPP
Audio analyzer
Ideal for production with high measurement speed, parallel signal processing and high reliability.

R&S®CMW100
Communications manufacturing test set
Calibrate and verify wireless modules, including cellular standards, Bluetooth® and WLAN. Designed for use in fully automated robotic production lines.

R&S®CMW500
R&S®CMW-KT022
CMWCards
Wideband radio communication tester
Individually verify the performance of cellular, Bluetooth® and WLAN technologies. Create wireless signaling and application tests just by setting up a hand of cards – no programming required.

R&S®ETL
TV analyzer
Benefit from the combined functionality of a TV and FM (radio) signal analyzer, video and MPEG TS analyzer and spectrum analyzer in a single instrument. Also contains generators to create analog video signals, audio signals and MPEG-2 transport streams.

R&S®VTC-VTE-VTS
Video testers
Test HDMI and analog audio/video interface protocols and analyze media content in realtime. These testers are ideal for all lifecycle phases, from a high-end platform for R&D or a compact box for test systems to a cost-effective test module for device manufacturing.

R&S®TS8980
RF test system family
Test LTE, WCDMA and GSM conformance for precompliance and R&D. Fully automated test system for validated RF conformance test cases during design, precertification and type approval.

R&S®TS8997
Regulatory test system
Test enhanced performance and coexistence behavior of DUTs. Fully meets all ETSI standardization requirements, e.g. for the 2.4 GHz and the 5 GHz bands.

R&S®TSMW
Universal radio network analyzer
Measure RF in block and continuous streaming mode. Two frontends for input frequency from 30 MHz to 6 GHz, preselection and software-defined architecture offer unsurpassed performance and flexibility.

Communications

Connecting infotainment systems with mobile devices and the Internet, advanced telematic systems and non-cellular technologies like Bluetooth® and WLAN is becoming increasingly important. End users expect fast and reliable device connectivity, handsfree calling systems and telematic systems that provide feedback from the field and essential firmware updates over the air.

Cellular communications

Time-saving: simultaneous measurement of cellular and non-cellular standards

Efficient: simulation of real-world test scenarios

Compact: only one 19" box for all technologies

Connecting a wide range of different standards
Telematic units can contain multiple RF systems, such as LTE-A, 3G, CDMA2000®, 2G and non-cellular technologies like WLAN, Bluetooth® and various GNSS systems. Built-in WLAN hotspots and built-in femto cells provide unlimited mobile Internet access. The use of multiple wireless communications standards in parallel in such a confined environment can lead to quality problems, a reduction in data rates or even complete failure. Repeatable real-world test scenarios are required to verify stable performance.

Flexible in configuration and for all wireless communications standards
The flexibly configurable R&S®CMW500 test platform measures all major cellular and non-cellular wireless communications standards. It simulates multiple radio systems in parallel. A single instrument generates both the wanted and the unwanted signal. The frontend includes multiple RF connectors for transmit and receive signal paths, eliminating the need for a switch matrix in the simplest scenarios. To ensure realistic simulation, you can add an integrated fading option to the test setup. For small setups, a compact test chamber is ideal for radiated testing.

Connectivity

Verifying Bluetooth® functionality and performance

Nearly all new vehicles today offer Bluetooth® handsfree equipment. Bluetooth® has become the established short-range radio standard for communications between smartphones and infotainment systems in automobiles. The individual components must undergo RF and audio tests to ensure that the headset, speakers, infotainment system and smartphone all function smoothly with each other and are in line with the Bluetooth® SIG specifications.

Audio testing of Bluetooth® components

Audio signals can be transmitted with different Bluetooth® profiles: handsfree profile (HFP) for voice calls or advanced audio distribution profile (A2DP) for stereo playback. To ensure correct performance, functional tests, inter-operability tests and range tests need to be run. The R&S®CMW wideband radio communication testers were designed for such precertification testing and are approved by the Bluetooth® Special Interest Group (SIG).

Transmit characteristics such as power, spectrum, frequency accuracy, frequency drift, frequency deviation and the modulation index need to be verified with high accuracy. The R&S®CMW500 uses an integrated two-channel audio generator to check the Bluetooth® audio quality. It supports audio tests, and all defined RF test cases. For the time-consuming spectrum measurements, the R&S®CMW testers provide first test results in less than one second – something no other Bluetooth® tester on the market can do.
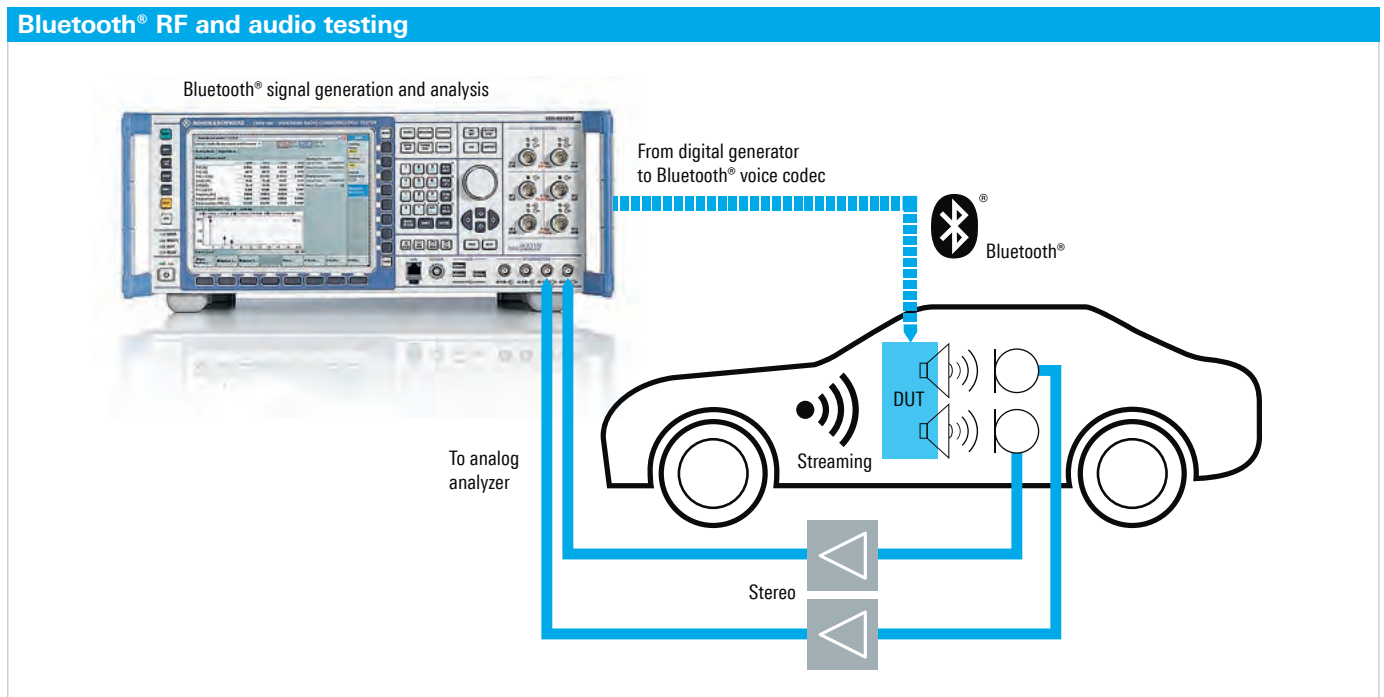
Flexible: support of all relevant wireless standards in a single box

Complete: supports relevant codecs and profiles for audio transmissions

Quality: highly accurate data from a precise generator

The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. and any use of such marks by Rohde & Schwarz is under license. CDMA2000® is a registered trademark of the Telecommunications Industry Association (TIA-USA).

Bluetooth® RF and audio testing

Bluetooth® signal generation and analysis

From digital generator to Bluetooth® voice codec

Bluetooth®

DUT

Streaming

To analog analyzer

Stereo

Mobility testing

Time-saving: easy creation of wireless signaling and application tests

User-friendly: software wizard

Simple: no programming knowledge required

Testing data and voice handover scenarios

Since wireless communications modules are becoming increasingly common in cars, the automotive industry is also faced with the challenge of testing cellular mobility scenarios such as data and voice handovers. Due to the number of different mobile communications and connectivity standards, developers of telecommunications control units (TCU) and car manufacturers need to reproduce a number of field test cases. This requires in-depth knowledge of mobile communications standards and it takes time to configure such complex scenarios on a mobile communications tester. The R&S®CMW500 mobile radio tester and its graphical interface R&S®CMWcards make it easy to recreate such scenarios.

Convenient solution for configuring wireless communications cells

The revolutionary R&S®CMWcards user interface for the R&S®CMW500 mobile radio tester offers a convenient solution for creating wireless signaling and application tests – you just have to set up a hand of cards.

It combines creation, parameterization and execution of test cases as well as log file analysis in a single tool. A unique software wizard helps you arrange specification-compliant message flows.

Test case for handover from one network to another network

PLMN =
Parallel testing
of eight
telematic units

PLMN 1

PLMN 2

PLMN 1 rejected

PLMN 2 attached
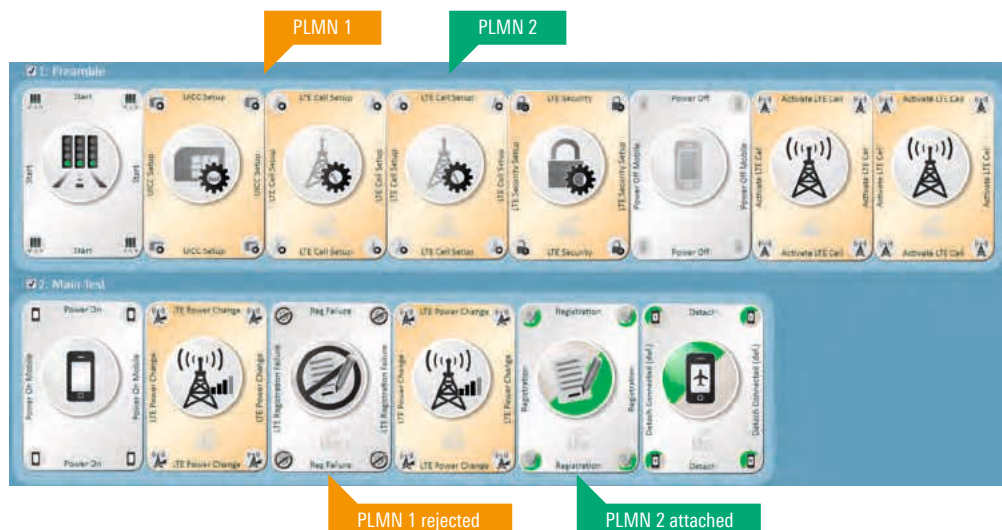
Battery life testing

Battery life and current drain measurements

With the ever-increasing number of connected ECUs in the automotive world, it is necessary to know how much power they are consuming. Important areas include monitoring infotainment and telematics units to understand their data activity during idle time, monitoring the applications running on an infotainment system and determining how long a battery will work with an eCall/ERA-Glonass module after a crash. In order to reduce power consumption, the performance of these features has to be tested and analyzed in a controlled emulated network environment.
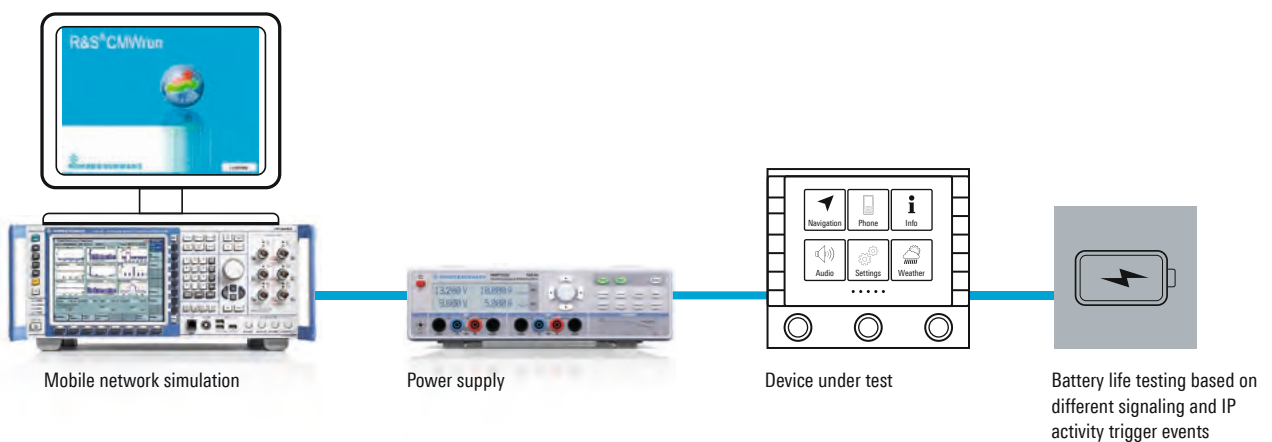
Performance testing

R&S®CMWrun offers the right solution for such tests under real, yet controlled conditions based on the well-established R&S®CMW500. The R&S®CMWrun R&S®CMW-KT051 collects samples from the R&S®RT-ZVC02/R&S®RT-ZVC04 multi-channel power probe at a high sample rate and displays the current and voltage or even the calculated instantaneous power (in Watt) over time. Specific signaling trigger events (e.g. LTE attach, connected, idle signaling state or IMS registration) have been implemented to provide even more details (i.e. more samples). These are displayed time-correlated on the power consumption diagram.

Repeatable: test and analyze application behavior in an emulated network environment

Powerful: correlate signaling events with power drain

Flexible: analyze power consumption, current drain and estimated battery life

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User experience testing scenario

Mobile network simulation

Power supply

Device under test

Battery life testing based on different signaling and IP activity trigger events

Telematics production

Future-oriented:
multitechnology solution

Efficient: parallel testing on up to eight RF ports

Space-saving:
minimum footprint

In-device coexistence measurements
Telematic units can contain multiple RF systems, e.g. cellular multiband antennas for LTE-A, 3G, CDMA2000®, 2G and non-cellular technologies such as WLAN, Bluetooth® and various GNSS systems. To understand how these different radio signals are interacting and the resulting impact on performance, it is necessary to measure in-device coexistence and the resulting desensitization, i.e. the reduction in RX sensitivity within a telematics unit that supports different access technologies.
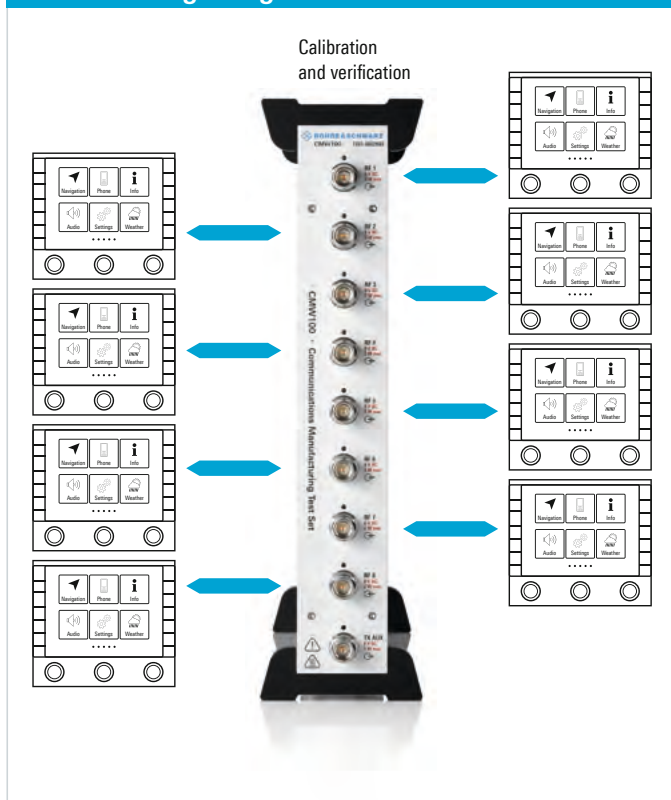
The R&S®CMW500 wideband communication tester can act as an LTE, GSM, WCDMA, TD-SCDMA, CDMA2000 base station or a WLAN access point. It can measure the relative RX sensitivity of two different wireless systems acting in parallel. Running an automated test plan for in-device coexistence makes it possible to perform coexistence measurements and provide a detailed report containing information such as the packet error rate (PER) for WLAN in combination with an LTE cell.

Production testing
In production, it is necessary to calibrate and verify telematics units in non-signaling mode across all supported wireless interfaces, including LTE, GSM, WCDMA, TD-SCDMA, CDMA2000, WLAN incl. 802.11p, Bluetooth® and GNSS. This requires a highly flexible tester. The R&S®CMW100 can be mounted horizontally or vertically for optimum use of production space. It covers multiple technologies, including 802.11p, and supports parallel testing on up to eight RF ports.

The fanless tester is silent and offers highest reliability thanks to its dustproof housing. Because it is code compatible with the industry-leading R&S®CMW500, it is possible to quickly transfer tests developed in R&D into the production environment with very little implementation effort and fast ramp-up.

Parallel testing of eight telematic units

Calibration and verification

Communications product portfolio

R&S®CMW500
Wideband radio communication tester
Individually verify the performance of cellular, Bluetooth® and WLAN technologies.

R&S®CMW290
**Functional radio communication tester**
Measure fundamental RF characteristics of LTE, WDMCA and GSM and perform Go/NoGo and checks in line with communications standards. Verify that DUTs comply with specifications to ensure proper operation and no interference with other devices.

R&S®CMW-KT022
CMWcards
Create wireless signaling and application tests just by setting up a hand of cards – no programming required. Ideal for all phases of product development and production.
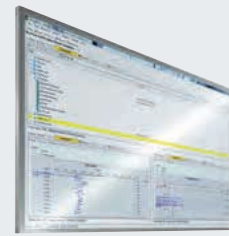
R&S®CMWrun
Sequencer Software Tool
Easily configure test sequences by remote control.

R&S®CMW100
Communications manufacturing test set
Calibrate and verify wireless modules, including cellular wireless standards, Bluetooth® and WLAN. Designed for use in fully automated robotic production lines.

R&S®CMW270
Wireless connectivity tester
Emulate networks for non-cellular technologies such as WLAN, Bluetooth®, GNSS and various broadcast technologies. The cost-effective alternative for development, production and service.

R&S®HMP2020
Power supply
Emulate different types of batteries to ensure that tests are not invalidated despite the general trend toward lower supply voltages.

In-vehicle
networks

More than 70 electronic control units (ECU) are implemented and connected in cars via different in-vehicle bus networks. These buses are used to exchange information and coordinate control. To verify the functionality and quality of these data streams, automotive engineers need to be able to trigger, decode and search these signals easily and to measure crosstalk.
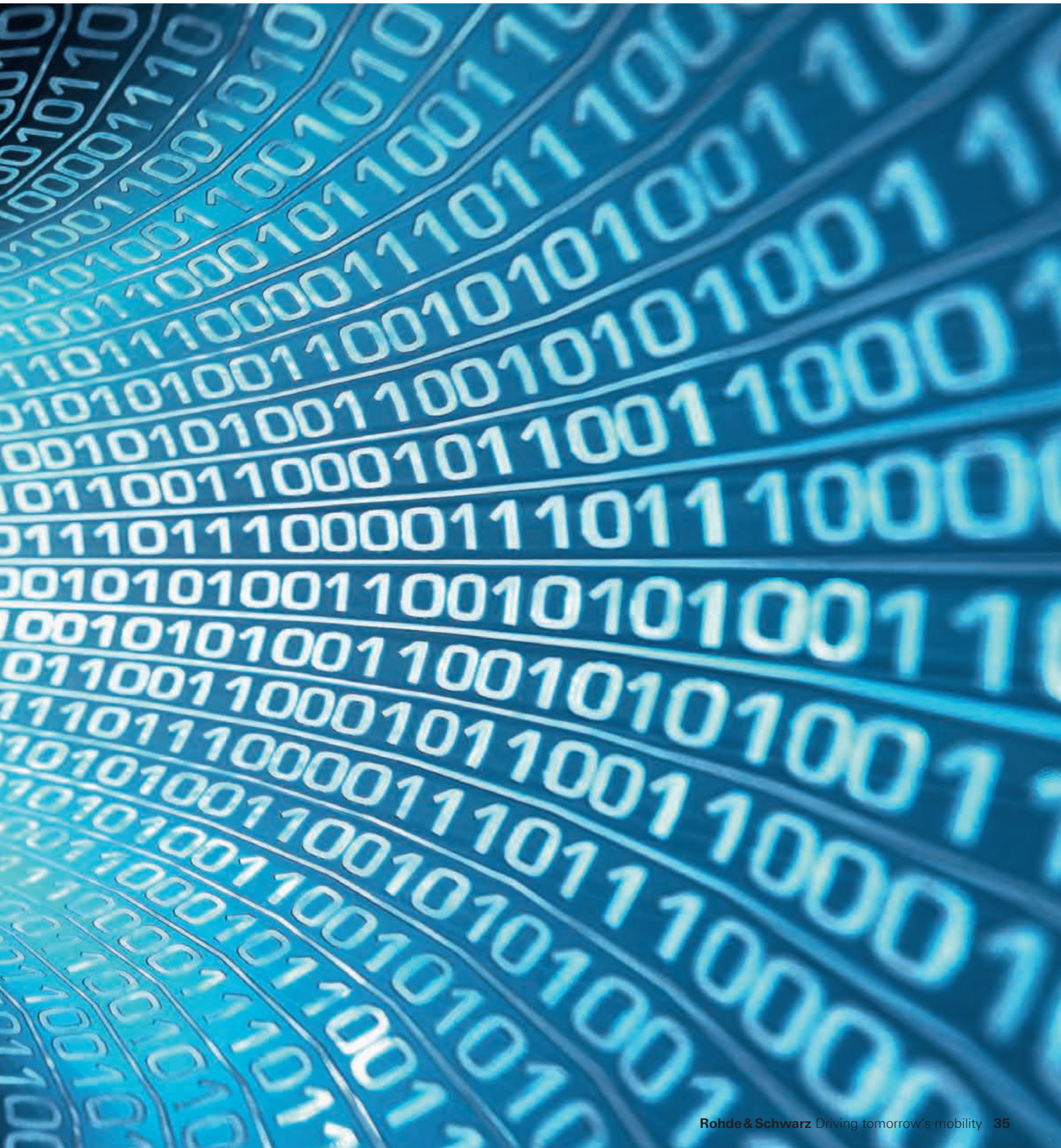
In-vehicle bus systems

All-in-one: decoding, triggering and searching

User-friendly: digitized signal displayed with decoded content

Efficient: several event types for complete acquisition cycle

Easy debugging of failure sources

CAN, CAN-FD, LIN, FlexRay™ and SENT are the most common technologies used for in-vehicle bus systems. The decision on which technology to use depends on the requirements with respect to cost, data rate and reliability. The signal quality is the key parameter for ensuring correct transfer of the bus telegram. Oscilloscopes are used to determine failure sources in such applications. Reflections and echoes reducing the quality of the signal are made visible by using eye diagrams. This tool is a must on every R&D engineer's desk.

Triggering on various events

Rohde&Schwarz oscilloscopes are the right choice for this task. The R&S®RTx family provides decoding, triggering and searching functions for typical automotive bus systems. You can trigger on various events that are typical for the selected protocol type, such as start and stop of messages, specific addresses or specific data patterns in the message. The digitized signal data is displayed on the screen together with the decoded content of the messages. The decode results are listed in a table. Labeling (e.g. CAN-dbc) is also supported. For most serial protocols, it is possible to find various events in the decoded data.
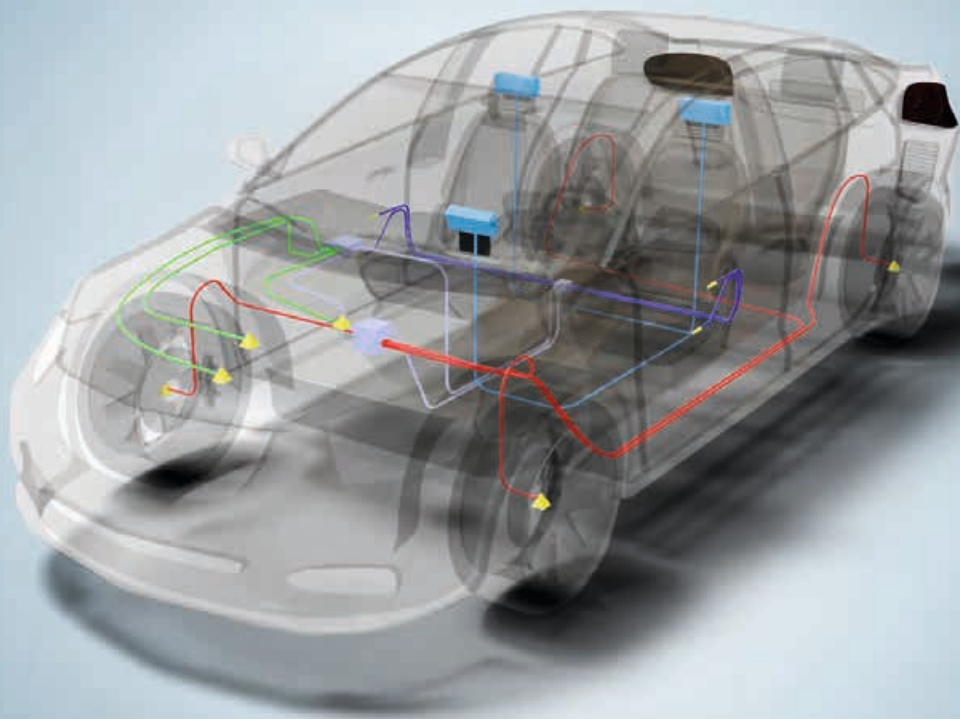
Determine brief interference during drive tests

Millions of drive test kilometers are driven during the development phase before a vehicle is launched. Any failure during such tests, e.g. a bus system outage, needs to be debugged and its source analyzed and eliminated. Onboard drive test units track the most relevant parameters. The problem is when the equipment reports a function failure, but does not indicate the reason. A handheld oscilloscope lets you further analyze the bus and determine if such a bus system outage comes from e.g. defective contacts or unwanted emissions.

On-board protocol debugging

When debugging complex problems in the field, the R&S®Scope Rider offers the performance and capabilities of a lab oscilloscope with the form factor and ruggedness of a battery-operated handheld device. The R&S®Scope Rider is the first isolated handheld digital oscilloscope with trigger and decode capability for in-depth troubleshooting on CAN/LIN buses. You can trigger on protocol events or data to selectively acquire relevant events, data and signals. Capturing and analyzing rare anomalies in electric

signals is a typical use case when debugging electronic systems. With an acquisition rate of up to 50 000 waveforms per second – more than 1000 times faster than conventional handheld oscilloscopes – R&S®Scope Rider sees signals other scopes miss. You can reliably capture and analyze rare signal faults. The long-term data logger of the R&S®Scope Rider lets you monitor up to four key measurements at a speed of 1, 2 or 5 measurements per second to uncover such rare faults.

Unique: first handheld oscilloscope with protocol analyzer

Versatile: eight instruments in one package

Superior: lab performance in a rugged and portable design

Automotive Ethernet

Precise: superior signal fidelity
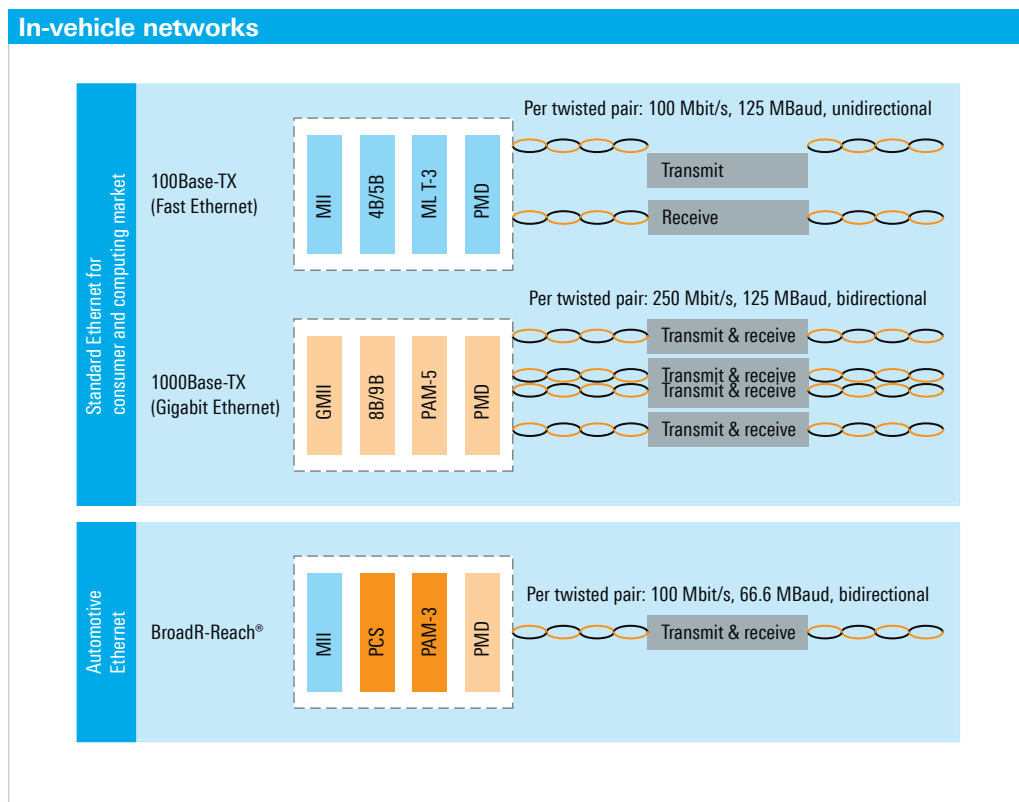
User-friendly: automated
test execution

Convenient: test software
to automate result calculation

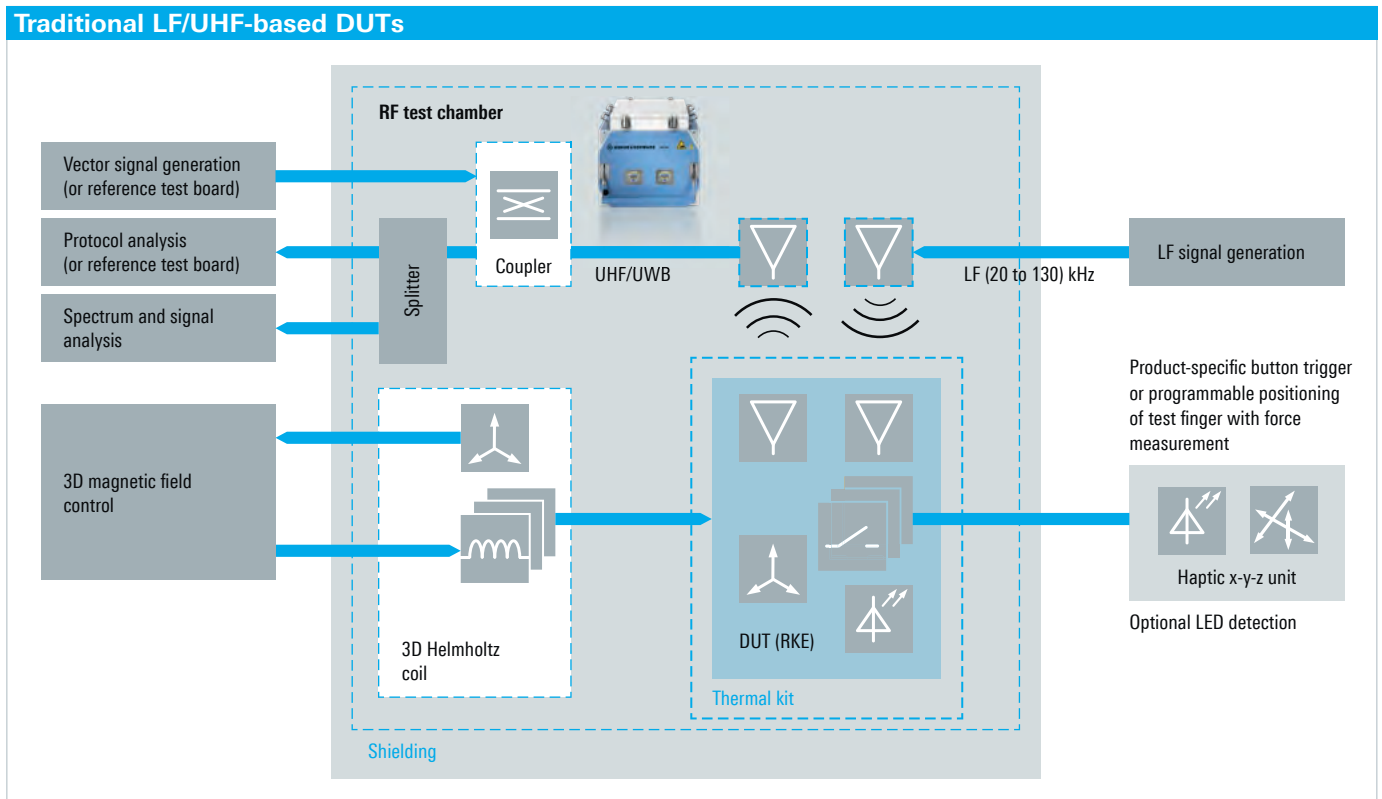## Network for high data rate applications

Ethernet is used in automotive networks to enable fast and cost-effective data communications. The automotive industry has specified the OPEN Alliance BroadR-Reach® (OABR) physical layer, also called IEEE 100BASE-T1, as the automotive Ethernet communications standard. It runs on standard FlexRay™ cabling and is used for high-speed communications such as audio or video streaming or for advanced driver assistance systems. 100BASE-T1 uses full duplex communications, enabling up to 1 Gbit/s to be transferred over one twisted pair. For interface verification, a 100BASE-T1 conformance test with six test cases is specified. This compliance test focuses on transmitter quality similar to most IEEE Ethernet compliance test specifications.

BroadR-Reach® compliance testing

The R&S®RTO is ideal for 100BASE-T1 compliance testing due to its superior signal fidelity and automated test execution capability. The high measurement dynamics of more than 7 effective bits (ENOB) provides reliable results even in tests with interfering signals, enabling you to assess and check your products during type tests or end-of-line production tests. The signal quality of the Ethernet interface can be verified using drop-out tests. The solution's graphical display options offer step-by-step measurement support.

In-vehicle networks

Standard Ethernet for consumer and computing market

100Base-TX (Fast Ethernet): MII, 4B/5B, MLT-3, PMD
Per twisted pair: 100 Mbit/s, 125 MBaud, unidirectional
Transmit / Receive

1000Base-TX (Gigabit Ethernet): GMII, 8B/9B, PAM-5, PMD
Per twisted pair: 250 Mbit/s, 125 MBaud, bidirectional
Transmit & receive / Transmit & receive / Transmit & receive / Transmit & receive

Automotive Ethernet

BroadR-Reach®: MII, PCS, PAM-3, PMD
Per twisted pair: 100 Mbit/s, 66.6 MBaud, bidirectional
Transmit & receive

Remote keyless entry (RKE)

Traditional LF/UHF-based DUTs

Combining convenience with safety

Passive entry/passive start (PEPS) systems are playing an increasingly prevalent role in access security and convenience. Vehicle status information and starting of the engine are handled by coded messages sent using ultra-wideband technologies (UWB). Two-way communications with a bandwidth of 1 GHz at 6.5 GHz prevent illegal attacks on such systems. Multi-node wireless sensor networks (WSN) can have data rates of up to 6.8 Mb/s. All this functionality needs to be tested.

Turnkey, state-of-the-art production solution

Rohde & Schwarz offers a turnkey, state-of-the-art solution for end-of-line production testing. It allows the integration of third-party products and the development of test management software for all specified test cases. The system is especially designed for remote keyless entry (RKE) units and is based on equipment such as a platform for RF switching and controlling (R&S®OSP-120 and R&S®OSP-B115), a spectrum analyzer (R&S®FSL18) and a shielded box (R&S®TS7124AS). These RF technologies comply with the UWB frequencies for PEPS as described above. The platform can also be used to test and calibrate magnetic compass systems.
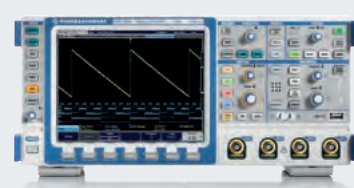
Flexible: integration of third-party products

Accurate: specifically designed for remote keyless entry units

Safe: compliance with UWB frequencies for PEPS

# In-vehicle bus systems product portfolio

Product families

R&S®RTx Family Digital oscilloscopes
Perform precise measurements at high input sensitivity with very low inherent noise. Benefit from a fully integrated multi-domain test solution with frequency, protocol and logic analysis functions in a unique high definition mode.

R&S®Scope Rider
Handheld digital oscilloscope
Capture and analyze rare anomalies in electric signals with excellent signal fidelity, up to 16-bit resolution and high acquisition rates with a single compact device in the 600 MHz to 6 GHz class.
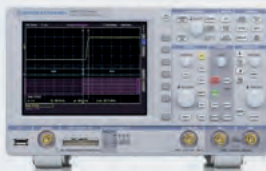
R&S®HMO
Compact Series Mixed Signal Oscilloscopes
Time domain, logic, protocol and frequency analysis plus an advanced component tester in a single, compact instrument.

The right oscilloscope for your application

	R&S®Scope Rider	R&S®HMO 1000	R&S®RTB2000	R&S®HMO 3000	R&S®RTM	R&S®RTE	R&S®RTO
Power integrity	•	•	•	•	•	•	•
I²C/UART/SPI T&D	•	•	•	•	•	•	•
LIN T&D	•	•	•	•	•	•	•
CXPI T&D						•	•
CAN T&D	•	•	•	•	•	•	•
CAN-FD T&D	•					•	•
SENT T&D	•					•	•
FlexRay™ T&D						•	•
Ethernet decoding						•	•
MIPI D-PHY							•
100BASE-T1 Compl.							•
1000BASE-T1 Compl.							•
EMI debugging						•	•
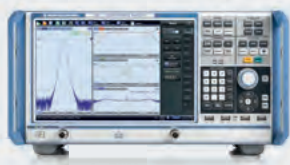
R&S®ZND
Vector network analyzers
Unidirectional measurements up to 4.5 GHZ. Options for bidirectional measurements and extended frequency range up to 8.5 GHz. Multiple results displayed simultaneously on the analyzer's large touchscreen.

R&S®CompactTSVP
Test system versatile platform
Wide range of measurement modules for production test systems. The open test platform, based on Compact PCI and PXI, is suitable for loads up to 30 A.

R&S®TS7124
RF shielded box
For reliable and reproducible measurements in the lab and in production. Rated for 1 million open/close cycles. Suitable for RF up to 110 GHz.

R&S®FPS
Signal and spectrum analyzer
High measurement speed, 160 MHz signal analysis bandwidth and wide range of analysis and wireless/wideband communications standards. Perfect for production and monitoring systems. Only 2 HU of rack space required.

Electromagnetic compatibility

Car manufacturers have to prove that unwanted car electronics emissions are within specified limits (EMI) and that cars are immune to disturbances from external and internal sources (EMS), e.g. from TV transmitters, mobile base stations or other electronic car components.

As a world market leader in this field, Rohde & Schwarz delivers effective test solutions to make sure your products comply with electromagnetic compatibility (EMC) standards and to help you quickly detect, analyze and solve any EMC problems.

Electromagnetic compatibility

Identifying sources of unwanted interference

The increased use of electronic devices and wireless technologies in vehicles has created many new sources of interference. Identifying these sources and developing solutions with low emissions and adequate immunity is a challenging task for design engineers. Frequent testing throughout the complete development process reduces the probability of a major redesign, effectively decreasing product launch costs and delays. Designing, installing and maintaining test systems that grow with your needs and keeping them up-to-date with the complexity of the equipment under test (EUT), test procedures and the requirements in standards/specifications is a challenging project.

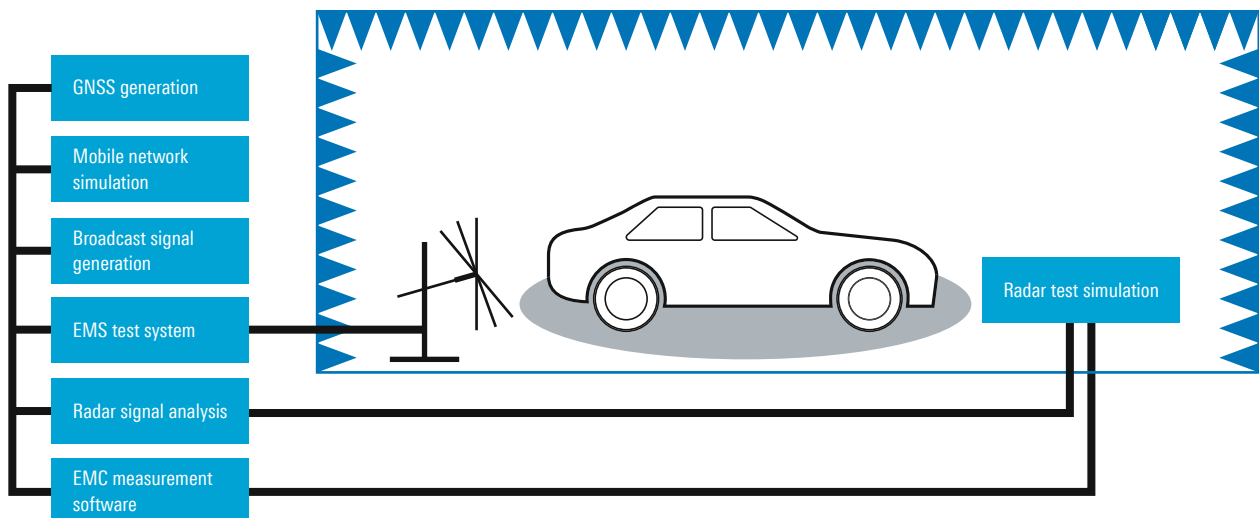**Customizable, turnkey EMS and EMI test systems**

Rohde & Schwarz offers customizable, turnkey test systems for performing EMI and EMS measurements on vehicles and components in line with all major automotive EMC standards such as CISPR, ISO, UN/ECE and EC directives as well as with manufacturer and country-specific test specifications. The R&S®TS9982 for EMS and R&S®TS9975 for EMI are the base systems for radiated and conducted measurements during development and certification. The systems adapt to the required frequency ranges and test levels for all types of EUTs, including full vehicles. Additional test capabilities for wireless communications

Highly efficient: turnkey solutions for all major standards

Flexible: all key instruments available in-house

Trustable: reference projects all over the world

Complete real-world smart vehicle scenarios

- GNSS generation
- Mobile network simulation
- Broadcast signal generation
- EMS test system
- Radar signal analysis
- EMC measurement software
- Radar test simulation

functionality, broadcast technologies, real-world modulated interferer signals and radar target simulation during EMC test can be added to the system if required. From system design, implementation and installation to training and maintenance, the turnkey systems provide everything you need from a single source, enabling engineers to concentrate on testing. The systems can be customized to offer solutions ranging from a small precompliance system with compact test cells to an accredited test systems for complete vehicles.

Control software for development, compliance and batch testing

The R&S®EMC32 measurement software is the standard system control software in EMC. It offers easy-to-use configuration dialogs to define test steps and complete sequences for electromagnetic interference (EMI) and electromagnetic susceptibility (EMS) measurements. Automated execution of test sequences and reporting functionality, including graphical presentation of results, ensures efficient testing. Interactive measurements help EMC experts debug EUTs. The modular software structure allows you to flexibly expand the system to meet various testing requirements. Software upgrades and improvements as part of Rohde & Schwarz software update service ensure that the system adapts to future measurement tasks, amendments to standards and new devices.

**Profitable:** sequential test runs for higher degree of automation

Future-oriented: modular software structure and option concept

Customizable: individual and comprehensive reports

Smart linking of EMC test sequences

The R&S®EMC32 software options help you define and run tests to be in line with automotive EMC standards. The software supports the multiple test hardware setups required for measurements on multiple EUT antennas as well as the test setups with reverberation chambers and semi-anechoic, absorber-lined shielded enclosures (ALSE). Scripting tools help you execute actions on custom equipment and on interfaces to higher-level control and reporting systems. The software offers basically unlimited support of measurement components. The huge library of standard tools makes it possible to integrate any remote control capable instrument or equipment such as positioners or amplifiers.

Smart linking of EMC test sequences with modular software.
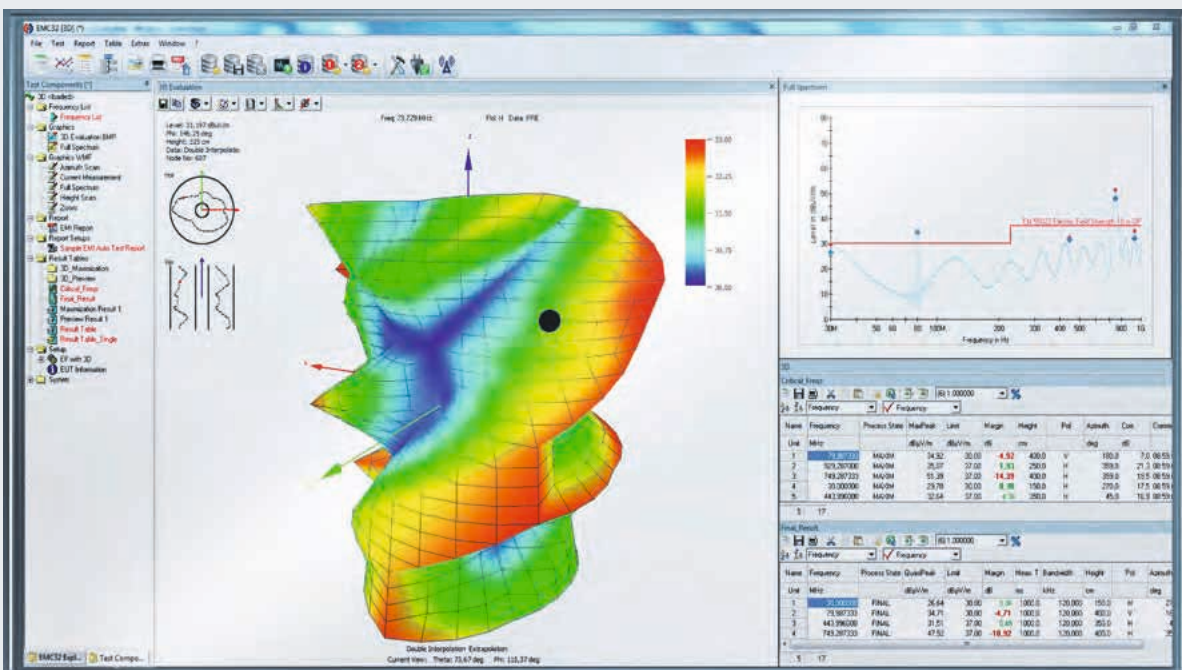
Time-saving: fully automated failure detection system

Versatile: interfaces to CAN buses, automatic monitoring tools, etc.

**Adaptive:** widespread use by OEMs and Tier 1 customers

Automatic DUT monitoring during EMC measurements

The rules for electromagnetic compatibility (EMC) require that electrical products not emit any electromagnetic interference (EMI) and that they do not react to external interference (electromagnetic susceptibility, EMS). These reactions can be completely different depending on the product under consideration.

Realtime analysis with up to 60 frames/s

If such problems are indicated optically, e.g. by warning lamps or status display, a solution is now available for automatic detection: the R&S®AdVISE visual monitoring system. It consists of software, an R&S®AtomixLT video board and one to two video cameras and requires a workstation with NVIDIA GPU. R&S®AdVISE is typically run as an expansion of the R&S®EMC32 EMC software. It analyzes the camera images of the DUT in realtime at up to 60 frames/s – for example views of the dashboard during automotive measurements. For each camera image, you can define up to 32 regions of interest (ROI). The system monitors the behavior of these ROIs and links the behavior to event messages. It detects changes in the brightness, color and color intensity of an ROI as well as the length of bar diagrams. Each ROI is individually configurable. Even DUTS with complex reaction behavior can be measured automatically. R&S®AdVISE is available in three models: lite, mid-level and high performance.

Continuous DUT monitoring during EMS testing
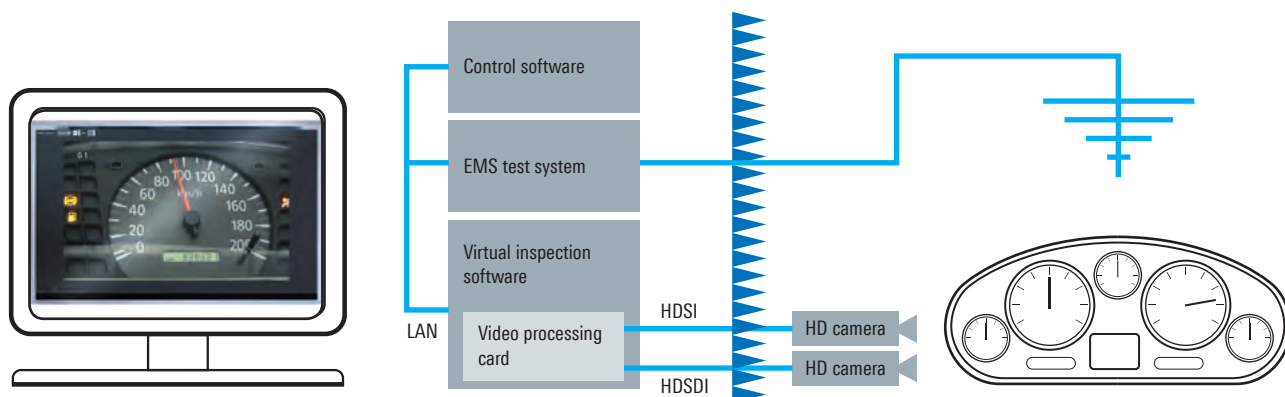
Capturing and analyzing unwanted emissions

When debugging electromagnetic interference (EMI) problems, electronic design engineers face the challenge of identifying the sources of unwanted emissions and developing a solution for them. Frequently, the only information that comes back from the EMC test laboratory is a spectrum curve indicating the frequencies where emissions are critical or violating the limits. Repetitive testing at the EMC compliance laboratory to identify and resolve the problem is costly and often significantly delays the product launch.

Detecting the complete spectrum of interferers

Rohde & Schwarz offers a range of instruments featuring dedicated test modes such as spectrum analyzer mode (combined with zero span), realtime measurement persistence mode and spectrogram view. For the EMI test procedures, a stepped scan receiver mode (classic mode) and a time domain (FFT-based) receiver mode are available. While the stepped scan mode offers point-by-point coverage of the complete spectrum, the time domain mode allows parallel handling of numerous frequency points.

Timely pre-analysis with oscilloscopes

The R&S®RTO/RTE digital oscilloscope is a powerful instrument for debugging EMI problems during design. In combination with a near-field probe set, it allows designers to quickly locate and analyze EMI problems early on, eliminating the need for debugging in costly test locations. This saves a significant amount of time and money. High dynamic range and a high input sensitivity of 1 mV/div ensure that even weak emissions can be analyzed. The R&S®RTO fast Fourier transformation (FFT) implementation provides a fast update rate and the FFT frame overlay processing and persistence display provides insights into the structure of unwanted emissions.

DUT timing behavior via the spectrogram view.
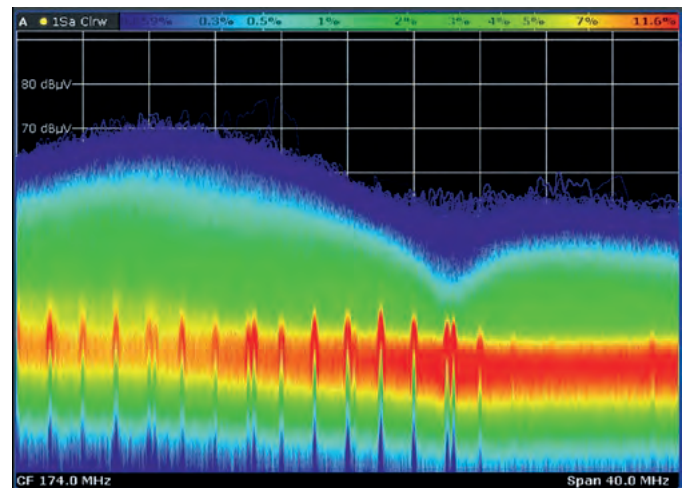
Emissions captured by an oscilloscope using a near-field probe.
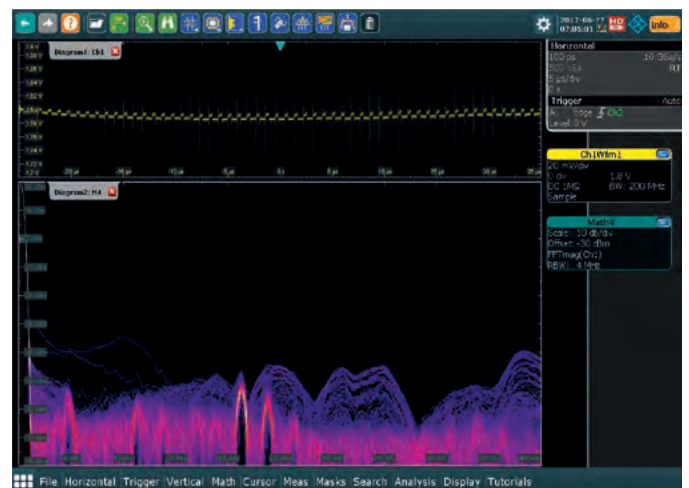
Electromagnetic compatibility product portfolio

Product families

R&S®ESW
EMI test receiver
Capture and weight disturbance spectra in virtually no time at all. Outstanding RF characteristics, high dynamic range and measurement accuracy. Meets requirements for certification measurements in line with CISPR, EN, MIL-STD-461.

R&S®FSW
Signal and spectrum analyzer
Low phase noise, wide analysis bandwidth and straightforward and intuitive operation for fast and easy RF measurements.
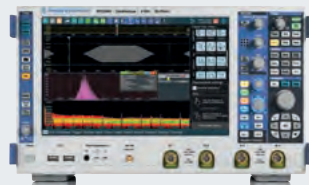
R&S®ESR
EMI test receiver
Analyze electromagnetic disturbances in detail with the conventional stepped frequency scan or – at an extremely high speed – with an FFT-based time domain scan.

R&S®BBA150
Broadband amplifier
Generate power in the frequency range from 9 kHz to 6 GHz. Rugged and highly reliable.

R&S®RTO
Digital oscilloscope
Debug EMI problems during design. Use with a near-field probe set to quickly locate and analyze EMI problems.
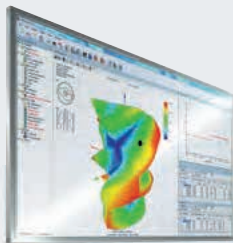
R&S®OSP
Open switch and control platform
Automatic path switchover in complex RF test systems. Compact size and plug & play for easy installation.

R&S®AdVISE
Visual inspection software
Automate the process of visually detecting failures of a DUT during immunity testing to eliminate the problem of human inattention and save test time.

R&S®EMC32
Measurement software
Monitor and control EUTs fully automatically. Common user interface for electromagnetic interference (EMI) and electromagnetic susceptibility (EMS).
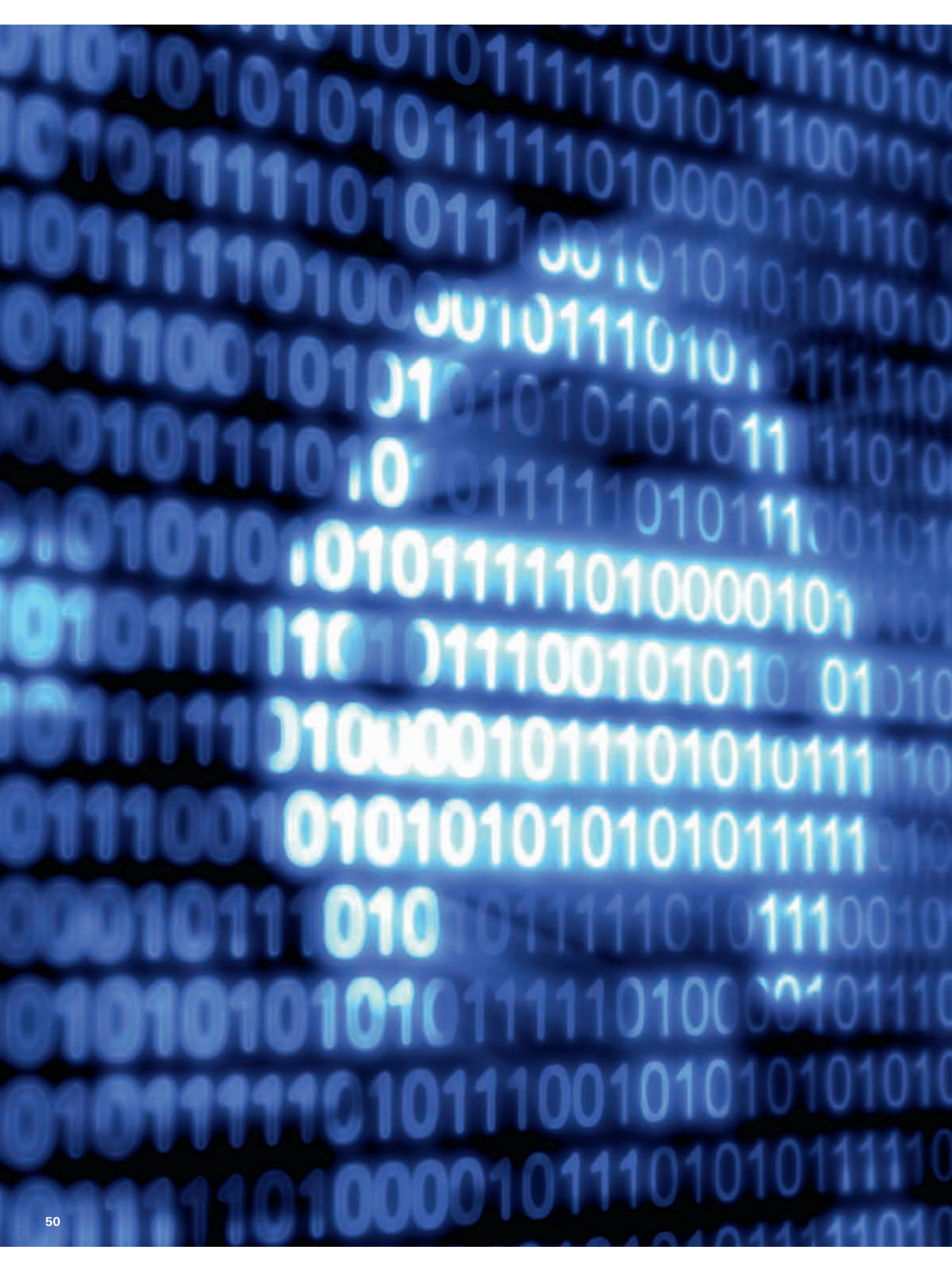
R&S®TSx
Family EMS test systems
Base system for conducted and radiated EMS measurements. Modular design to cover a wide range of applications and adapt to the given measurement task.

R&S®RT-Zxx
Standard probes
High-quality active and passive probes supplement the Rohde&Schwarz oscilloscopes.

Secure automotive

As more and more frightening hacks are made public, platform operators are becoming increasingly concerned about the security of vehicles and data centers. Security cannot be achieved simply by choosing the right telematics platform. The platform operator has to take appropriate security measures to prevent a potential telematics platform compromise from escalating and threatening the safety of vehicle owners.

Deep packet inspection

Precise: no false positives

Fast: up to 10 Gbps
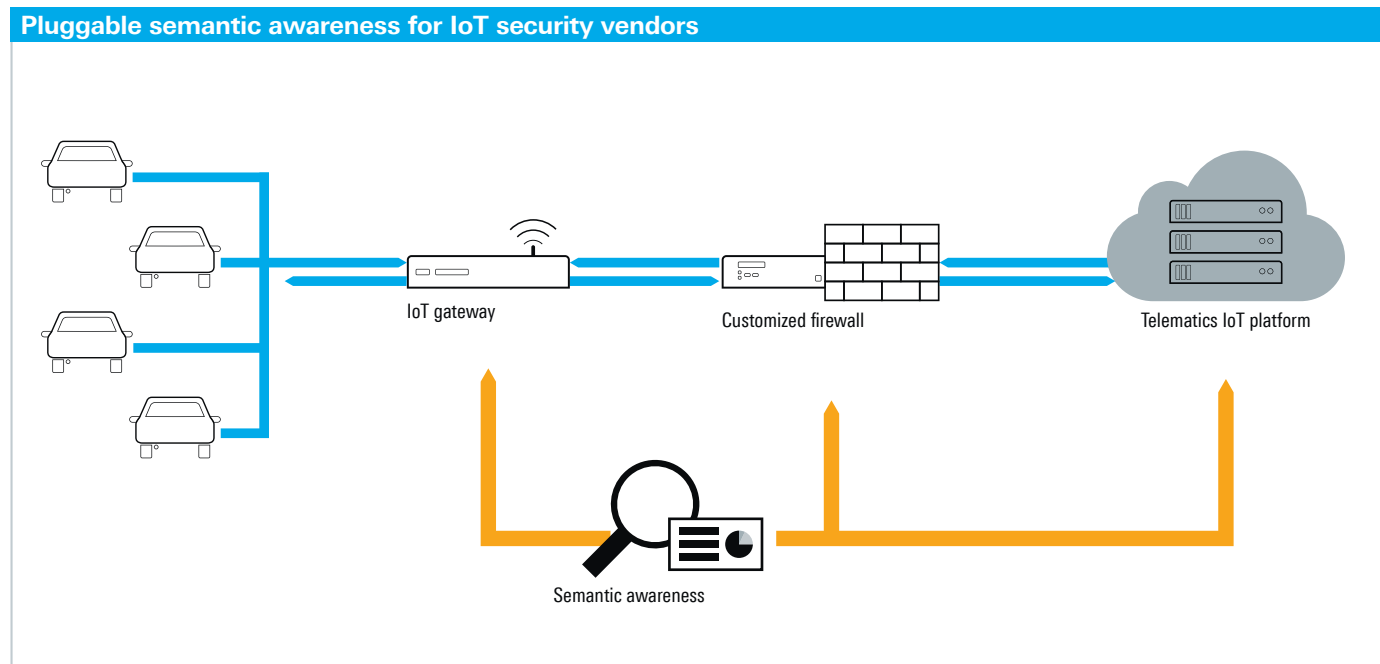per single core

Efficient: low
memory footprint

The security challenge

Mobile network operators have become the natural part-ner to car manufacturers by offering IoT-based telematics services. Operators monetize the vehicle data collected by telematics platforms in a variety of ways, such as over-the-air (OTA) customer services, usage-based insurance (UBI) and fleet management. Vehicles connect via a telematics unit placed inside the car. The devices communicate with data centers controlled by the operator via the mobile network. As more and more frightening hacks are made public, operators are becoming increasingly concerned about the security of the vehicles and data centers. Such incidents demonstrate that vehicles can be hijacked and that threats to vehicles have escalated from the imaginary realm of possibility to reality. Telematics platforms are most likely proprietary since standardization of a common IoT platform is still in progress and technical specifications are not yet ready for implementation. This makes it difficult for operators to assess the quality of the implemented security functions.
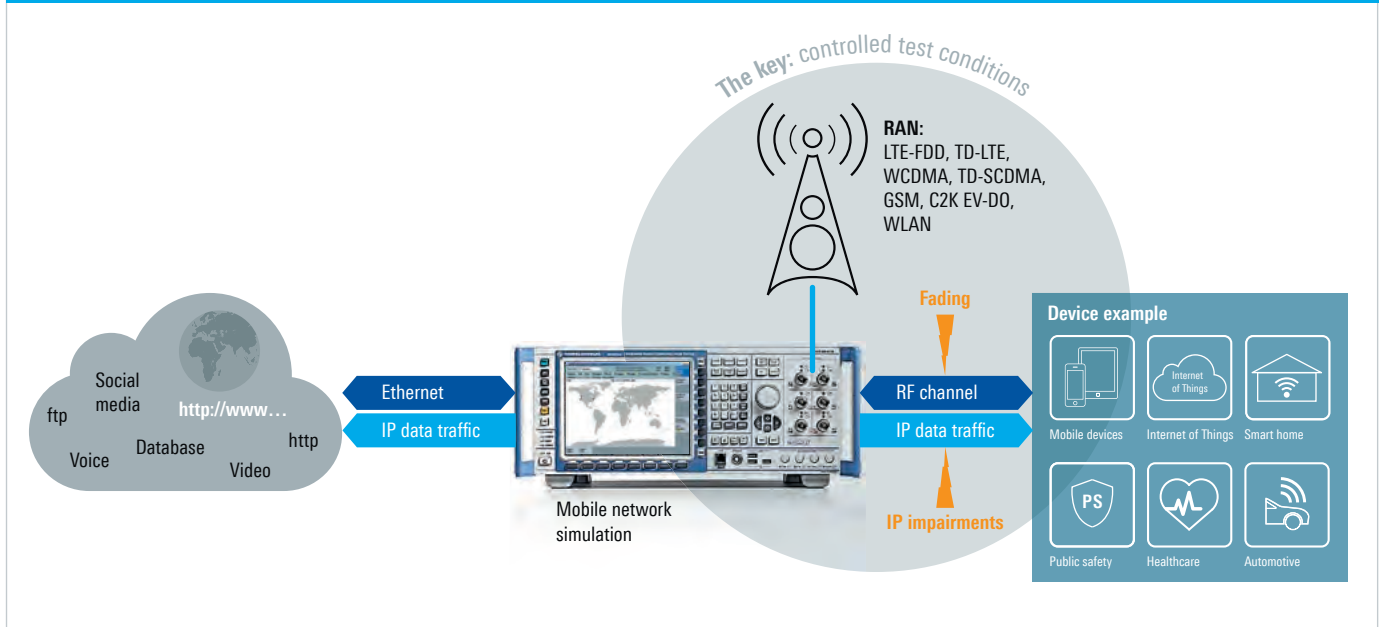
Embedded software DPI engine

The security solutions offered by Rohde & Schwarz Cybersecurity help operators establish a second line of defense that is isolated from the vehicles and the telematics platform and therefore not prone to privilege escalation, compromise of vehicles or accidental misuse of the telematics platform. The R&S®PACE 2 protocol and application classification engine is a software engine used by IoT network and security equipment vendors to enhance their products with state-of-the-art IP traffic analytics capabilities. This allows manufacturers to imple-ment state-of-the art security functions in their IoT de-vices, e.g. gateways, firewalls and (telematics) platforms. R&S®PACE 2 uses deep packet inspection technology together with a comprehensive toolbox of methodologies. This allows operators to detect even encrypted and actively hidden applications and protocols – with a low rate of false negatives and virtually no false positives.

Pluggable semantic awareness for IoT security vendors

IoT gateway

Customized firewall

Telematics IoT platform

Semantic awareness

Connection security

Test setup to analyze IP traffic of car telematic units

The key: controlled test conditions

RAN:
LTE-FDD, TD-LTE, WCDMA, TD-SCDMA, GSM, C2K EV-DO, WLAN

Fading

RF channel
IP data traffic

IP impairments

Device example
Mobile devices · Internet of Things · Smart home
Public safety · Healthcare · Automotive

Ethernet
IP data traffic

Social media · ftp · http://www… · Voice · Database · http · Video

Mobile network simulation

Securing the channel

Connection security describes the procedure of securing the communications channels between two devices, which typically requires authentication, integrity and encryption. Authentication is required to verify the communications partners and ensure both parties that the other partner is trusted and allowed to receive the information. Integrity and encryption are necessary to protect the transmitted information against eavesdropping and modification during the transmission.

Connection security measurements under controlled network conditions

The R&S®CMW500 wideband mobile communication tester has integrated IP connection security analysis measurement capabilities. The R&S®CMW-KM052 option, which is based on the R&S®PACE 2 protocol and application classification and analysis engine, detects and analyzes IP data traffic in realtime. It is a powerful add-on to the R&S®CMW500 realtime tester, which supports all common cellular radio standards such as LTE, WCDMA and GSM as well as non-cellular standards such as WLAN in a single unit. For the test, the R&S®CMW500 simulates the relevant radio network, including country and mobile network codes. It establishes a connection to the device under test as well as the IP connection to the device and the Internet. The R&S®CMW-KM052 captures and analyzes the data streams of the DUT´s established IP

connections and visualizes the data streams and relevant IP connection security parameters, including certificate-based authentication details and the SSL/TLS handshake. The R&S®CMW500 offers detailed analysis capabilities to ensure that the device has no unwanted open ports to the Internet and that it doesn't transmit passwords or user-relevant data unencrypted. It also determines the location and domain name of the endpoint to which communications has been established. This analysis functionality enables car telematics manufacturers to identify vulnerabilities in the IP connection security under controlled network conditions in the lab. Development engineers can now improve the IP connection security of their devices at an early stage of development.

Repeatable: measurements under controlled conditions

Convenient: no additional solution required

Flexible: easy configuration of real-world applications

Network security

Safe: zone concept for dedicated security areas

Flexible: easy integration into IoT networks

## Customizable: supports special protocol decoding

Maximum network security for various applications

The requirements for IT network security solutions vary according to the size of the company. While small companies need easy-to-use products to protect their office environment, IT administrators in medium-sized businesses have to monitor a complex network and be able to configure the firewall accordingly. Industrial enterprises and companies that operate critical infrastructures require firewalls that protect specific network areas and can be adapted to individual requirements. The interlinking of communications brought about by Industry 4.0 poses additional IT security challenges.

Specialized Line firewalls

The Rohde & Schwarz Specialized Line firewalls revolutionize the concept of next generation firewalls by using a unique full-validation whitelisting solution to ensure maximum network security. Its general operation can be compared to X-ray scanners used at airports where no unknown item is allowed through the security checkpoint – each and every item has to be positively identified. Specialized Line uses a novel technology to achieve the same for today's networks. Semantic awareness assures security by design. Every single network transaction is analyzed down to the application and content level. Only transmissions that are fully understood and validated are allowed to pass through. Everything else is blocked from entering or leaving the network. This not only effectively secures the network from outside attacks, it is also highly effective in preventing data loss. Now telematics platform operators or the OEM can define firewall rules based on the whitelisting concept. The Specialized Line firewalls ensure that no OTA software updates are sent to any connected vehicle – even if the telematics platform is compromised and criminals have full access to the telematics platform. The Rohde & Schwarz in-house deep packet inspection (DPI) technology allows you to implement semantic awareness in firewalls, even for the control bus and proprietary protocols that are commonly used in telematics platforms. Operators and OEMs can implement policies based on a full understanding of the transferred communications.

Specialized Line firewall – innovative routing functionality for industrial protocols
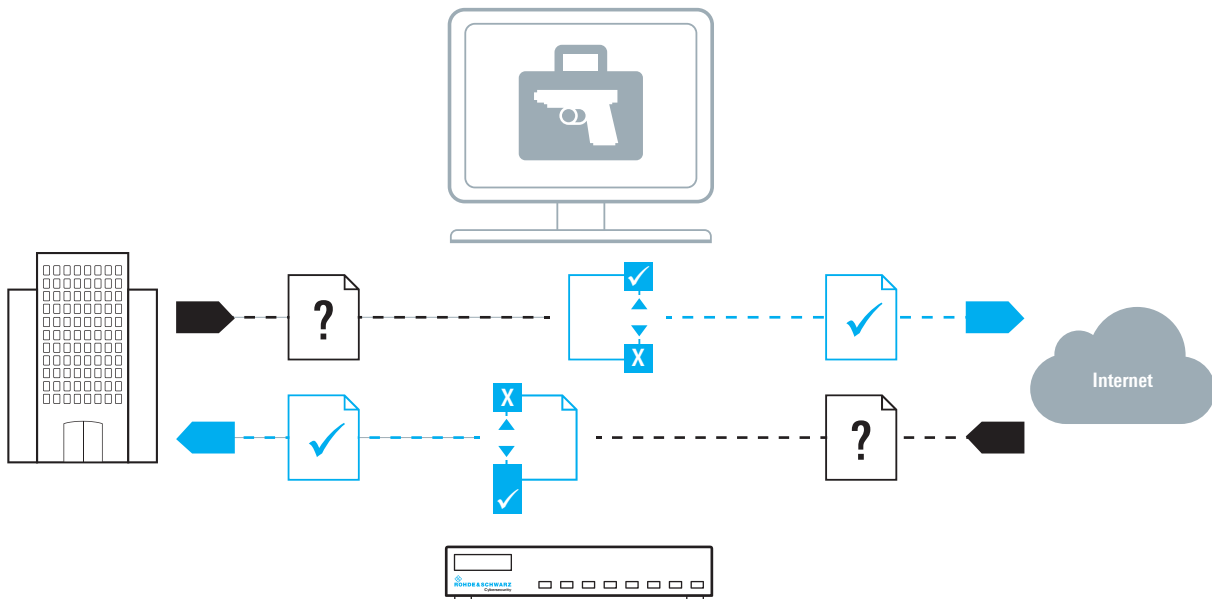
Secure automotive product portfolio

Product families
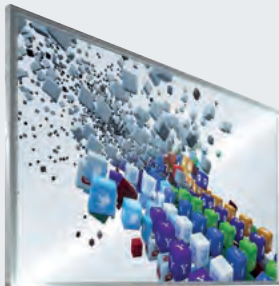
R&S®PACE 2
Software library
Use different technologies – deep packet inspection, behavioral, heuristic and statistical analysis – to reliably detect network protocols and applications and extract metadata in realtime. Deployable in a variety of use cases, including network decurity, network monitoring and traffic management, application delivery and optimization, analytics and mobile data offload.

Specialized Line
Next generation firewall
Routing functionality for complex IT environments requiring a high level of protection. Easy to integrate into industrial process networks. The special protocols can be quickly adapted and integrated to meet customer requirements.

R&S®CMW500 platform
R&S®CMW-KM052
IP connection security analyses option
Identify telematics units' IP connection vulnerabilities in an early stage of development. A unique and powerful test solution, especially in combination with cellular technologies such as LTE/LTE-A, WCDMA and GSM.

About
Rohde & Schwarz

For more than 80 years, Rohde & Schwarz has stood for quality, precision and innovation in all fields of wireless communications.

The privately owned company group has a global presence. It develops, produces and markets a wide range of electronic capital goods for industry, infrastructure operators and government customers.

Rohde & Schwarz is among the technology and market leaders in all of its business fields, including wireless communications, EMC and TV test and measurement, TV broadcasting and technologies related to the monitoring and analysis of radio signals.

Numerous subsidiaries and representatives not only ensure competent and customer-oriented on-site support anywhere in the world, they also safeguard customer investments with comprehensive service and support offerings.

Our business fields

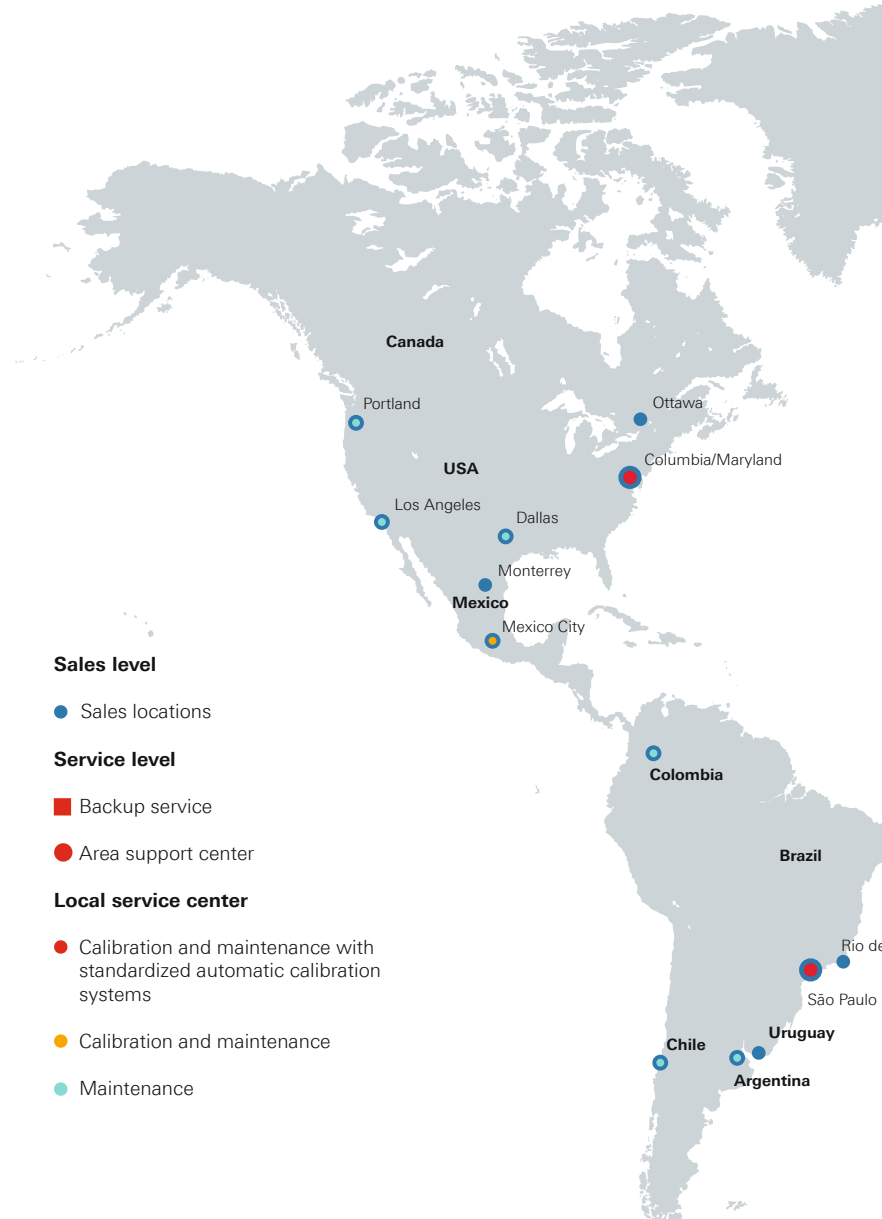| Test and measurement	Broadcast and media	Cybersecurity	Secure communications	Monitoring
T&M instruments and systems for wireless communications, aerospace and defense, automotive, research and industrial electronics applications	Broadcast, T&M and studio equipment for network operators, broadcasters, studios, the film industry and manufacturers of entertainment electronics	Security products to protect communications, IT and other critical infrastructures	Communications systems and encryption technology for air traffic control (ATC) and armed forces	Spectrum monitoring and mobile network testing systems for regulatory authorities and network operators as well as COMINT and ELINT systems for homeland and external security

Service that adds value.

Rohde & Schwarz operates a global service network in order to safeguard the investments of its customers. The following on-site services are offered worldwide:
▌ Calibration
▌ Maintenance and repair
▌ Product updates and upgrades

We have service solutions for everyone. And can tailor them to your specific needs.
Our customer focus is uncompromising. The service we provide equals the quality, innovation, precision and excellence of our products in every aspect. To ensure this, we stay focused on what's most important – you.

Our highly capable service organization is rigorously centered around your specific needs and requirements. You benefit from flexible service concepts designed to bring you sustained benefit and long-term satisfaction. And because cutting-edge electronics rightly belong in the hands of specialists, our service engineers are there where and when you need them. With an extensive service network around the globe, we can provide 24-hour assitance whatever your time zone. We take care of your requests quickly and reliably, in our 70 locations worldwide or directly on site.

Canada

Portland

Ottawa

USA

Columbia/Maryland

Los Angeles

Dallas

Monterrey

Mexico

Mexico City

Sales level

● Sales locations

Service level

■ Backup service

● Area support center

Local service center

● Calibration and maintenance with standardized automatic calibration systems

● Calibration and maintenance

● Maintenance

Colombia

Brazil

Rio de

São Paulo

Chile

Uruguay

Argentina

Rohde & Schwarz regional service centers, plants and specialized
subsidiaries provide a wide range of additional services:
- System integration
- System support
- Installation and commissioning
- Application support
- Development of customized modules,
  instruments and systems
- Software development
- Mechanical and electrical design
- Manufacturing to order
- Technical documentation
- Logistics concepts

Service that adds value
◗ Worldwide
◗ Local and personalized
◗ Customized and flexible
◗ Uncompromising quality
◗ Long-term dependability

Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

Sustainable product design
◗ Environmental compatibility and eco-footprint
◗ Energy efficiency and low emissions
◗ Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

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