NEWS

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ROHDE&SCHWARZ

UltraHD – the future of TV

4K TVs are conquering the market. But in order to distribute ultra high definition programs via traditional broadcasting, the entire production and transmission chain needs to be upgraded. Rohde&Schwarz has all the equipment to enable broadcasters to do this.

General purpose

Compact team for production: generator and signal and spectrum analyzer

Secure communications

Increased air traffic safety through automatic detection of simultaneous transmissions

Radiomonitoring / radiolocation

Hybrid radiolocation systems for conventional direction finding and TDOA

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NEWS

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Cover feature

Developments come thick and fast in the world of audiovisual consumer electronics. While the SD medium, DVD, still dominates the sales charts, the 3D wave has already ebbed away and HD technology is only halfway into our living rooms. Now the latest hype is all about 4K and UltraHD (UHD). Relatively inexpensive cameras and TVs already use this resolution, which is likely to become standard, since manufacturing image sensors and panels no longer poses problems. But there is still a wide gap between recording and playback

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when it comes to the playout of professional video productions. With mass-market UHD storage media not expected to be available until the end of 2015, early adopters of this technology need to continue relying on streaming services for the time being. Streaming services require a fast Internet connection, but pioneering countries like South Korea are showing how UHD content can also be distributed over the traditional channels of terrestrial, satellite and cable broadcasting. To achieve this, however, broadcasters need to upgrade their resources across the board. Rohde&Schwarz has all the equipment to enable them to do this (page 44). In addition, fine-tuning is still being carried out on the consumer electronics end, with HDMI 2.0 a must for UHD. Turn to page 52 to learn how the interface can be tested easily.

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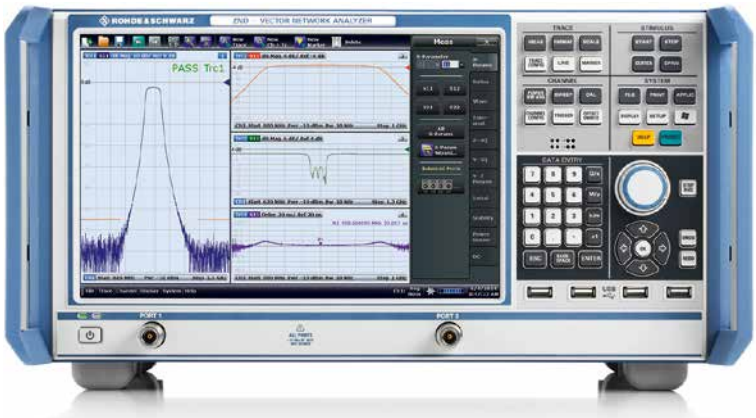
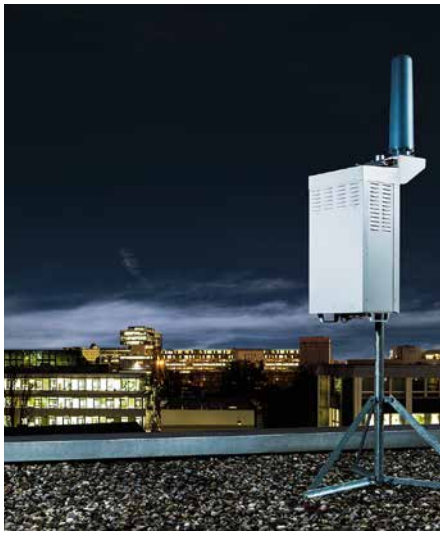
The new, affordable R&S®ZND network analyzer is an adequate solution in many cases when it comes to production testing of cables, attenuators, antennas or filters (page 22).



24 ports in a single network analyzer, each with the performance of a fast two-port analyzer – you won't find that anywhere but at Rohde&Schwarz (page 18).

The compact outdoor R&S®UMS300 monitoring and radiolocation system for ITU-compliant monitoring, direction finding and emitter location based on TDOA (page 64).



R&S®TS8997 tests ISM band products in line with latest EMC standards

In January 2015, the revised versions of the ETSI EN 300 328 and 301 893 EMC standards took effect for all products transmitting in the 2.4 GHz and 5 GHz ISM bands. The standards were made more stringent and include new requirements. The changes were driven by the rising popularity of WLAN/Wi-Fi, Bluetooth® and remote control applications, which are occupying the bands with a broad range of radio technologies (high and low-speed data, wideband or narrowband, MIMO, frequency hoppers) and increasingly conflicting with each other. The revision of the standards is to ensure that these diverse services can coexist without interference in the future. The R&S®TS8997 test system, wich is controlled by the R&S®EMC32 software platform (see page 40), carries out all required tests fully automatically. It is especially convenient to use in connection with the R&S®DST200 RF diagnostic chamber as an antenna coupler.

New four-line V-network for disturbance voltage measurements in line with CISPR, EN, VDE, ANSI, FCC and MIL STD 461F

Line impedance stabilization networks are used for standard-compliant EMC measurements of loads operating on the power supply. They feature precisely defined electrical characteristics and ensure the precision and reproducibility required for T&M purposes. With the R&S®ENV432, the Rohde&Schwarz portfolio now includes a model that is ideal for measuring most loads. The R&S®ENV432 can be connected to single-phase and multiphase devices. Multiphase devices can draw up to 32 A per phase continuously and even 50 A for short periods. An automatic fan keeps temperatures safe under all operating conditions, and a pulse limiter protects the measuring receiver input. TTL control inputs are provided for remote control of phase selection in automatic test systems. They can be driven by Rohde&Schwarz controllers or measuring receivers, and their firmware is configured for use with the R&S®ENV432.

R&S®SMW200A vector signal generator with up to eight independent basebands

T&M equipment developers must constantly innovate to keep pace with the steadily growing complexity of modern radio systems. There was previously no such thing as eight independent basebands in a single signal generator. The multi-entities option for the R&S®SMW200A makes it possible to implement applications with ultracompact setups that previously required considerable effort and resulted in limited performance. From multistandard base station testing, interference scenario simulation and aggregated LTE carrier generation to beamforming, MIMO and radar signals, the R&S®SMW200A delivers the desired signal mix with top quality in just a few operating steps. The instrument can be equipped with two internal RF paths, and external R&S®SGT100A RF generators (Fig., see also page 24) can be connected via I/Q interfaces, making it possible to build a complete solution with up to eight paths in a minimum of space.

New power sensors with better performance and measuring convenience

Rohde&Schwarz is launching an entirely new family of power sensors: the R&S®NRPxxS/SN series of three-path diode power sensors. The R&S®NRPxxS/SN series offers (even) more of everything than the very well-designed previous models: more speed, more dynamic range, more sensitivity, more configuration options. An additional LAN interface in the SN models, for example, enables browser-controlled remote measurements over any distance. There is also a bidirectional trigger port, which makes it possible to elegantly synchronize measurements in time-critical setups. A status LED shows the instrument's operating status at a glance – a helpful feature when using multiple sensors in production. The focus of development was on low measurement noise, as this has a decisive impact on key quality parameters such as sensitivity, dynamic range and measurement speed. At a typical noise level of 20 nW, the R&S®NRPxxS/SN sensors achieve top values in these disciplines. They are available with upper frequency limits of 8 GHz, 18 GHz and 33 GHz. Further models are in development.

Comprehensive automotive radar tests with target simulator and FMCW signal analysis

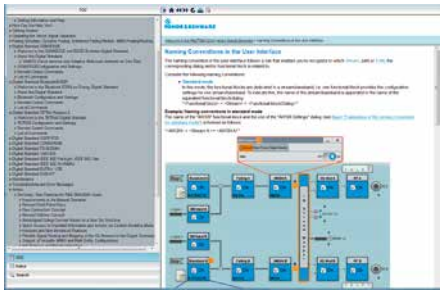
Rohde&Schwarz is now the exclusive distributor of the turnkey automotive radar target simulator (ARTS) from ITS and miro-sys. Combined with the R&S®FSW signal and spectrum analyzer and its analysis option for FMCW chirp signals, ARTS constitutes an innovative test solution for the development and production of automotive radar sensors. The R&S®FSW automatically characterizes chirp signals that are typical of automotive radar according to parameters such as chirp rate, chirp length and chirp rate deviation. ARTS enables realistic simulation of moving targets with adjustable distance, speed and size. Depending on the configuration, up to four independent targets with different parameters can be displayed in real time. This instrument duo offers major advantages in development, production, quality assurance and approval. For the first time ever, production serial tests can be performed with a reasonable test depth and 100 % test coverage. The test solution operates in the common 24 GHz and 77 GHz automotive radar bands.

Cost-effective automatic four-port calibration of network analyzers

The R&S®ZN-Z153 automatic calibration unit makes it fast and easy to calibrate a Rohde&Schwarz network analyzer up to 8.5 GHz. It is another economical four-port model in the company's automatic calibration unit product range. Port arrangement is the primary selection criterion that sets it apart from the R&S®ZN-Z51, the other four-port model. The ports on the R&S®ZN-Z153 are arranged in a single row, while the R&S®ZN-Z51 has two ports on each side. The user's test setup will dictate the most advantageous port arrangement. The unit features a built-in memory for recording user-specific calibration data in complete setups, or an easily removable micro SD card can be used. This makes it easier to organize efforts and archive results. The Rohde&Schwarz R&S®ZNB/R&S®ZNBT/R&S®ZNC/R&S®ZND and R&S®ZVA/R&S®ZVT network analyzers recognize the calibration unit as soon as it is connected via USB interface.

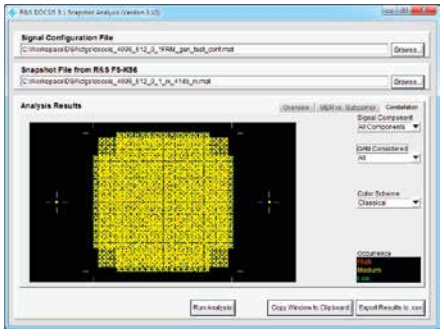
R&S®HMC power supplies come with a broad range of functions

Tracking, sequencing and FuseLink – these terms describe some of the most interesting additional functions that Rohde&Schwarz has included in its new R&S®HMC804x power supply series. The logging function and the energy meter mode are also absolute innovations for devices available for under EUR 1000. Developed by Rohde&Schwarz subsidiary HAMEG Instruments, R&S®HMC power supplies are equipped with one, two or three channels. All devices deliver up to 100 W of power and are adjustable between 0 V and 32 V in steps of 1 mV. A tracking function makes it possible to carry out changes to current/voltage limits synchronously in combined channels. FuseLink is based on a similar idea. It combines the safety switch-off current limits for multiple channels. Sequencing makes it possible to switch on individual channels sequentially over a period of up to 10 seconds. The logging function stores all current, voltage and time values. The energy meter mode continuously displays the power in watts drawn by a connected load. A wealth of sensible features at an attractive price – that is what makes the R&S®HMC804x models typical Value Instruments.



Convenient access to manuals and descriptions with browser-based web help

Rohde&Schwarz places great importance on user friendliness. That is why the company invests so much effort in the ergonomic design of user interfaces. Even the most sophisticated GUI, however, is no replacement for well-prepared documentation. For this reason, many instruments offer a context-sensitive help function, which is quickly accessible at any time via a dedicated button. This solution, however, does not work for instruments with only a small display or none at all. This is where web help is a convenient alternative to the available paper and PDF files. Web help provides the complete instrument documentation in a structured HTML format with index and search functions. If web help is available for an instrument, it can be accessed in the download area of the relevant product page, but does not need to be downloaded. It runs online, and users can learn every detail of a product with just a few mouse clicks. Just add the address of the homepage to your browser favorites.



First solution for analyzing DOCSIS 3.1 signals

The new data over cable service interface specification (DOCSIS) 3.1 ensures fast data transfer via existing hybrid fiber coax (HFC) cable TV networks. Manufacturers of cable headends, cable modems and network components as well as cable network operators can now take advantage of the R&S®DSA PC analysis software in preparation for the planned rollout of this standard. It works in combination with the R&S®FSW signal and spectrum analyzer, which records signals using OFDM vector signal analysis. The software analyzes recorded I/Q samples and outputs diverse MER values as well as bit and codeword error statistics that comprehensively describe the quality of a DOCSIS 3.1 signal. The R&S®DSA software provides a straightforward graphical display of MER versus subcarriers to allow easy detection of interferers and other negative influences in the transmission channel. The analysis solution is optimized for use in the development of cable TV network components but can also be used for testing entire network segments under lab conditions. This is especially easy when it is coupled with the R&S®CLGD DOCSIS cable load generator presented by Rohde&Schwarz last year.

High-performance, modular storage solution for video post production

Broadcast studio and post production IT environments place high demands on realtime bandwidth and video server reliability. The new R&S®SpycerBox Cell meets these demands in unparalleled fashion. Measuring only one height unit, it boasts 30 SAS or SSD enterprise hard disks with a total capacity of up to 36 Tbyte (continuously adapted to the state of the art) and a transfer rate of 3 Gbyte/s. Easy scalability makes it possible to adjust performance and capacity to customer needs, so that even 8K (UHD 2) video material can be processed. Data is protected by a combination of RAID 1 and RAID 5 or 6, which almost nullifies the possibility of data loss. If a (lossless) disk error does occur, the affected disk can be changed during operation in just a few minutes. This is made possible by a sophisticated design featuring two slide-in disk units to provide convenient access from both the front and rear of the instrument. The fans, power supplies and controllers are also hot-swappable. The R&S®SpycerBox Cell belongs to a tiered family of storage products with a suitable solution for all professional video production needs. For details, see www.dvs.de.

All-in-one innovative antenna system for easy radiomonitoring

The new R&S®AU600 active omnidirectional receiving antenna system is one of a kind on the market. It is designed primarily for regulatory authorities responsible for monitoring the entire VHF and UHF range as well as portions of the SHF spectrum in line with ITU recommendations. An all-in-one solution, the R&S®AU600 handles this task in a way never seen before in this format. The system consists of four separate omnidirectional receiving antennas covered with a weatherproof radome. Weatherproof is meant to be taken quite literally. The radome can withstand wind speeds of up to 275 km/h and is highly wear-resistant in all other respects. Its internal features are even more impressive. The system is designed for horizontally and vertically polarized signals and covers the range from 20 MHz to 8 GHz – an unmatched spectrum for such antennas. Integrated, switchable bandstop filters for critical frequencies such as wireless bands reduce unwanted intermodulation products. The active/passive switchover enables sensitivity adjustments based on the situational requirements so that the antenna can be operated even in the vicinity of powerful transmitters. The system is controlled via the R&S®OSP120/R&S®OSP130 open switch and control platform or manually via LAN interface.

New high-speed scanning direction finder for complex signal scenarios

The R&S®DDF5GTS is the new flagship of the Rohde&Schwarz direction finder family. It sets new standards for speed, accuracy and versatility. The superior features of the direction finder are especially beneficial in demanding signal environments characterized by dense spectrum occupancy, large shares of reflexions and major level differences. The especially fast three-channel architecture and 80 MHz realtime bandwidth for the VHF/UHF/SHF range are the basis for DF scan speeds of up to 60 GHz/s. These speeds also enable detection and direction finding of frequency agile, low probability of intercept signals. Thanks to an independent digital downconverter channel, the R&S®DDF5GTS permits direction finding and reception at the same time. The demodulated signal, for example, can be used to feed a downstream analyzer. As an option, the R&S®DDF5GTS can handle ITU-compliant measurement methods. The direction finder offers a broad range of applications, which is reflected in its large selection of DF antennas. One of many interesting features: a mouse click is all that is needed to switch the antennas between active and passive mode and flexibly adapt to the signal environment at hand.

WLAN traffic offload – bypass for crowded mobile networks

WLAN traffic offload – the rerouting of mobile data traffic to WLAN networks – is an interesting alternative for network operators to cope with the constantly growing data volume. Now that the specification has been completed, test operation for the new feature is the next major obstacle to be taken prior to the official launch. The test systems play a key role, since they have to ensure smooth interoperation of a wide variety of different components used in these complex systems.

It is foreseeable that even the most advanced mobile networks will reach their capacity limits before long. This is mainly due to the increasing consumption of videos via smartphones and tablets. Since the lion's share of the resultant data volume is generated inside buildings, WLANs can be used as economical alternatives and addition to mobile networks, provided that access points are available. The two types of network ideally complement each other. While mobile networks provide comprehensive coverage for mobile services, broadband WLANs reduce the load on mobile networks for indoor applications.

The underlying technology is referred to as WLAN traffic offload; it basically works in combination with any mobile communications standard (GSM, WCDMA, CDMA2000®, LTE, etc.).

The advantages for network operators are obvious. Almost all modern mobile devices have a WLAN interface. The acquisition costs for access points (WLAN access points – WLAN AP) are relatively low. What is more, WLANs use two license-free frequency blocks at 2.4 GHz and 5 GHz within the ISM bands that lie outside those assigned to cellular standards.

Before the launch of WLAN traffic offload, the standardization bodies of 3GPP and IEEE had to expand a number of standardized protocols and procedures.In the following, we will focus on how this feature works with LTE.

Authentication and authorization

When gaining access to the core network of a mobile network operator via WLAN, it must be ensured that access is authorized. As with the cellular standards, this is verified using the SIM card in the mobile device. To avoid having to enter the password and to facilitate a seamless transition, the same procedure is applied as would be used with a secure WLAN AP. A number of protocols has been defined to enable the SIM card data to be automatically compared via WLAN on the network operator's authentication server (extensible authentication protocols – EAP) and incorporated into the diverse cellular standards.

Policy – the rules of the network operators

Network operators can balance the load on their networks using a set of rules, known as policy. For this purpose, mobile devices are for instance informed what WLAN APs are available where and when for the offloading of what data services (audio or video telephony, Internet services, etc.). This makes it easier especially in metropolitan areas to find WLAN APs that are suitable for offloading, and helps smartphones save energy at the same time. The policy is distributed to the mobile devices by the access network discovery and selection function (ANDSF) server via Open Mobile Alliance (OMA) device management, and the subscribers can query the information where necessary. The signal field strength at the WLAN AP is also a key criterion for the use of LTE-to-WLAN traffic offload. The mere presence of a WLAN AP is not sufficient; a specified minimum field strength must be available (Fig. 1). If the required field strength is no longer present, the connection is terminated and the device returns to LTE.

LTE or WLAN?

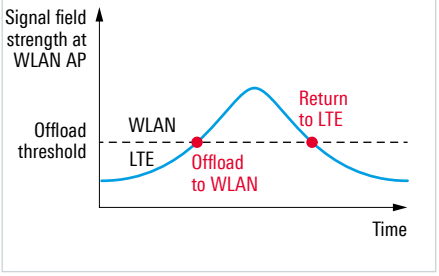


Fig. 1: WLAN traffic offload takes place only if a minimum signal field strength is present at the WLAN access point.

Encryption

Protection against eavesdropping is also required. Let us assume that a mobile subscriber makes a video telephone call with a subscriber in the LTE network via a freely accessible WLAN AP. To ensure data protection, additional encryption is provided by establishing an IPsec tunnel to the smartphone via the WLAN AP starting from the firewall in the LTE core network (Fig. 2).

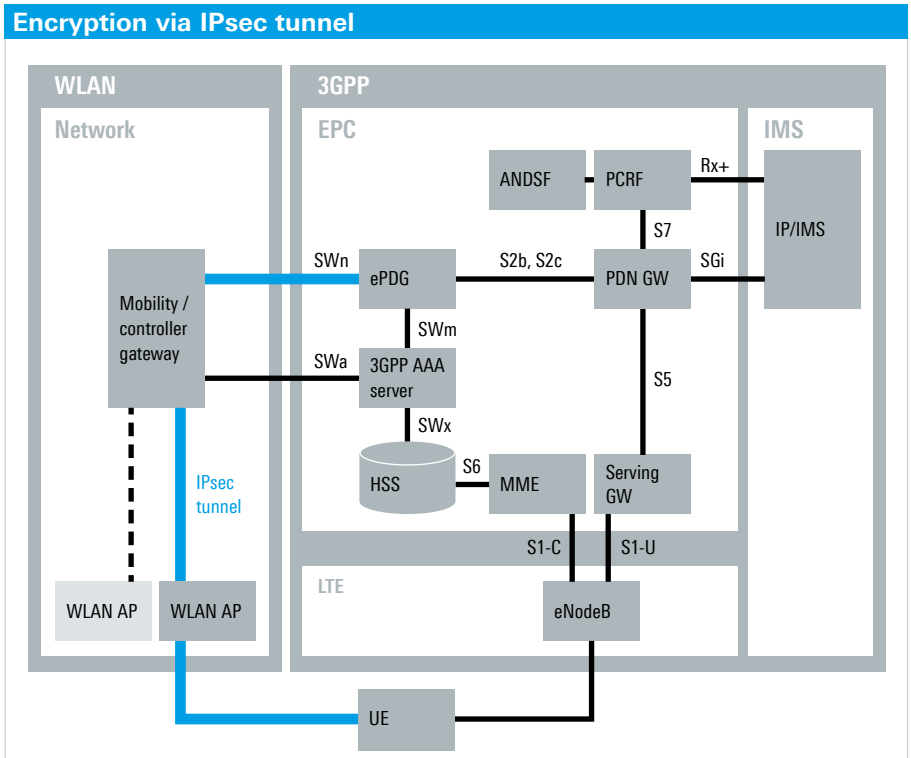


Fig. 2: Protecting communications from unauthorized access: Additional encryption is provided by establishing an IPsec tunnel to the smartphone via the WLAN AP starting from the firewall in the LTE core network.

Automated and accelerated WLAN access

The IEEE 802.11 standardization group has expanded the WLAN access protocol in a new version (Amendment IEEE 802.11u) to include the access network query protocol (ANQP). This protocol automates and accelerates the WLAN access of smartphones to the mobile network. Even before the actual connection with the WLAN AP is made, the smartphone receives information about 3GPP mobile networks or roaming consortia that are accessible via the WLAN AP. The Wi-Fi Alliance issues a certificate (Wi-Fi Hotspot 2.0, also known as Passpoint™) to ensure uniform implementation of the new standard and a maximum degree of interoperability for certified WLAN components.

The IEEE 802.11u amendment added further information to the beacons that a WLAN AP transmits every 100 ms (Fig. 3). Before the connection with the WLAN AP is actually established, which takes place after an authentication and association procedure, the smartphone can use the ANQP to determine via the new generic advertisement service (GAS) whether a WLAN AP can be used for an offload.

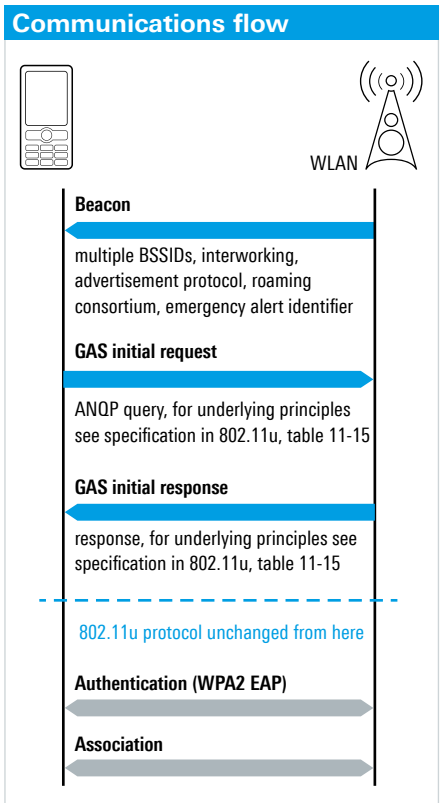


Fig. 3: Additional information in the beacons provides the smartphones with criteria as to whether a WLAN access point is suitable for traffic offload.

Network change – ideally unnoticed by subscriber

An important precondition for the acceptance of WLAN traffic offload is an uninterrupted transition between a mobile network and a WLAN. No interaction or entry should be needed on the part of the subscriber; in the ideal case, the subscriber should not notice the transition at all.

Interruption-free continuation of IP-based services after a mobile cell change or change of the radio access technology (RAT) calls for IP flow mobility. In a world in which communications are based on a client/server architecture, this requires intelligent address management with dynamic IP address assignment. This has been achieved with a number of protocol amendments by 3GPP and enhanced IP addressing.

High demands placed on verification test systems

Comprehensive tests need to be carried out to ensure that all system components are implemented uniformly and in conformity with the standards. The tests focus above all on the mobile device as the pivotal element of the standard amendment. The device under test (DUT), with its particularly critical interface to the user, takes on vital significance in this scenario. In the tests, the DUT is connected with the test setup via both WLAN and LTE.

The test setup for LTE-to-WLAN traffic offload includes the following main components:

- Emulation of an LTE base station, including the LTE core network
- Emulation of a WLAN AP (HotSpot 2.0 or Passpoint)
- Gateway / firewall at the entrance to the LTE core network from the WLAN end
- IMS server for implementing real-world applications such as video or speech telephony
- Message analyzer for recording all protocol messages between the DUT and the WLAN AP and the LTE base station

The individual components are either networked to form a test system or, as with the R&S®CMW500 wideband radio communication tester (Fig. 4), are integrated into a single device. As a general rule, to ensure that tests are reproducible, professional instruments should be used and the number of commercial system components reduced to a minimum.

Fig. 4: The R&S®CMW500 offers, in a single box, all that is needed to carry out the tests required to verify LTE-to-WLAN traffic offload functionality.

Custom solutions for every test requirement

For the integration of the LTE and the WLAN protocol stacks, tests on the lower protocol layers are needed in an early development phase. The required signaling tests can be performed with the R&S®CMW500 and suitable medium level application programming interface (MLAPI) test scenarios.

The R&S®CMW-KF650 option contains a package with roughly 50 test scenarios. They range from establishing a connection with the gateway of the LTE core network (ePDG) to authentication and to changing the IP service from LTE to WLAN and back. The appropriate source code and interface description are also provided, allowing test scenarios to be adapted to individual test requirements.

Using the MLAPI test scenarios offers a very wide range of testing options for the lower protocol layers, but requires expert programming knowledge. An alternative is R&S®CMWcards (R&S®CMW-KT022), a graphical user interface that resembles a card game. This tool makes it possible to compile signaling tests without requiring any specific programming skills (Fig. 5).

To be able to ensure smooth communications in their networks, network operators specify test cases that all devices wishing to use their services must pass. For a number of network operators, Rohde & Schwarz offers options to verify LTE-to-WLAN traffic offload functionality, e.g. R&S®CMW-KO576 and R&S®CMW-KO569.

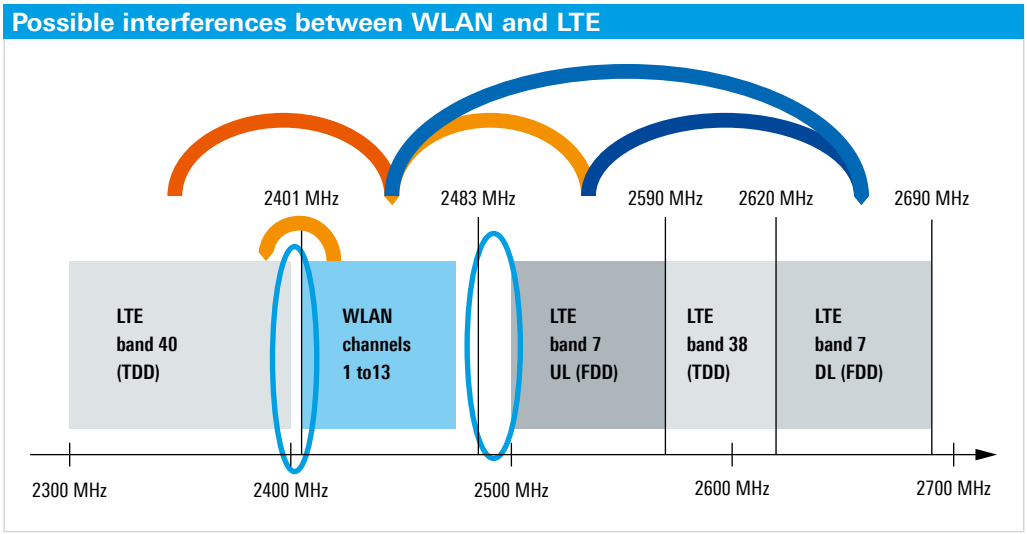
The R&S®CMW500 can be used as a callbox for the development and verification of the WLAN traffic offload feature. In this case, tests range from verifying the DUT's RF characteristics to functional tests, including analysis of the LTE and WLAN protocol messages.

Protocol analysis

The possibility to record LTE and WLAN protocol sequences at the same time is a major bonus when it comes to

Fig. 5: The R&S®CMWcards graphical user interface for the R&S®CMW500 makes it very easy to compile signaling tests in line with the specification.

Fig. 6: Mutual interference between WLAN in the 2.4 GHz ISM band and the LTE bands 7 and 40 is particularly critical.



verifying whether the process is operating according to standard, discovering any errors or optimizing the process. The R&S®CMWmars message analyzer can be used, for example, to verify whether a smartphone has established a Hotspot 2.0 compliant connection with a WLAN AP. The message analyzer records data messages and protocol information across several layers of the ISO OSI model. Filters can be set to record precisely what is required.

Packet loss and performance test

The change of a data service, such as a video telephone call, from LTE to WLAN should take place without interruption wherever possible and with no data packet loss. In addition to a visual check, this can be verified in detail using the message analyzer, which is also a valuable tool for error correction. Moreover, for data services, the minimum requirements as to the stipulated data transmission rates are to be verified under a variety of conditions and operating modes. In general terms, such quality of service (QoS) criteria, including round trip time, form part of comprehensive IP data analyses.

In-device coexistence test

Ensuring operation in conformity with the standards is not the only vital issue when testing WLAN traffic offload functionality. Another focus is on determining interference between two radio standards used at the same time within a mobile device and avoiding this interference as far as possible. In-device coexistence tests are performed to measure interference caused by the LTE transmitter to the WLAN receiver as well as interference caused by the WLAN transmitter to the LTE receiver within a smartphone. To this end, for instance, a smartphone could transmit a video on LTE band 7, while a receiver quality test (PER measurement) is carried out at the same time on WLAN channel 13, which is only 17 MHz away. In the ideal case, no interactions will be detected here, and the PER measurement will provide the same result as would be obtained without an LTE transmission. As can be seen in Fig. 6, possible mutual interference between WLAN in the 2.4 GHz ISM band and the LTE frequency bands 7 and 40 is particularly critical. While mutual interference between LTE band 40 and the WLAN channels needs to be investigated, it can be presumed that the interference caused by the transmission from LTE band 7 only affects WLAN reception.

Summary

Even if full use is made of the data transmission rates that are theoretically possible according to Shannon in today's mobile networks, it is only a matter of time before available capacities are no longer able to meet increased data throughput requirements. Alternative solutions need to be found. WLAN traffic offload is a promising technology that can significantly reduce the load on mobile networks. Following specification and standardization, there will now be a test phase prior to rollout. During this phase, suitable test systems will be needed above all. The R&S®CMW500 makes it possible to realistically simulate the entire system and to carry out all relevant tests.

Thomas A. Kneidel

Future-ready RF shielded boxes for development and mass production

With the best shielding in its class, the new R&S®TS7124 RF shielded box makes reliable and reproducible measurements possible. Available in a manual or automatic version, it ensures that measurement conditions are identical in development and production environments.

The new R&S®TS7124 RF shielded boxes (Fig. 1) can be used to test devices with radio interfaces meeting a variety of standards, such as mobile radio, RFID, Bluetooth®, ZigBee, WiMAX™, NFC, ISM, GPS and WLAN. In doing so, they cover every requirement and application. Whether used as diagnostic tools in product design or as RF test boxes in production scenarios, they are ideal when a shielded, reproducible test environment is needed.

Compact test setup with more volume

With its spacious interior, the R&S®TS7124 RF test box complements the product range, which previously comprised the smaller R&S®TS7121 and R&S®TS7123 RF test boxes. At 19" wide, the new boxes can be rackmounted, offering more space to accommodate DUTs while still retaining a compact test setup.

A key parameter of small RF test boxes is their coupling factor. This is optimal with the R&S®TS7124 RF test boxes, since there is sufficient space between the antenna couplers and the DUT.

Excellent shielding effectiveness

In terms of shielding effectiveness, the most important parameter of an RF test box, the R&S®TS7124 RF shielded boxes achieve the exceptionally high value of 80 dB in the 300 MHz to 6 GHz frequency range. They attain this outstanding characteristic thanks to the top-quality absorbers, which are also the reason for the extremely low reflection levels.

Fig. 1: Together with a generator and analyzer, the R&S®TS7124 RF shielded box forms a compact test setup for testing DUTs with radio interfaces meeting a variety of standards (the picture shows a manual test box, an R&S®SMBV100A signal generator and an R&S®FSV spectrum analyzer).

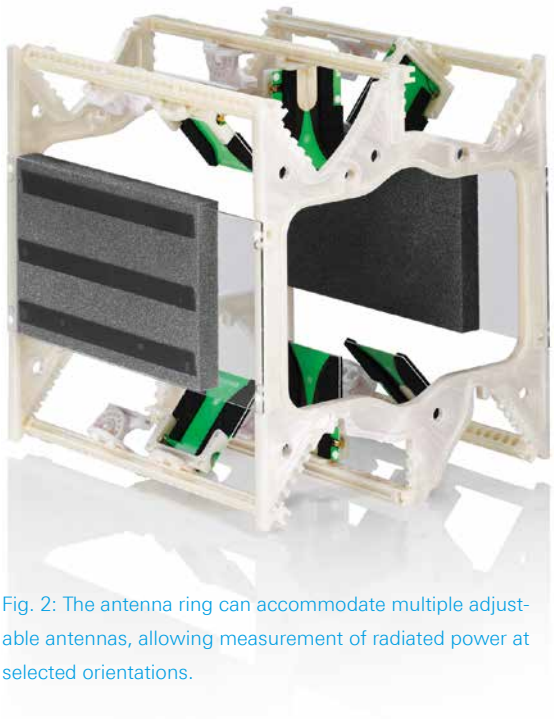


Fig. 2: The antenna ring can accommodate multiple adjustable antennas, allowing measurement of radiated power at selected orientations.

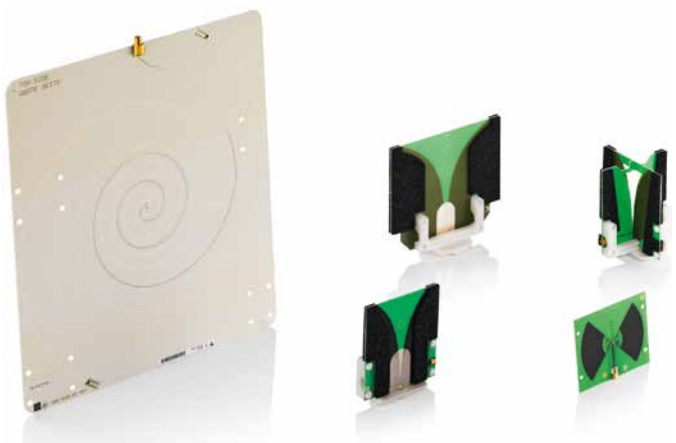


Fig. 3: The RF test box antennas cover every requirement.

Antenna configurations for any application

Reproducible test results are essential for achieving comparable measurements. This is where the antennas play a key role. Different antenna configurations can be used with the R&S®TS7124 RF shielded box. Placing multiple antennas in the box allows customers to create their own radiation patterns and measure radiated power at selected orientations. A newly developed antenna ring to accommodate multiple antennas (Fig. 2) includes brackets that allow the antennas to be positioned as desired. In addition, its material properties have only a negligible impact on RF measurements. As an addition to the spiral broadband antenna, the new Vivaldi antennas (Fig. 3) ensure high gain and excellent repeatability.

Robust for mass production environments

Thanks to the RF test boxes' sturdy construction, they can withstand over a million opening and closing cycles without any noticeable impact on their shielding performance. This is why the automatic model with its high-performance closing-mechanism cylinders and its immunity to shocks performs reliably in mass production environments.

Flexible configuration for any application

The manual version for labs and the automatic version for production environments ensure that measurement conditions are comparable and identical measurement scenarios are used in both instances. Furthermore, the RF test boxes can be controlled remotely via Ethernet or RS-232-C interface. As each application poses different requirements, the RF test boxes have interface panels on the front and rear with shielded feedthroughs that can be configured in a wide variety of ways for Ethernet, USB, fiber-optic and pneumatic connections (Fig. 4).

The R&S®TS7124 RF shielded boxes offer high quality and reliability in lab and production environments at an affordable price. They will be available from the first quarter of 2015.

Iratxe Fernández Antón

Fig. 4: Configurable interface panels (here on the rear) make it possible to implement feedthroughs that meet any need.

World champion: network analyzer with 24 ports

Fig. 1: On the right: The new R&S®ZNBT8 network analyzer with 24 ports for simultaneous multiport measurements maintaining the highest standards of performance. In terms of measurement speed, the R&S®ZNBT8 outperforms even the fast switch matrix based solution delivered by Rohde&Schwarz, which includes the R&S®ZNB and the R&S®ZN-Z84 (shown on the left).

Twenty-four ports in a single network analyzer, each with the performance of a fast two-port analyzer – you won't find that anywhere but at Rohde&Schwarz. This opens up entirely new options in development and production, such as rapid and precise measurements on a DUT with 24 ports in a single sweep or division of ports into groups for simultaneous measurements on multiple DUTs.

Meeting the increased demands made on measurement accuracy and throughput in development and production of multiport components for smartphones and tablets, the R&S®ZNBT8 (Fig. 1) is the first commercially available network analyzer with 24 ports. It covers the frequency range from 9 kHz to 8.5 GHz. It has been designed for use in the development and production of active and passive multiport components, such as for mobile radio and for GPS, WLAN and Bluetooth® modules.

Multiport measurements made easy

The R&S®ZNBT8 has been designed for use in automated systems and can be remotely controlled via GPIB or LAN, for example. Manual control is also possible after connecting a monitor, mouse and keyboard. Users can benefit from the same intuitive user interface as that implemented in the R&S®ZNB network analyzers. Every aspect of the R&S®ZNBT8 software architecture was designed for multiport applications. The user selects measurement quantities such as S-parameters, waves and wave ratios directly via the user interface. All analyzer functions can be accessed in no more than three operating steps, even when testing DUTs with a large number of ports, because the test port indices for S-parameters and power levels can be entered directly (Fig. 2).

Cross-platform compatibility

The R&S®ZNBT8 is based on the same platform as the R&S®ZNB analyzer, with identical user interface and remote control commands. It can also emulate the remote control commands from the R&S®ZVA, R&S®ZVB and R&S®ZVT analyzer families, and can therefore be used to exchange analyzers or to upgrade a test system without making laborious changes to the system software.

True multiport architecture for maximum performance

The uncompromising, true multiport architecture of the R&S®ZNBT8 with one reflectometer per test port delivers excellent RF characteristics. This design does away with electronic switches between the test ports and receivers typically found in switch matrix based multiport systems and eliminates the associated loss which degrades the RF characteristics. Thanks to this elaborate architecture, users can benefit from a wide dynamic range, high output power and very good power handling capacity. Multiport measurements with the R&S®ZNBT8 are highly stable, reproducible and precise.

The base model, with four test ports, can optionally be expanded to include additional ports (Fig. 3) up to a maximum of 24 in order to precisely meet the requirements of any measurement task in a production environment.

Fig. 2: Fast S-parameter selection by direct entry of test port indices.

R&S®ZNBT8 true multiport network analyzer

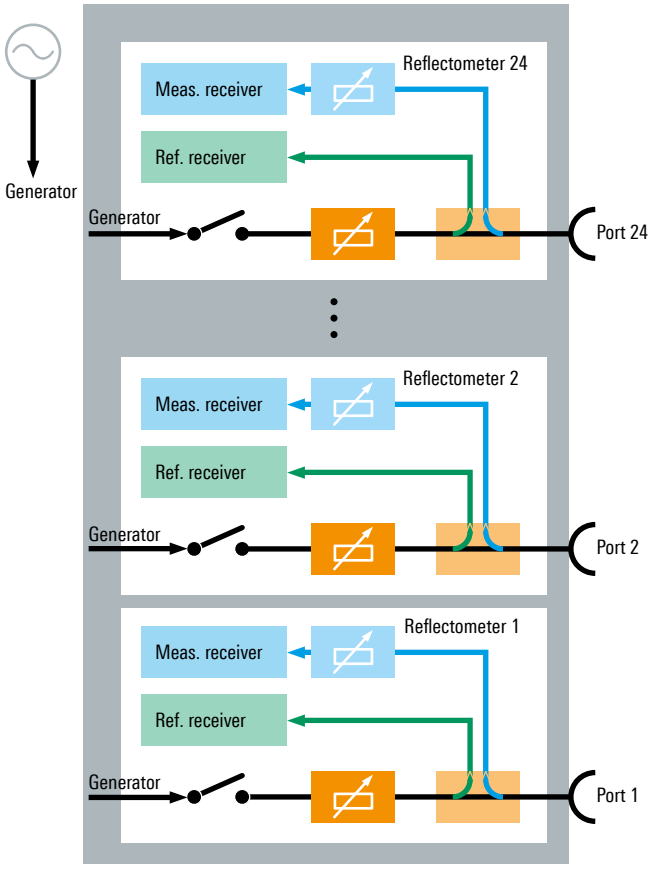


Fig. 3: True multiport architecture is the key to the excellent RF characteristics of the R&S®ZNBT8.

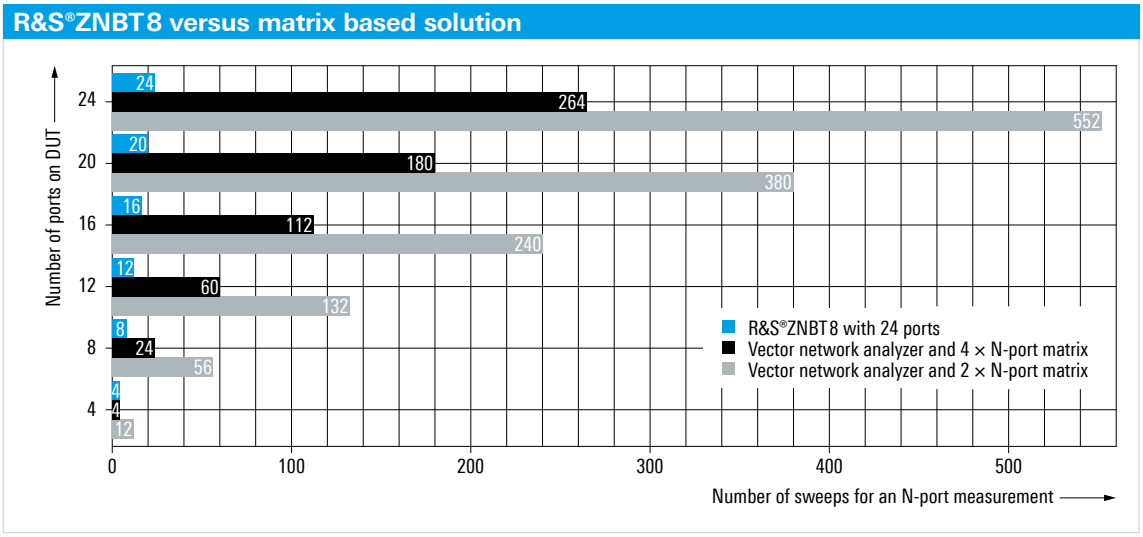


Fig. 4: Measurement time: the R&S®ZNBT8 versus matrix based multiport solutions.

Unrivaled short measurement times

The instrument's multiport architecture makes it possible to perform simultaneous measurements on all ports of a DUT. Data from all ports is captured synchronously and processed in parallel from the RF test port through the IF stage to the display – thereby significantly reducing the measurement time as compared with matrix based multiport systems. For example, only 24 sweeps are needed to measure all S-parameters of a 24-port DUT. A matrix based solution with a four-port network analyzer, by contrast, requires multiple switching operations and a total of 264 sweeps. At a measurement time of e.g. 5 ms per sweep*, a four-port R&S®ZNB network analyzer with a matrix requires 1.3 s. The R&S®ZNBT8, however, is nearly four times faster at just 340 ms. Fig. 4 highlights the gain in speed with the R&S®ZNBT8 as compared with matrix based solutions.

* 201 points, 100 kHz IF bandwidth, start at 800 MHz, stop at 1 GHz.

The R&S®ZNBT8 features a dynamic range 10 dB higher than that of conventional multiport solutions. This means that, for the same dynamic range, the R&S®ZNBT8 delivers an IF bandwidth ten times larger and measures up to ten times faster than conventional setups. For example, for a sweep with 80 dB dynamic range at 1 MHz IF bandwidth covering 201 points, the R&S®ZNBT8 requires no more than 6 ms.

12 network analyzers in a single box measure 12 DUTs in parallel

The architecture of the R&S®ZNBT8 makes it possible to stimulate all DUT ports simultaneously in order to measure multiple paths on a single DUT or to measure multiple DUTs in parallel (Fig. 5). The analyzer organizes its test ports into groups and runs the measurements for each group in parallel. A 24-port R&S®ZNBT8, for example, can simultaneously test six DUTs with four ports each or 12 DUTs with two ports each. This saves not only time and money, but also space in the test setup.

Fig. 5: Measuring multiple DUTs in parallel with the R&S®ZNBT8.

Excellent measurement characteristics

Offering up to 140 dB dynamic range for measurements between all ports, the R&S®ZNBT8 is the best commercially available multiport network analyzer and can also be used for measuring high-blocking DUTs. Its wide, electronically variable output power range from –85 dBm to +13 dBm permits fast analysis of linear and nonlinear amplifier characteristics. Electronic step attenuators in the receiver paths increase the 0.1 dB compression point to +27 dBm. They operate wear-free, providing a particular boost to measurement speed and long instrument life in production environments.

The R&S®ZNBT8 features independent synthesizers for its generators and receivers, enabling it to transmit and receive on different frequencies. This allows the R&S®ZNBT8 to measure harmonics and intermodulation products on amplifiers, or conversion loss on mixers. Wizards guide the user through the required settings and calibrations (Fig. 6). Any external generators that may be needed to deliver multitone signals or provide local oscillator functionality for a mixer are controlled by the R&S®ZNBT8 via LAN or GPIB.

Summary

The R&S®ZNBT8 is the world's first network analyzer with 24 test ports. Offering superior accuracy, speed, long-term stability and dynamic range, it outperforms switch matrix based multiport systems when carrying out measurements on active and passive multiport DUTs.

Thilo Bednorz

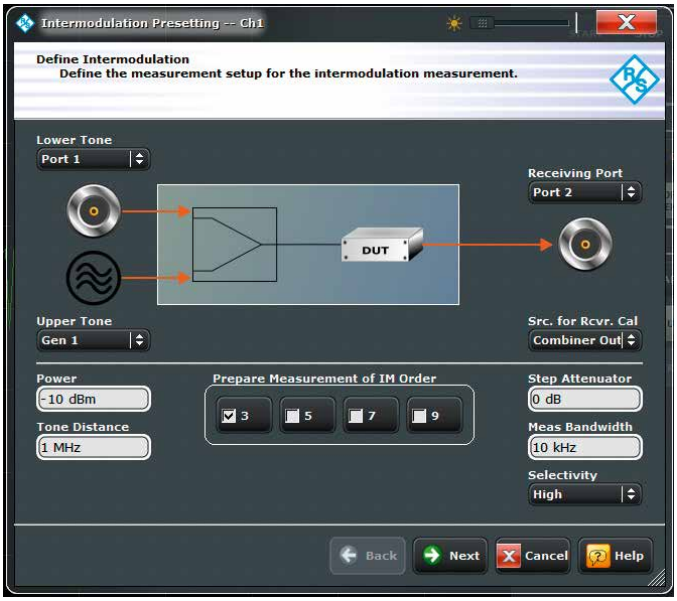
Features for amplifier and mixer measurements

- High output power (typ. +15 dBm) on all ports
- Large power sweep range (typ. 100 dB)
- High 0.1 dB compression point of receivers (typ. > 27 dBm)
- Intermodulation, harmonics and compression measurements
- Absolute power measurements
- Four DC inputs for measuring supply currents and power detector characteristics
- Power added efficiency (PAE) measurements
- Measurement of stability factors
- Determination of Y- and Z-parameters
- Conversion loss measurements on mixers

Features for filter measurements

- Wide dynamic range (up to 140 dB)
- Display of filter parameters, e. g. center frequency, bandwidth, quality factor
- Determination of mixed-mode S-parameters of balanced DUTs
- Virtual matching networks for real-time embedding/deembedding of balanced and unbalanced DUTs
- Impedance conversion
- Time domain analysis with gating function, e. g. for suppressing triple transit echo in SAW filters

Fig. 6: Wizards for intermodulation and mixer measurements.



Cost-efficient network analyzer for uni- and bidirectional measurements

In order to characterize cables, attenuators, antennas or filters, a network analyzer offering basic functionality and solid performance will in many cases be an adequate solution. An affordable, easy-to-operate analyzer such as the R&S®ZND is an attractive choice, especially when it comes to production testing of these components.

The new R&S®ZND vector network analyzer (Fig. 1) is the right instrument for any application requiring a basic, solid-performance network analyzer for carrying out component tests. The instrument's RF performance, including a dynamic range of typically 130 dB, makes it ideal for standard applications. Its attractive price makes it a perfect choice for use in production.

No compromise on operating ease and flexibility

The analyzer's large touchscreen offers plenty of space for displaying traces as well as for the soft panel containing control elements. Users can access all instrument functions in a maximum of three operating steps without getting lost in submenus. Wizards make it quick and simple to set up the instrument for a desired measurement. Context-sensitive online help provides information about the currently selected menu.

The large touchscreen also makes it easy to configure the display as required. Diagrams and traces can be arranged in any desired position and combination. Traces can be moved between diagrams and represented in a way that best matches the measurement task at hand. Several instrument setups can be loaded into RAM and are available simultaneously on the R&S®ZND. The user simply touches or clicks a tab to select the desired setup. This saves time and makes result presentation clear and concise, since only the diagrams actually needed are displayed.

Fig. 1: The new R&S®ZND vector network analyzer has two ports. In its basic configuration, the instrument enables unidirectional measurements from 100 kHz to 4.5 GHz.

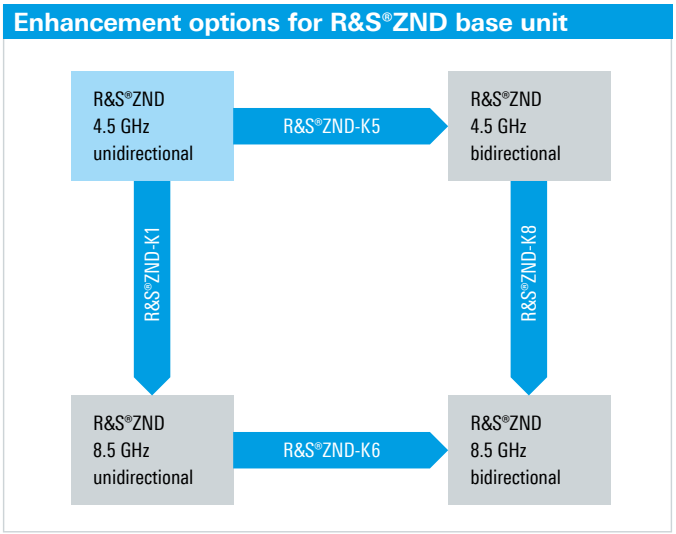


Fig. 2: The unidirectional base unit can be upgraded to provide a higher frequency range and to enable bidirectional measurements.

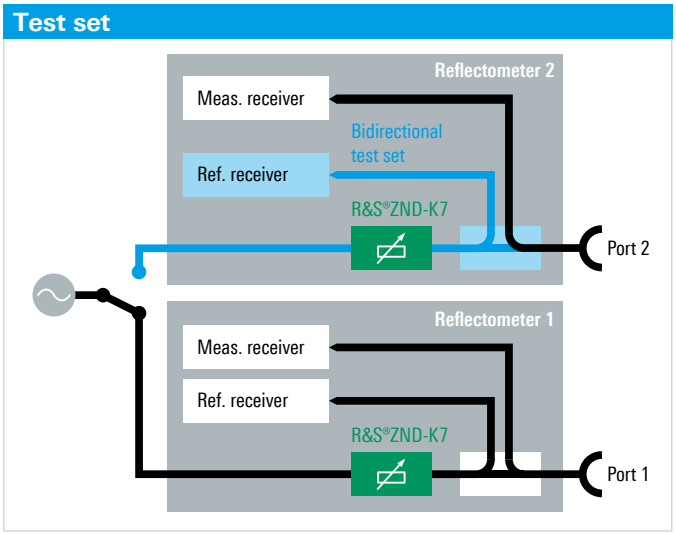


Fig. 3: The unidirectional test set can be upgraded to a bidirectional test set.

Upgradable to meet future requirements

Requirements placed on test equipment may vary over time. Expanding test equipment functionality with software options is the customary approach in order to keep pace with changing requirements. The R&S®ZND adopts a new direction. Its hardware can be subsequently upgraded to provide an extended frequency range and to enable bidirectional instead of unidirectional measurements. In this way, the R&S®ZND can easily accommodate future or changing requirements (Fig. 2).

In its basic configuration, the R&S®ZND contains a unidirectional test set with a frequency range from 100 kHz to 4.5 GHz. The unidirectional base unit is equipped with a reference plus a measurement receiver at port 1 and a measurement receiver at port 2, allowing S_{11} and S_{21} to be measured. It can be upgraded to a full test set containing a reference and a measurement receiver at each port (Fig. 3). In this configuration, the analyzer can measure all four S-parameters (S_{11}, S_{21}, S_{12}, S_{22}). In addition, the frequency range can be extended from 4.5 GHz to 8.5 GHz for the unidirectional as well as the bidirectional test set.

Versatile calibration capabilities

The R&S®ZND can be calibrated using either manual calibration kits or calibration units for automated calibration. All manual calibration kits from Rohde&Schwarz can be used. For unidirectional configurations, users can perform normalization (transmission and reflection), full one-port calibration (open, short, match) or a combination of the two (one-path two-port). Bidirectional configurations support further calibration methods, e.g. TOSM and TRL.

Important standard functions for component testing

Time domain analysis is a key capability when it comes to cable and filter testing. The function is optionally available for the R&S®ZND. It allows, for example, identifying cable faults and eliminating the influence of connectors by means of gating, including transformation back into the frequency domain. The frequency range of the R&S®ZND can be virtually extended. This yields higher time resolution, making it possible to distinguish between closely spaced cable faults.

The power sweep range can be optionally extended from 28 dB to 48 dB to enable compression measurements on amplifiers. The time domain analysis and the extended power range function are both enabled with a key code.

Ready for use in production environments

The R&S®ZND can be remotely controlled via LAN or GPIB and integrated into RF component production test systems. A dedicated I/O interface enables control of a parts handler in systems with fully automated test equipment (ATE). Via the user control port, digital signals can be output to synchronize external components in a test setup to the analyzer's internal test sequences.

The R&S®ZND is based on the same firmware as the R&S®ZNB and R&S®ZNC network analyzers. As a result, existing software routines can be continued to be used. Plus, in order to accommodate more stringent T&M requirements, the R&S®ZND can be replaced with an analyzer from the R&S®ZNB family without any modification to the instrument software.

Andreas Henkel

Strong team for production

The R&S®SGT100A vector signal generator and the screenless R&S®FPS signal and spectrum analyzer form an exceptionally compact package. Optimized for use in production environments and test systems, they help to ensure high throughput during testing of RF components and devices, including mobile radio base stations.

Specialized instruments for use in production combine three key characteristics: They take up very little space in typically jam-packed racks; they generate and analyze complex signals very fast, increasing the production throughput in spite of the wide range of tests to be performed on state-of-the-art components; they make very accurate and reproducible measurements so that DUTs can be reliably and correctly assessed.

These three key characteristics were the driving force behind the development of the two specialized instruments for production, the R&S®SGT100A vector signal generator and the R&S®FPS signal and spectrum analyzer (Fig. 1). Together they represent a versatile mini-system for measurements of RF components, in particular those used for wireless communications. They integrate perfectly into the production environment as well as into automated test systems.

Fig. 1: Requiring very little space in test systems: the R&S®SGT100A vector signal generator (top) and the R&S®FPS signal and spectrum analyzer.

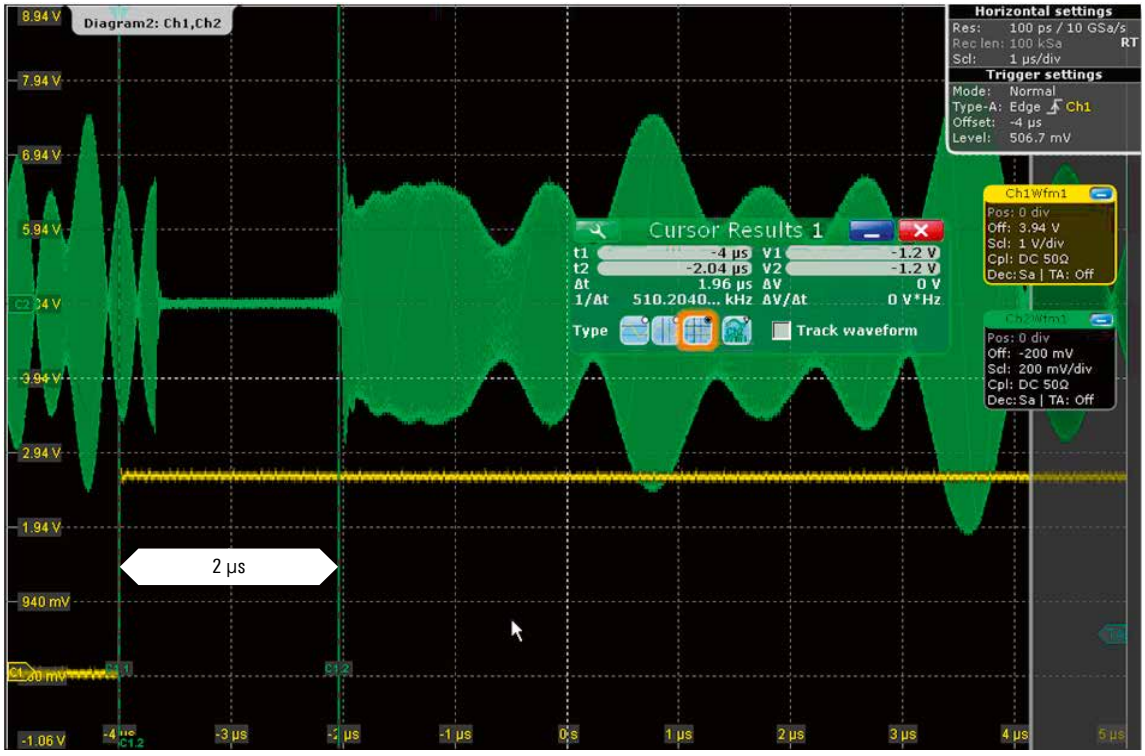


Fig. 2: The R&S®SGT100A takes just 2 µs to switch between two signals in multisegment waveform mode (WDCMA test signal at a sampling rate of 30.72 MHz).

Signal generation in its most compact form

The R&S®SGT100A is the first vector signal generator with integrated baseband whose housing requires only one height unit and ½ 19" width. This compact design makes the generator ideal for use in automated test environments where the racks are usually crammed full. Conventional signal generators with a full 19" width generally require two height units, whereas four R&S®SGT100A instruments can be housed in the same space.

Though small, the R&S®SGT100A does not skimp on performance. With RF frequencies up to 6 GHz and an I/Q modulation bandwidth up to 160 MHz (RF), the R&S®SGT100A supports all common mobile radio standards. It generates good-quality, modulated signals with low EVM and is therefore a reliable reference source for correct analysis of DUTs.

Its typical maximum output level of +22 dBm compensates for any attenuation resulting from cable loss or switching matrices. This makes an external amplifier unnecessary in many instances.

The perfect partner: R&S®FPS signal and spectrum analyzer

The R&S®FPS boasts similarly excellent characteristics that have been optimized for production. At only two height units, it is half the height of conventional instruments, while providing the full functionality of a signal and spectrum analyzer. Five models are available, providing upper frequency limits of 4 / 7 / 13 / 30 / 40 GHz.

The R&S®FPS features high measurement speed, 160 MHz analysis bandwidth and numerous measurement applications for analog modulation as well as for all essential mobile radio and wireless standards. It is up to five times faster than comparable analyzers and offers measurement routines that are optimized for high speed and large data throughput – exceptional advantages in production environments.

An external monitor or remote operation via a PC ensure full access to all instrument functionality via the user interface. This simplifies development of remote control programs or troubleshooting during operation.

Cost of ownership – the most significant factor during production

With a power consumption of just 65 W, the R&S®SGT100A reduces the overall cost of ownership thanks to its low current drain and correspondingly low heat dissipation. This decreases cooling costs for the entire test system.

Costs are closely linked to an instrument's operating time. One of the key points of focus during the development of the generator lay in ensuring the greatest possible system uptime. For the R&S®SGT100A, this was achieved by extending the recommended calibration interval to three years. And if a defect does show up, the modular design makes the instrument fast and cost-effective to repair.

Changing requirements in production can be addressed simply by enabling software options on the generator. For example, a key code can be entered on site to quickly extend the frequency range from 3 GHz to 6 GHz.

Both instruments are optimized for fast tests

Short switchover times

Tests on state-of-the-art DUTs require a wide variety of signals that must be made available as quickly as possible. The R&S®SGT100A was designed with this in mind. Its memory depth of up to 1 Gsample permits playback of long signal sequences or storage of many different signals, minimizing the switchover times (Fig. 2). For example, in multisegment waveform mode, up to 100 different test signals are available within microseconds.

PCIe interfaces for fast remote control

For communications with the control PC or with test instruments, the R&S®SGT100A uses the standard USB and Gbit LAN interfaces, while the R&S®FPS also uses GPIB. For automated tests, however, any time that can be saved when switching the frequency or amplitude is of tremendous significance. This is why both instruments also have a PCIe interface, as used on PCs. With this interface, key remote control commands can directly access the instrument-internal architecture, without needing to be routed through an SCPI interpreter. As a result, the commands are performed exceptionally fast – at three times the speed of communications using SCPI command sets – as proven e. g. by the very short setting times on the R&S®SGT100A for frequency or amplitude changes (Fig. 3).

High measurement accuracy and speed

The R&S®FPS features an absolute measurement uncertainty of < 0.4 dB up to 7 GHz – a considerably better value than that exhibited by comparable modular systems. Of greater importance is

Level setting times

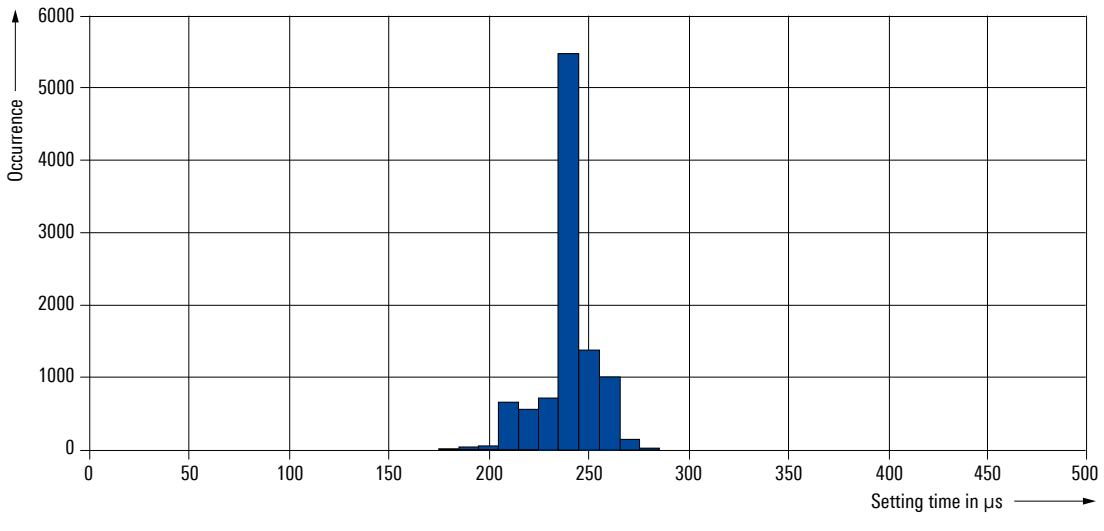
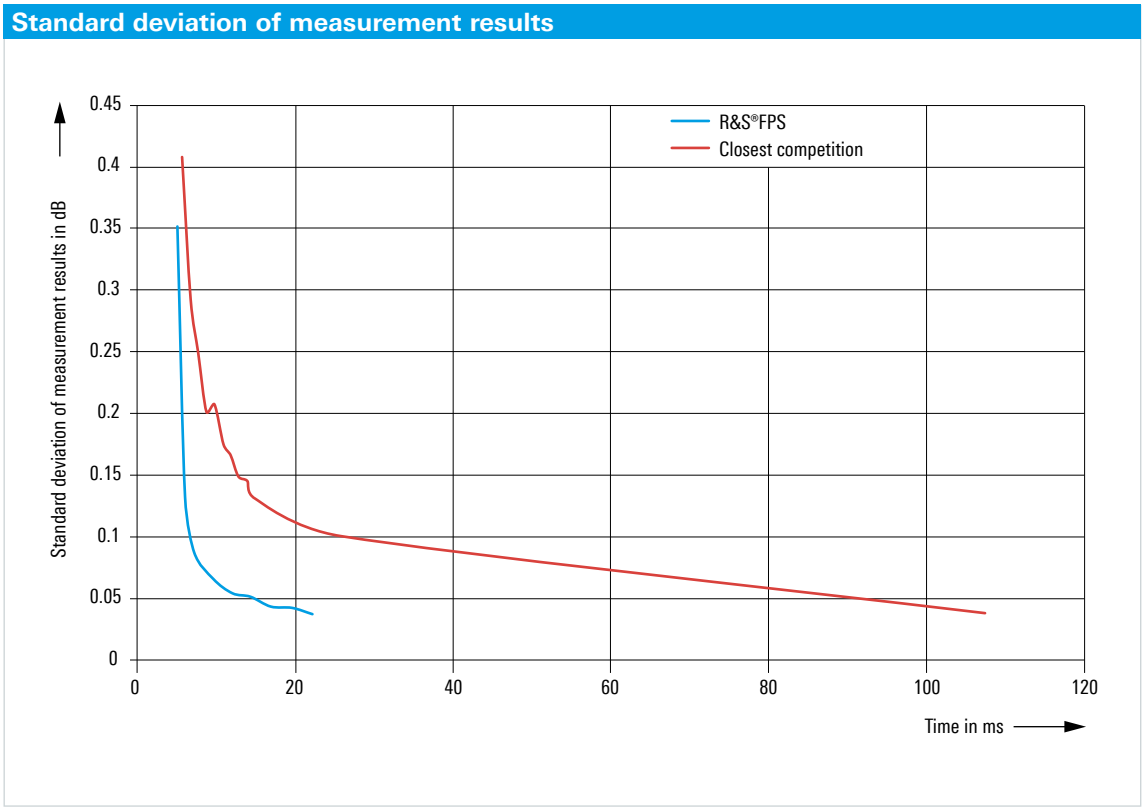


Fig. 3: Histogram of level setting times via the PCIe interface on the R&S®SGT100A (I/Q modulation via the integrated baseband generator; setting characteristic: AUTO).

Fig. 4: Standard deviation of the results of a power measurement on a WCDMA signal as a function of measurement time.



the reproducibility of the measurements, as they directly affect the production yields. The yield could be increased through longer test times, but that would negatively affect throughput. No compromises are necessary with the R&S®FPS because its high measurement accuracy and good reproducibility ensure a large production throughput.

Its fast measurement speed also contributes to a high production throughput. For example, the analyzer can measure the level of a WCDMA signal with a standard deviation of < 0.01 dB and transmit the results to the control PC in under 15 ms. That is five times faster than the competition. The same is true for adjacent channel measurements: The R&S®FPS offers a reproducibility of 0.1 dB, making it five times faster than the closest competitor (Fig. 4).

Simultaneous analysis of signals from multiple mobile radio standards

With the increasing complexity of modern communications scenarios, a conventional RF connection transmits signals from a variety of mobile radio standards. When measuring signal quality and signal interactions, analyzers face major challenges with respect both to speed and the ability to analyze different signals simultaneously. The R&S®FPS handles the challenges with ease. With its multistandard analysis function and an analysis bandwidth of 160 MHz, it can measure signals of different standards (GSM, WCDMA, LTE, etc.) at different frequencies simultaneously. That is also an advantage when optimizing sequences in automated test systems, such as when the time required to configure a DUT represents a significant amount of the overall test time. In these cases, the R&S®FPS can analyze the acquired data while the DUT is already being configured for the next measurement.

Summary

The R&S®SGT vector signal generator and the R&S®FPS signal and spectrum analyzer are measuring instruments for use in automated test systems for production or verification. They were designed to provide fast and accurate measurements in a compact unit with low cost of ownership.

Johan Nilsson; Matthias Weilhammer

Fig. 1: See more with up to 16-bit vertical resolution. The R&S®RTO-K17 and R&S®RTE-K17 high definition software options allow for a 256-fold increase in the oscilloscopes' vertical resolution.

High definition oscilloscopes: 16-bit vertical resolution for signal analysis

The high definition mode increases the vertical resolution of the R&S®RTO and R&S®RTE oscilloscopes to up to 16 bit – a 256-fold improvement over 8-bit standard mode. Waveforms are sharper and show details that would otherwise be masked by noise. Users benefit from even more precise analysis results.

Increased resolution for precise measurement of small signal amplitudes

High definition (HD) refers to the capability of the R&S®RTO and R&S®RTE oscilloscopes (Fig. 1) to be used for applications requiring high vertical resolution. This is especially the case when low-voltage components of a signal that also exhibits high-voltage components need to be analyzed in detail. One example is the measurement of switched-mode power supplies, where voltages across the switching device must be determined during the off and on times within the same acquisition. Because the voltage variations can be several hundred volts, a high resolution of more than 8 bit is required for precise measurement of small voltage components. Another example is amplitude-modulated signals with low modulation index as can be found in radar applications.

R&S®RTO	
Filter	**Resolution**
Inactive	8 bit
1 GHz	10 bit
500 MHz	12 bit
300 MHz	12 bit
200 MHz	13 bit
100 MHz	14 bit
50 MHz to 10 kHz	16 bit

R&S®RTE	
Filter	**Resolution**
Inactive	8 bit
500 MHz	10 bit
300 MHz	11 bit
200 MHz	12 bit
100 MHz	13 bit
50 MHz	14 bit
30 MHz to 10 kHz	16 bit

Fig. 2: Vertical resolution as a function of filter bandwidth.

HD mode offers up to 16-bit vertical resolution

The R&S®RTO-K17 and R&S®RTE-K17 high definition options increase the vertical resolution of Rohde&Schwarz oscilloscopes up to 16 bit by applying a digital lowpass filter to the signal after it passes through the A/D converter. The filter reduces the noise, which increases the signal-to-noise ratio and improves resolution (Fig. 3). The bandwidth of the lowpass filter can be flexibly adjusted from 10 kHz to 1 GHz to match the characteristics of the applied signal. The lower the filter bandwidth, the higher the resolution and noise suppression (Fig. 2).

The increase in resolution leads to sharper waveforms, showing signal details that would otherwise be masked by noise (Fig. 4). To be able to analyze these signals in detail, the input sensitivity of the oscilloscopes has been increased to

Noise of the R&S®RTO1044 oscilloscope

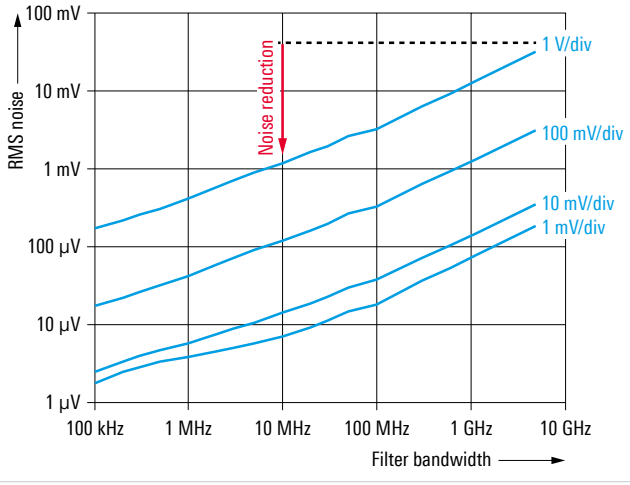


Fig. 3: Noise of the R&S®RTO1044 oscilloscope (4 GHz model) as a function of the set filter bandwidth of the R&S®RTO-K17 high definition option. Reducing the noise increases the signal-to-noise ratio, which improves resolution.

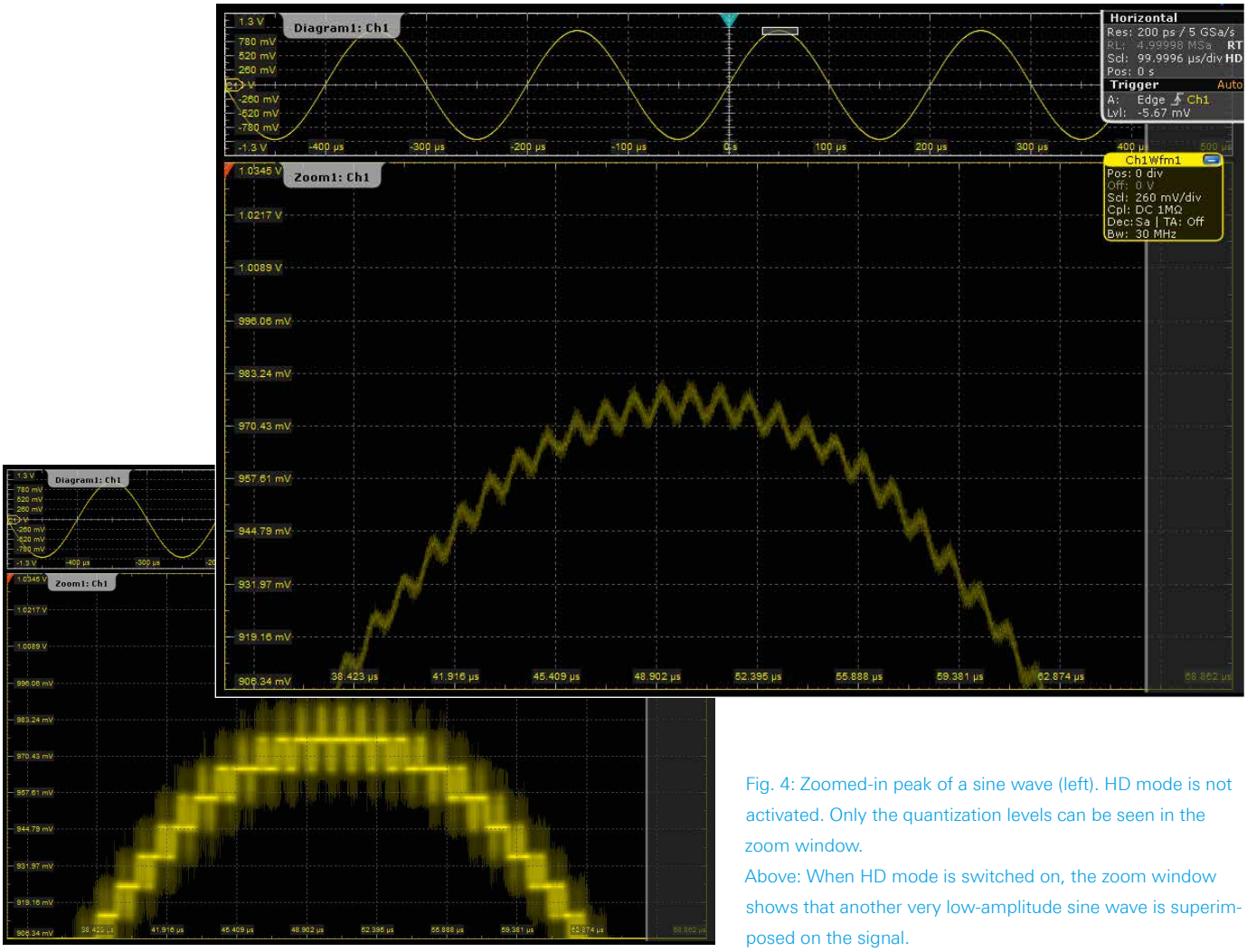


Fig. 4: Zoomed-in peak of a sine wave (left). HD mode is not activated. Only the quantization levels can be seen in the zoom window.
Above: When HD mode is switched on, the zoom window shows that another very low-amplitude sine wave is superimposed on the signal.

Fig. 5: The high sensitivity of the digital trigger in this example makes it possible to trigger on signal overshoots of less than 9 mV. At a vertical scale of 140 mV/div, this corresponds to only a fraction of one display division.

500 µV/div. The R&S®RTO and R&S®RTE oscilloscopes have an excellent dynamic range and measurement accuracy thanks to their low-noise frontend and highly accurate single-core A/D converter. Switching on HD mode allows users to benefit from even more precise measurement results.

HD mode offers crucial advantages over high resolution decimation (also supported by Rohde&Schwarz oscilloscopes). Users know exactly what signal bandwidth is available due to explicit lowpass filtering, and there are no unexpected aliasing effects. Since HD mode is not based on decimation, the increase in resolution is not accompanied by a reduction in the sampling rate. When HD mode is switched on, the full sampling rate can be used, ensuring the best possible time resolution. Moreover, HD mode permits users to trigger on the signals with increased resolution, whereas high resolution decimation only takes place after the trigger unit.

Realtime triggering on smallest signal details

The success of triggering on the smallest details in HD mode for more thorough examination depends greatly on the capabilities of the trigger system in use. The digital trigger system from Rohde&Schwarz has the sensitivity required to benefit from the high-resolution signal. Each of the up to 16-bit samples is checked against the trigger condition and can initiate a trigger. This means that the oscilloscopes are able to trigger on even the smallest signal amplitudes and isolate relevant signal events (Fig. 5).

High acquisition rate and full functionality for fast measurement results

Switching on HD mode does not compromise measurement speed or functions. Since the lowpass filtering, which improves resolution and noise suppression, is implemented in realtime in the oscilloscope's ASIC, the acquisition and processing rates remain high. The oscilloscope enables smooth operation, and measurement results are available quickly. All analysis tools, such as automatic measurements, FFT analysis and history mode, can also be used in high definition mode.

Sylvia Reitz

Analyzing long signal sequences with the R&S®RTM2000 oscilloscope

The R&S®RTM-K15 history and segmented memory option is ideal for analyzing signals with long communications pauses. The large segmented acquisition memory of 460 Msample is unique in this oscilloscope class and permits long observation periods, for example when debugging serial buses. The integrated history function permits perfectly timed access to any waveform for analysis.

The challenge: finding sporadic errors with oscilloscopes

Sporadic errors often cost valuable time during the development of new products. Debugging protocol-based buses or other pulsed signals is especially difficult and time-consuming because the communications pauses between the individual data packets can be very long (❶ in Fig. 1). In this example, a sensor transmits a protocol packet containing values over the I²C bus every 10 ms for a duration of 400 µs. The errors that occur during this time are to be analyzed. Oscilloscopes are the instrument of choice for debugging the I²C interface. Most oscilloscopes in this class – with the exception of the R&S®RTM2000 – have only a very limited memory. The oscilloscope memory typically limits the record length for analyzing errors and their history to a few milliseconds.

Disadvantages of single-shot acquisition

Normally, the user acquires long recordings in two steps. The first step is to select a sufficiently long timebase, e. g. 20 ms/div, which in the example corresponds to 19 protocol packets from the sensor under test. The second step is to trigger a single-shot acquisition in order to prevent the acquired signal from being overwritten by the next trigger event.

This process has two decisive disadvantages that make the analysis of sporadic errors especially difficult for pulsed signals with steep edges. On the one hand, the large percentage of irrelevant inactivity means that only a few of the protocol packets of interest are acquired (❷ in Fig. 1). Another disadvantage arises from the necessary limitation of the sampling rate, as seen in the next example. At 2 Msample memory and 2 Gsample/s sampling rate, the maximum record length is only one millisecond, which is just enough for one protocol packet from the sensor under test. The subsequent packet would be missed because of the 10 ms communications pause. The desired 200 ms, i. e. 20 ms/div for 10 divisions, can be acquired only by reducing the sampling rate to 10 Msample/s – which is actually too low for stable decoding of the I²C signal, never mind for finding signal integrity errors. This is why this type of analysis requires an oscilloscope with deep memory, such as that offered by the R&S®RTM2000 bench oscilloscope (Fig. 2). With the standard 20 Msample, the sampling rate in this example can be increased to 100 Msample/s, permitting seamless recording and analysis of all 19 protocol packets. This setup makes it possible to analyze signal errors, but the probability of isolating the error is low because only very few packets are recorded. A much better solution is the new R&S®RTM-K15 history and segmented memory option.

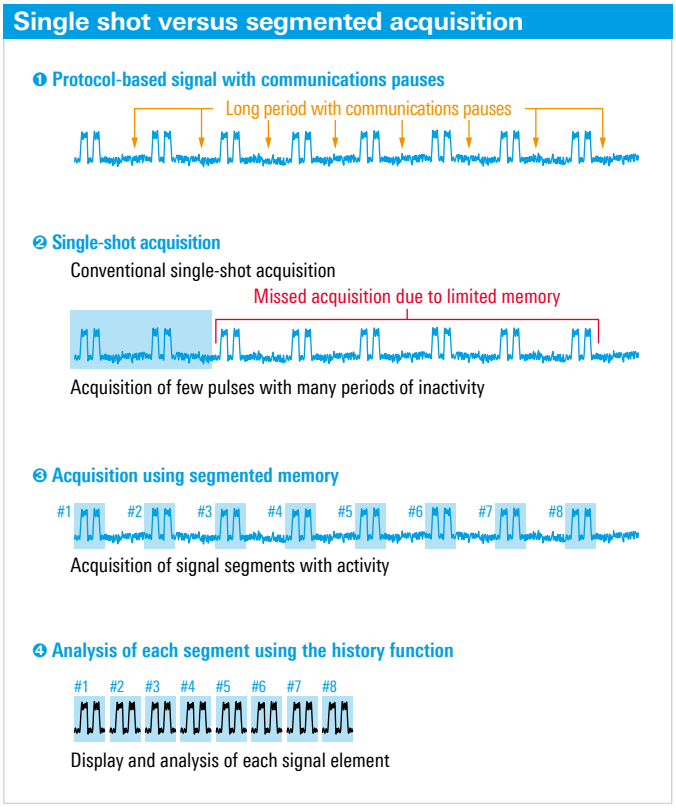


Fig. 1: Examples for acquiring and analyzing short-term signals from a sensor.

Advantages of segmented acquisition

A smarter approach limits the acquisition to only the data packets. This requires the definition of a dedicated protocol trigger, for example for triggering on the start symbol of the I²C bus. Fig. 3 provides an overview of the protocols supported by the R&S®RTM2000 oscilloscope.

The R&S®RTM-K15 history and segmented memory option supports debugging in two significant ways. It expands the available memory for analog and digital channels to 460 Msample, which is unmatched in this oscilloscope class. In addition, it divides the memory into equally sized segments. The user can modify the number of segments to meet the specific requirements of the task (Fig. 4). The R&S®RTM2000 ensures that the memory is optimally used. For a serial protocol, for example, the maximum packet length in the signal determines the record length. Starting at the trigger point, the signal segment of interest is stored in memory. Time periods without activity are not acquired (❸ in Fig. 1). An important detail for subsequent analysis: the R&S®RTM2000 saves the precise time of the trigger event at a resolution of 3.2 ns.

For the sensor used in this example, the desired record length is 500 µs per segment: 400 µs for the protocol packet, plus 50 µs each for a buffer before and after the event (Fig. 5). This 500 µs along with a segment length of 10 ksample – corresponding to a sampling rate of 20 Msample/s – makes it possible to achieve stable decoding. With the 45000 available segments, it is possible to record eight minutes of communications. "Protocol Start" is used as the trigger criterion for the serial protocol trigger.

Application	Serial standard	Option
Embedded	I²C / SPI	R&S®RTM-K1
	UART / RS-232 / RS-422 / RS-485	R&S®RTM-K2
Automotive and industry	CAN / LIN	R&S®RTM-K3
Audio	I²S / LJ / RJ / TDM	R&S®RTM-K5
Aerospace and defense	MIL-STD-1553	R&S®RTM-K6
	ARINC-429	R&S®RTM-K7

Fig. 3: Options for triggering and decoding.

Record length	Number of segments
20 Msample	23
10 Msample	46
5 Msample	92
2 Msample	230
1 Msample	460
500 ksample	921
200 ksample	2301
100 ksample	4591
50 ksample	9183
20 ksample	22500
10 ksample	45000

Fig. 4: R&S®RTM2000 segmented memory setting.

Fig. 2: Providing time, frequency, protocol and logic analysis plus a digital voltmeter in a single box, the R&S®RTM2000 is ideal for the development, production and servicing of embedded hardware.

Fig. 5: Decoded I²C signal with analog waveforms and acquisition table. The history function is accessed via the bottom menu.

History mode for analysis

Thanks to the R&S®RTM-K15 history mode, all acquisitions can be accessed at a later time. All oscilloscope tools, including the QuickMeas function, mask tests and protocol decoding, are available for analysis (❹ in Fig. 1).

The mask test that comes as standard in the R&S®RTM2000 is ideal for finding a deviation in the clock signal from the sensor under test, for example. Just a few keystrokes are needed to generate the mask on the R&S®RTM2000 from a correctly transmitted clock signal, or it can be loaded from a USB flash drive. The history function's play command (Fig. 5, bottom) automatically starts a comparison of all 45000 segments against the mask. Violations are statistically evaluated and, if enabled, the test is stopped and the segment displayed when a mask is violated.

The acquisition table that lists all segments and their timestamps (Fig. 5, bottom left) permits fast access to the acquired segments positioned before the faulty segment. This makes it possible to isolate the effects of preceding signals quickly. Periodicities can be uncovered by means of a subsequent analysis of the trigger times for all faulty segments. All segments can be saved to a PC for offline analysis.

And if an error was detected during standard operation and viewing the history would provide the necessary information for the solution? Not a problem: When equipped with the R&S®RTM-K15 option, the R&S®RTM2000 always saves all waveforms in segments with a timestamp so they are available via the history function at any time.

Summary

The serial triggering and decoding options together with the R&S®RTM-K15 option provide major analysis advantages. The large memory of 460 Msample (unmatched in this class) and flexible segmentation expand the effective record length from milliseconds to minutes or even longer.

The history function makes it possible to view and analyze all acquisitions at a later time. Timestamps with a resolution of 3.2 ns permit precise time correlation of signal events. Individual marked segments can be selected in the acquisition table for display. Alternatively, the history function can be used to automatically play back all segments. All R&S®RTM2000 oscilloscope tools are available for analyzing the faulty segment, including the QuickMeas function, mask tests, FFT and protocol decoding for analyzing the signal.

Philipp Weigell

Recording and using live spectra

Simulated RF signals are ideal for most test purposes because they can be set as needed and reproduced under controlled conditions. But sometimes "real" signals are needed for reproducible and reliable results. These are now supplied by the R&S®IQR I/Q data recorder at a high data rate over two channels.

I/Q data recorders bring live spectra into the lab

Today's vector signal generators supply any RF signal at the press of a button, configurable down to the finest detail. However, so many potential complications are involved in real-world scenarios that it seems advisable to use real signals during the development of top sellers such as mobile phones and satellite navigation systems in order to cover all eventualities. To do this, the appropriate signals must be recorded at typical locations identified as critical and then brought into the lab (field to lab or F2L). I/Q data recorders such as the R&S®IQR (Fig. 1) are used for this purpose. The instrument does not record the radio spectrum itself, but rather the digital modulation (baseband) that generates the spectrum in the form of I/Q data provided in real time by an upstream RF frontend. In the lab, the data is either exported to a PC for further processing or fed to a vector signal generator, where it is converted back into an RF spectrum. The R&S®IQR has been performing these tasks for some time as part of drive test systems. New firmware, faster memory packs and additional options now make the recorder even more versatile.

High-speed recording and replaying

The new high-speed configuration permits recordings of up to 99.5 Msample/s at a modulation bandwidth of just 80 MHz (Fig. 2). This means that the R&S®IQR can handle even broadband radio systems. Another alternative is to split the bandwidth in order to record more RF signals simultaneously (see below). An important criterion for practical applications is the maximum recording time which is based on the data rate, the I/Q resolution and the size of the memory pack. When equipped with a 2 Tbyte SSD, the R&S®IQR records I and Q values at a resolution of 16 bits and offers storage times ranging from 18 hours for a GPS signal at 6 MHz bandwidth to 1.3 hours at the maximum bandwidth (Fig. 3).

Use of the maximum bandwidth requires an appropriate broadband frontend. Rohde&Schwarz offers the R&S®FSW signal and spectrum analyzer for this purpose. The test setup for recording, replaying, analyzing and archiving broadband live signals is rounded out by an R&S®SMBV100A vector signal generator (Fig. 4).

Simultaneous recording and replaying of two spectra

Simultaneous recording and replaying of two spectra makes it possible to test various radio or broadcast services in parallel, including a DVB-T and a DAB transmitter or two satellite navigation systems (GPS, BeiDou or Glonass). In addition, the separate recording of nonadjacent, low-bandwidth spectra significantly reduces the entire required bandwidth as well as the resulting data rate and required storage capacity.

Another intriguing two-channel application is testing the A-GPS functionality (assisted GPS, also applicable for Glonass and BeiDou) on a smartphone. This test involves the simultaneous reception of a GNSS signal and a mobile radio signal. The R&S®IQR can record

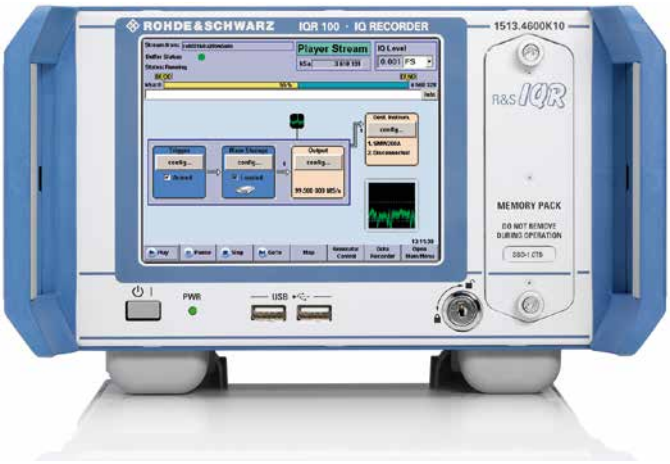


Fig. 1: The R&S®IQR I/Q data recorder is a universal, user-friendly storage medium for I/Q signals.

Correlation between bandwidth and sample rate

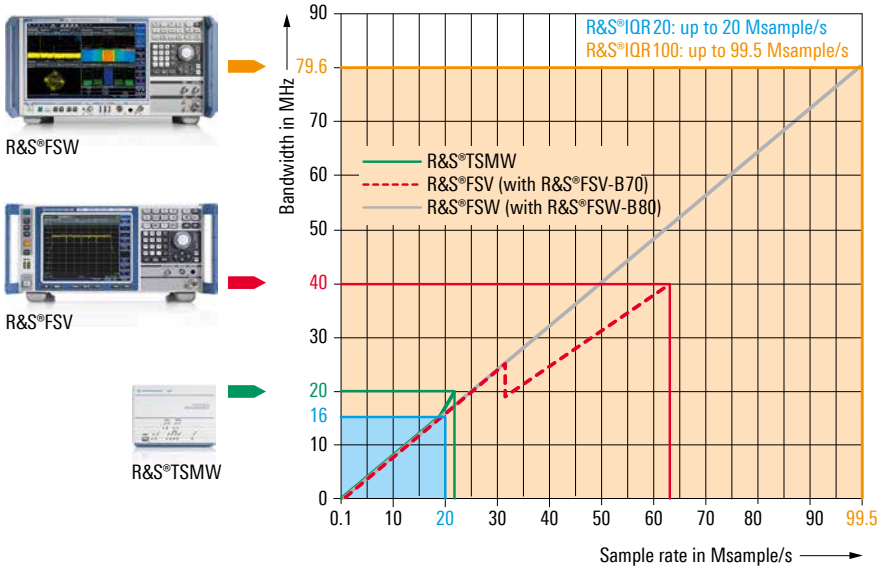


Fig. 2: Sample rates and bandwidths attainable with different frontends and R&S®IQR models.

Recording time as a function of data rate

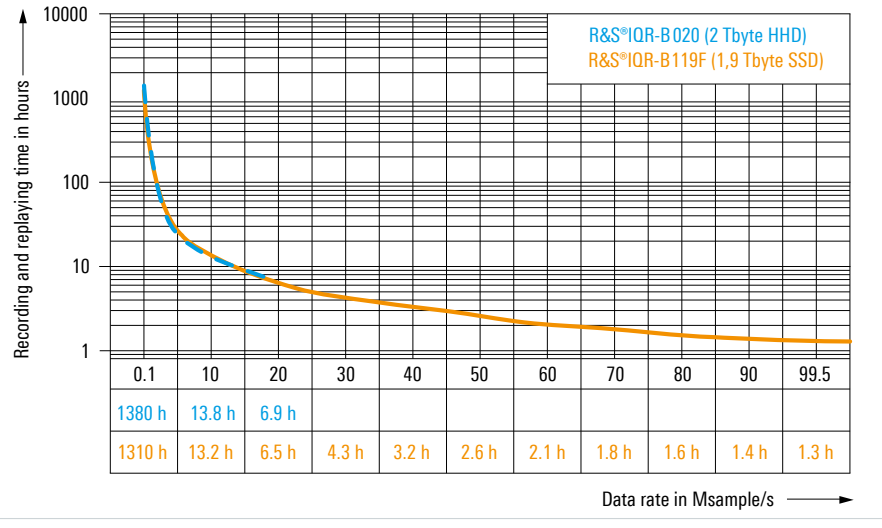


Fig. 3: For high-speed recording, the R&S®IQR must be equipped with an SSD.

Two typical setups

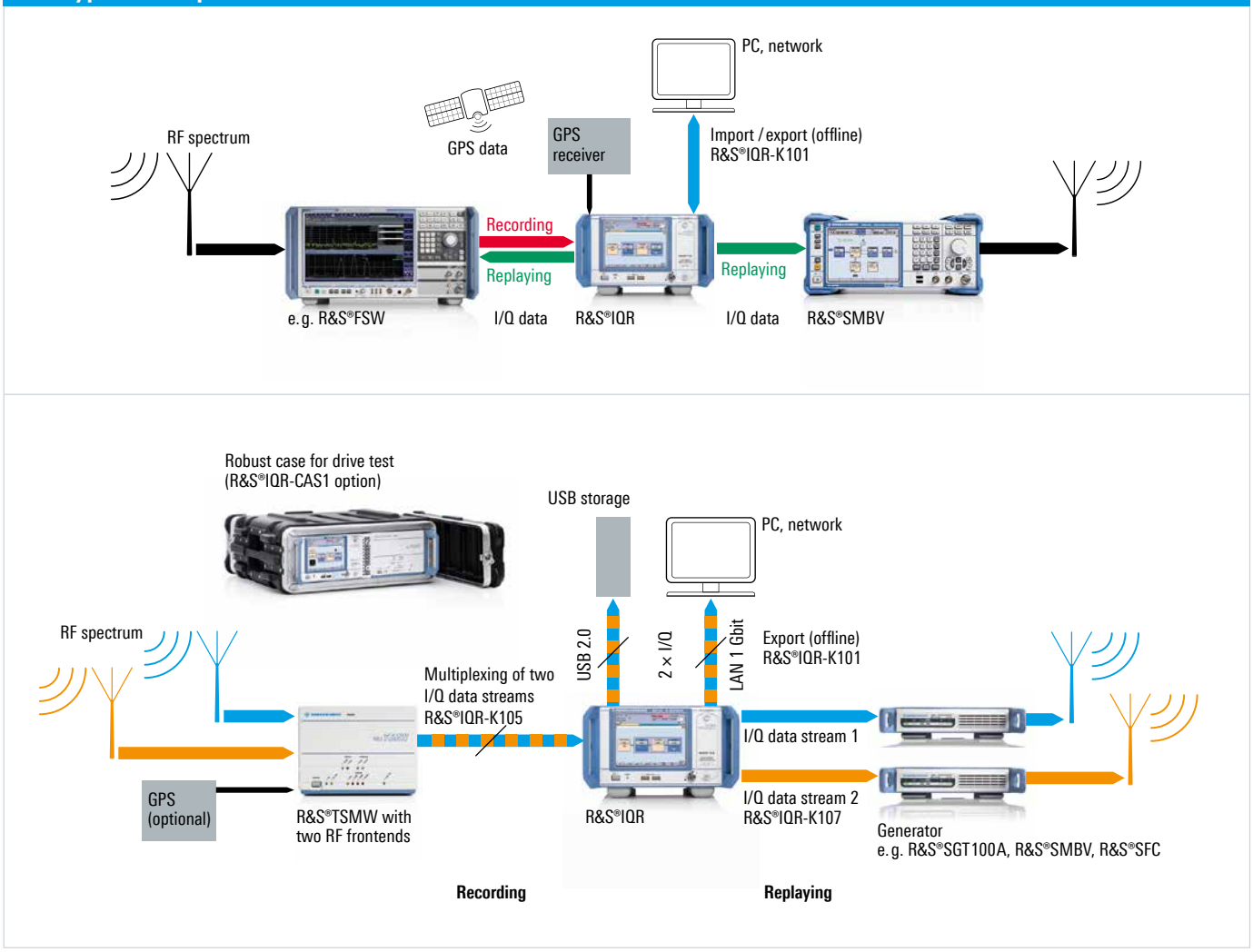


Fig. 4: High-speed setup with R&S®FSW signal and spectrum analyzer as frontend and R&S®SMBV100A vector signal generator as RF modulator (top); two-channel setup with R&S®TSMW universal radio network analyzer as frontend and R&S®SGT100A vector RF sources as RF modulators (bottom).

suitable live signals synchronously and then output them again in parallel via its two I/Q interfaces. In this case, the R&S®TSMW universal radio network analyzer, which can demodulate two signals simultaneously, serves as the frontend. The resulting I/Q data streams are multiplexed to the R&S®IQR over a single I/Q interface. The RF can be generated by any signal generator with the appropriate interface, such as the ultra-compact R&S®SGT100A (Fig. 4 and blue box). Alternatively, the I/Q streams can be exported to a PC via Ethernet or USB interface for further processing using an application such as MATLAB®.

Other useful functions

Recording of position data

The ability to assign a location to the recorded spectrum is an important function for drive test applications. When equipped with the appropriate options, this function is available on the R&S®IQR for displaying the route on a map.

Reference level controlled replaying

The RF signal can vary significantly during drive tests – such as when driving through a tunnel. It is precisely because of these real-life conditions that drive tests are conducted, and the conditions must be reproduced accurately in the lab. The R&S®IQR-K1 option helps ensure accurate level adaptation by activating the automatic gain control (AGC) function in the R&S®TSMW to optimize signal level reception during the drive test (Fig. 5).

Controlling external instruments
Both the RF frontend and the downstream signal generator must be configured appropriately for the current measurement task (e. g. frequency settings) and even dynamically controlled (RF reference level adaptation). The R&S®IQR-K2 software option supports the user to automatically control generators and permits later modifications of the center frequency and reference level offset. This is where the advantages of a complete solution from a single manufacturer become apparent, because the components can be optimized to work together.

Gert Heuer

RF level adaptation with AGC

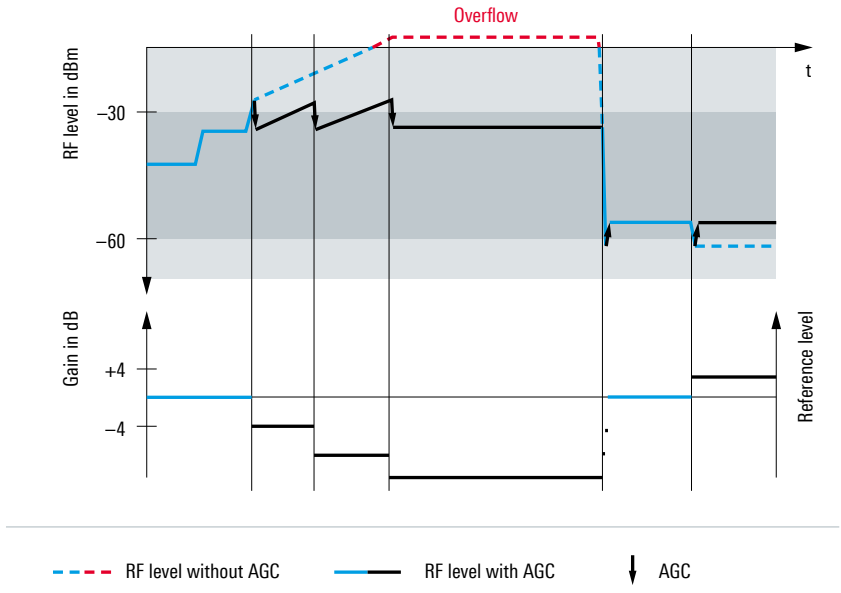


Fig. 5: The R&S®IQR-K104 option activates the AGC function in the R&S®TSMW scanner and stores the reference level for the I/Q data to allow conversion into a realistic spectrum.

Instruments with digital I/Q interface that can be used with the R&S®IQR*

Signal generators
R&S®AMU200A,
R&S®SMW200A, R&S®SMBV, R&S®SGT100A, R&S®SMU200A
Spectrum / signal analyzers
R&S®FSW, R&S®FSVR, R&S®FSV, R&S®FSQ, R&S®FMU36
Broadcast testers
R&S®SFE, R&S®SFC, R&S®SFU, R&S®SFE100
Scanner for drive tests and I/Q streaming
R&S®TSMW
Data converter
R&S®EX-IQ-Box
I/Q data recorders
R&S®IQR100, R&S®IQR20

* Due to different functionalities and performance parameters, not all instruments can be combined with each other as desired; see relevant data sheets, in particular the compatibility list found in the R&S®IQR data sheet.

The Rohde&Schwarz I/Q interface

In the age of digital radiocommunications, I/Q data is the usual method of describing signals. However, a universal digital I/Q interface has never been standardized, which is why Rohde&Schwarz has defined a proprietary standard for its own instruments. The connector is based on a commercially available design, while the serial transmission uses a proprietary protocol.

The interface is used for rapid transfer of the actual I/Q data and also for the transfer of metadata. This is because a pair of I/Q values can code only the (relative) amplitude and the phase of a sine-wave signal (baseband). The frequency information for generating a correctly positioned RF and the absolute level must be provided in a different way. Reserved pins (info interface) are used for this purpose as well as to exchange additional information between the instruments, for example regarding the transfer mode or the data rate.

Together with the I/Q data stream, control and status bits can be transmitted, e. g. for triggering or as markers.

When instruments that do not include the Rohde&Schwarz interface are to be included in a setup – typically all DUTs – the R&S®EX-IQ-Box can be used to convert the I/Q signals in both directions.

New RF modules expand the R&S®OSP control platform's scope of uses

RF modules with new relay types and relays with a different kind of drive (latching relays) broaden the R&S®OSP open switch and control platform's functionality. This increases versatility in switching RF test systems in research, development and production, making new applications possible.

The range of modules for the R&S®OSP open switch and control platform (Fig. 1) is being continuously expanded to provide an ever wider scope of applications, from simple switch systems to complex RF test systems. The large selection of generally deployable switch modules and modules with special, application-specific functions (e.g. for EMC test systems) allows versatile configuration of T&M systems for use in production, test labs and R&D. The possibility to expand existing configurations with R&S®OSP modules and the R&S®OSP150 extension unit creates added safety of investment.

Universal latching RF relays

The current RF modules for the R&S®OSP – for example, the universal base modules R&S®OSP-B101 with six changeover relays (SPDT) and R&S®OSP-B102 with two multiposition relays (SP6T) – are all equipped with failsafe (monostable) relays. These relay types are generally more economical but require a permanently applied control voltage for switching. Apart from the higher current drain, this characteristic is nevertheless advantageous for achieving a defined switching state with safety-relevant systems after power-off or a power outage.

In addition to the failsafe base modules, the range of options now includes the R&S®OSP-B101L and R&S®OSP-B102L latching (bistable) modules (Fig. 2). They remain in the prevailing switching state after a control voltage failure – which means that the control voltage is only required for the changeover but not for maintaining the switching state. This reduces power consumption, in particular in large test systems, and retains the switching state when the supply voltage fails.

Transfer relays

The two new failsafe DPDT transfer relay modules, R&S®OSP-B116 and R&S®OSP-B136 (Fig. 2), have two SMA relays (B116) and two N relays (B136) that make it easier to implement cross-wiring between two RF paths.

Additional new I/O and relay modules

Unlike the R&S®OSP-B103 digital I/O module, the new R&S®OSP-B158 digital I/O module (Fig. 3) makes it possible to drive external equipment via differential lines. Besides 16 digital inputs, it provides 16 differential RS-422 outputs, plus

Fig. 1: Thanks to the ever-growing number of modules, the R&S®OSP open switch and control platform is addressing more and more fields of application. The figure shows the R&S®OSP150 extension unit (top) and the R&S®OSP130 base unit (bottom).

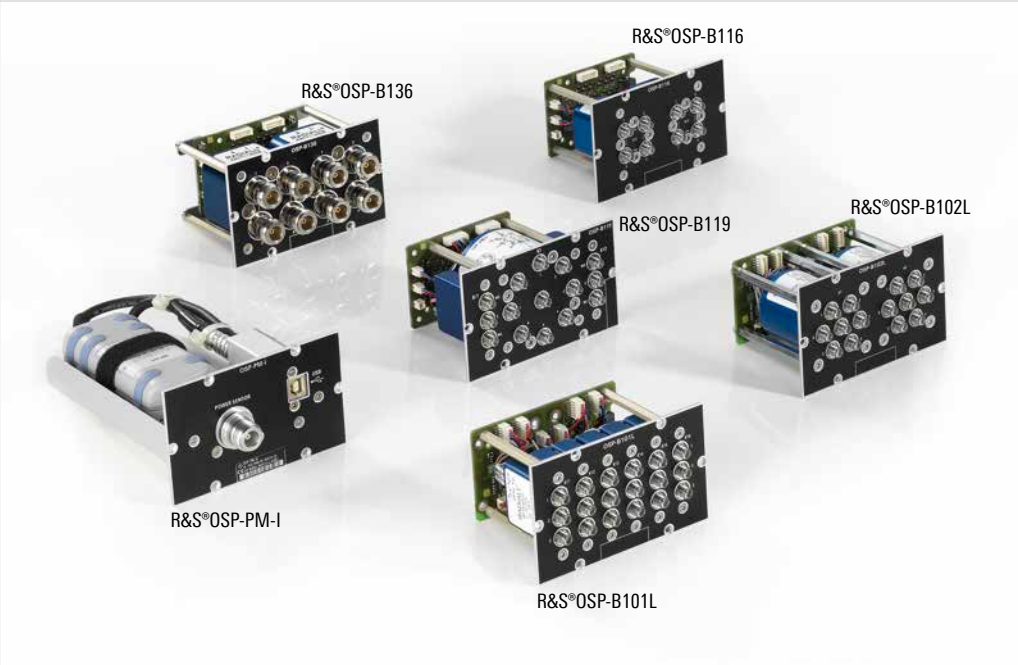


Fig. 2: The new relay modules.

Fig. 3: R&S®OSP-B158 I/O module.

Fig. 4: R&S®OSP-B121H module.

Test system for power measurements

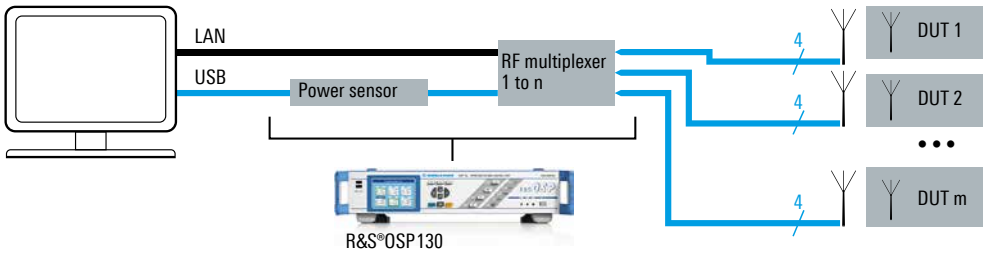


Fig. 5: Sequential power measurements on multiple DUTs with multiple antennas. Up to 42 measurement ports can be implemented with a single R&S®OSP.

four analog output voltages. The R&S®OSP-B158 module can be used, for example, to drive the new, remote R&S®AU600 active omnidirectional receiving antenna system (see page 9) and supply it with the required voltages.

The terminated version of the eight-fold multiposition switch (R&S®OSP-B129) is now complemented by the R&S®OSP-B119 nonterminated module comprising one SP8T and two SPDT relays. Along with the terminated relays for 0 Hz to 18 GHz, a model featuring 40 GHz and external termination is now available (R&S®OSP-B121H in Fig. 4).

The R&S®OSP-PM-I is a new passive module for integrating an R&S®NRP-Zxx power sensor into the R&S®OSP open switch and control platform. To prevent interferences from coupling into the R&S®OSP, the power sensor's USB port is routed outward via a USB feedthrough filter. The new module makes it possible to set up a compact test system for power measurements in connection with an upstream RF multiplexer consisting of terminated SP6T solid-state relays (R&S®OSP-B128) (Fig. 5). Depending on the R&S®OSP-B128 relay configuration, multiplexers up to SP42T or SP30T can be implemented in an R&S®OSP120 or R&S®OSP130 base unit, respectively. Using an R&S®OSP150 extension unit and additional R&S®OSP128 modules, as many as 72 antennas can be sequentially selected. It must be taken into account, however, that each switching step increases the path attenuation and the required measurement time for switching through all connected devices and antennas.

The R&S®OSP data sheet provides an overview of all available platform models and the diverse modules, including the associated front views.

Gert Heuer

Top efficiency in the test lab

At its Product Compliance Center, Fujitsu Technology Solutions GmbH uses T&M systems to perform EMC testing of electronic components and devices. The R&S®EMC32 EMC measurement software from Rohde&Schwarz is a key component in the infrastructure across all locations. The software is used to create test plans and automatically control and monitor test sequences.

For electromagnetic device and system tests, Fujitsu Technology Solutions GmbH (see gray box) has an accredited Product Compliance Center (PCC) with locations in Augsburg and Paderborn. There, products such as computers, monitors, displays, printers, measuring instruments, robots, process controllers, household appliances and medical equipment for commercial as well as private consumers undergo testing.

Due to the popularity of mobile radio and wireless applications, interference problems have increased greatly in recent years. International EMC standardization committees have responded by imposing more stringent requirements. At the start of last year, Fujitsu extended the PCC's range of services in the area of EMC testing. As head of the EMC test center in Augsburg, Hermann Möhring commented as follows: "The standards were extended to help prevent impairment of device functionality due to RF interference. For example, increased requirements must now be fulfilled in order to obtain the European CE marking."

EMC test service for internal and external customers

As a fully-owned subsidiary of the Japanese electronics manufacturer, Fujitsu Technology Solutions GmbH offers a wide range of products, solutions and services. Notebooks, PCs, thin clients, servers, storage systems and mainboards are developed and manufactured at several German locations. Electromagnetic device and system tests are handled by the 45 PCC employees in Augsburg and Paderborn. Electronic products for private and commercial consumers are tested. The test engineers also perform precompliance tests on prototypes to ensure EMC conformance in parallel to product development. This saves time and additional expenditures by avoiding subsequent modifications. Besides Fujitsu products, devices and components from other companies are also tested in the labs. About one third of all test orders are from external customers.

The Fujitsu Product Compliance Center in Augsburg.

In the past, it was sufficient to test the immunity to radiated disturbance at a field strength of approx. 10 V/m in a frequency range up to 3 GHz. As part of extended testing, the immunity of electronic products to radiated disturbance is now measured at an electric field strength of 20 V/m in a frequency range up to 6 GHz. Fujitsu manager Möhring explains: "For the extended immunity test, we worked with Rohde&Schwarz to create test setups that are specially tailored to meet the new requirements. The new test systems allow automated, uninterrupted measurements across the entire frequency range, saving time and money. In addition, they ensure stringent compliance with the latest EMC standards." Tests include disturbance field strength, disturbance voltage, harmonics, flicker, electrostatic discharge, radiated RF electromagnetic field immunity, immunity to conducted disturbance induced by RF fields, fast transients (burst), slow high-energy surge as well as voltage variations and interruptions in supply networks.

EMC certificates worldwide

EMC testing is a necessary part in the process of obtaining national and international certificates such as Europe's CE marking. The two EMC labs operated by the Product Compliance Center (PCC) are certified by the German Accreditation Body (DAkkS) in line with DIN EN ISO / IEC 17025. They are authorized to issue internationally recognized certificates in line with the standards of UL, CSA and FCC (USA), CCC (China), BSMI (Taiwan), MIC (Vietnam), VCCI (Japan), KC (Korea), C-Tick (Australia) and GOST-R (CIS countries).

Measurement software for all types of automated EMC tests

Various test chambers are available to help engineers study how the devices under test (DUT) respond to conducted disturbances as well as electromagnetic fields and analyze their immunity. In this manner, they can ensure that electrical equipment works properly in the intended environment and does not cause any electromagnetic disturbance that could disrupt operation of other equipment. EMC testing is a necessary prerequisite for national and international certificates such as the European CE marking (see blue box). Fujitsu uses the R&S®EMC32 EMC measurement software from Rohde&Schwarz to perform these diverse tests. This software supports measurements in line with European and international standards and covers a wide range of applications, including universal, standard-compliant EMS and EMI measurements (conducted and radiated). Moreover, the R&S®EMC32 software is capable of performing precompliance tests for product optimization, measurements of a DUT's radiation pattern (azimuth chart) and R&TTE conformance measurements in line with ETSI and FCC standards.

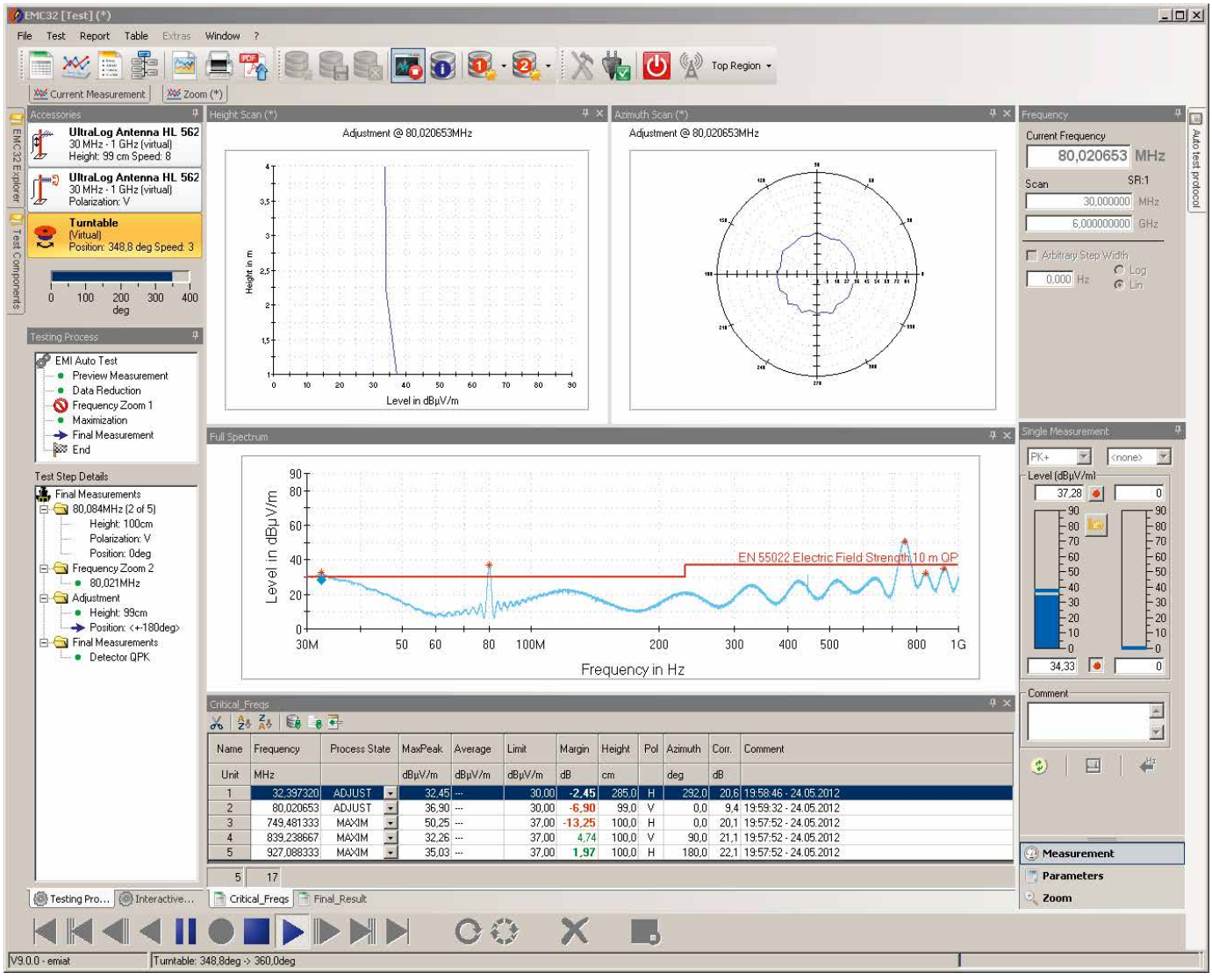
The EMC test chamber operated by Fujitsu Technology Solutions GmbH in Augsburg.

R&S®EMC32 is a key element for maximizing the automation of the test sequences. "Since we began using the Rohde&Schwarz software, we have been able to generate test reports much faster", happily noted EMC test center head Möhring. All procedures performed in the test lab are optimized thanks to the software's excellent integration with the lab management system. Resources are used more efficiently, leading to lower costs for the test sequences. Möhring continued: "The EMC measurement software is ideal for automated EMC testing in all relevant test domains and fields of standardization. It supports the test engineers as they work to optimally manage their growing range of tasks and allows them to conveniently evaluate measurement results with graphical presentation in the form of test reports and charts."

Both Product Compliance Center locations now with identical EMC measurement software

While the Augsburg PCC has taken advantage of this measurement software for some years already, the test lab in Paderborn used a different solution until one year ago. When the company carried out an organizational merger of the two labs, it decided to use the same EMC measurement software at both locations. Fujitsu manager Möhring: "Continuing to use two different solutions would have required twice the preparatory work and twice the maintenance expense. The EMC specialists would have had to separately develop and maintain regularly used test and report templates based on each standard for two different systems." Prior to the final choice of the product, the Paderborn test engineers tried out the

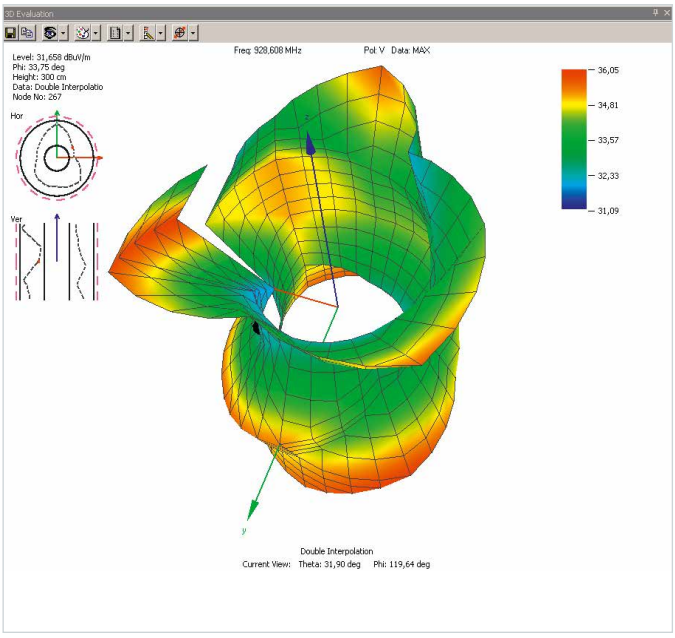
Interactive EMI measurement with R&S®EMC32-K24.



software in combination with the local T&M infrastructure. The result: The go-ahead to build a uniform measurement software architecture at both locations based on R&S®EMC32.

Although both PCC locations now use identical software, measuring instruments from different manufacturers are still deployed at the two locations. Ulrich Kracht, head of the Paderborn EMC test lab, emphasized that "the Rohde&Schwarz software allows us to use identical test sequences at the two locations despite any differences in hardware. This was very important for us because we frequently swap instruments between the two test centers to handle our current projects." Due to the many integrated drivers that allow control of different brands of measuring instruments, the benefits of the software can be enjoyed at both locations without limitations. "We were not required to make any additional investments to unify our pool of test hardware", explained Kracht.

Some manufacturers only require tests to meet certain standards. Other manufacturers wish to sell their products in a specific market and need consulting on the necessary tests and certifications. Möhring defines the objectives as follows: "We perform appropriate tests and can also transfer the results to the competent national authorities if so desired. Our goal is to provide the customer with a complete solution to a problem as opposed to just a set of test results. In this manner, customers can benefit from our many years of experience as a manufacturer laboratory. Thanks to our deep understanding of development and production processes, we are also capable of providing suggestions for improvement if required."



3D display generated with the R&S®EMC32-K23 option.

Comprehensive software functions for a wide range of requirements

At the Paderborn PCC location, the introduction of the Rohde&Schwarz measurement software went smoothly. Möhring continued: "The intuitive operating concept, which supports a wide range of EMC measurements, made the process much simpler. This applies to tests during development as well as to acceptance and compliance tests – from simple lab applications to complex test sequences in EMC test chambers." The modular concept with extensive functionality for adaptation to different requirements provides the foundation. The high degree of versatility cuts costs and forms the basis for future expansions. Special options make it possible to maximize automation while integrating the measured data into the test center's overall workflow.

The Rohde&Schwarz developers have also met special requirements of the Fujitsu Product Compliance Center. For example, additional functions needed to automate open site testing were implemented very quickly. It was also desired to adapt the software for deployment on a tablet. If the control computer is not located in the immediate vicinity of the test chamber, the test engineers can access the test system via the touchscreen and readjust an antenna directly on site, for example. Möhring emphasized: "For me, the measurement software's excellent functionality is just as critical as the close contact we have with the developers. Rohde&Schwarz is always able and willing to listen to our needs. Our technical questions are answered quickly without a long wait for a callback from the support department."

Jürgen Koch

UltraHD – the future of TV

4K TVs and cameras are already available for affordable prices at any electronics store. There is, however, a great shortage of original 4K content, not least due to broadcast infrastructure insufficiencies. Rohde&Schwarz supplies content providers and network operators with all of the technical means to change this situation.

Ultra high definition television (UHDTV) is one of the hottest topics in the TV industry. Motivated by major sporting events such as the upcoming Olympic Games in Rio, broadcasters, consumer electronics manufacturers and their suppliers are working hard to make UHD solutions ready for use, perfect them and ultimately establish them on the market.

The consumer electronics industry has clearly gained the upper hand in the usual chicken-and-egg dispute this time by offering UHD cameras and TVs. Infrastructure suppliers and broadcasters are faced with the challenge of closing the producer / consumer supply gap and creating a marketable UHD ecosystem. This is no easy task, considering that data volumes have exploded due to drastically increased picture resolutions (UHD-1: 3840 × 2160 pixels; UHD-2: 7680 × 4320 pixels) and other improvements such as frame rates up to 120 fps, extended color ranges and more powerful audio formats (Fig. 1). The goal, however, is – by using the HEVC (H.265) next-generation coding standard – to achieve twice the compression efficiency of MPEG-4 (H.264) currently used in today's HDTV. As a result, UHDTV programs can then be broadcast via terrestrial networks. In the spring of 2013, the Korean Broadcasting System proved that this entirely feasible when it began using a transmitter from Rohde&Schwarz to regularly broadcast a UHD program in the Seoul metropolitan area (see NEWS 211, page 45).

Pixel resolution of current and coming video formats

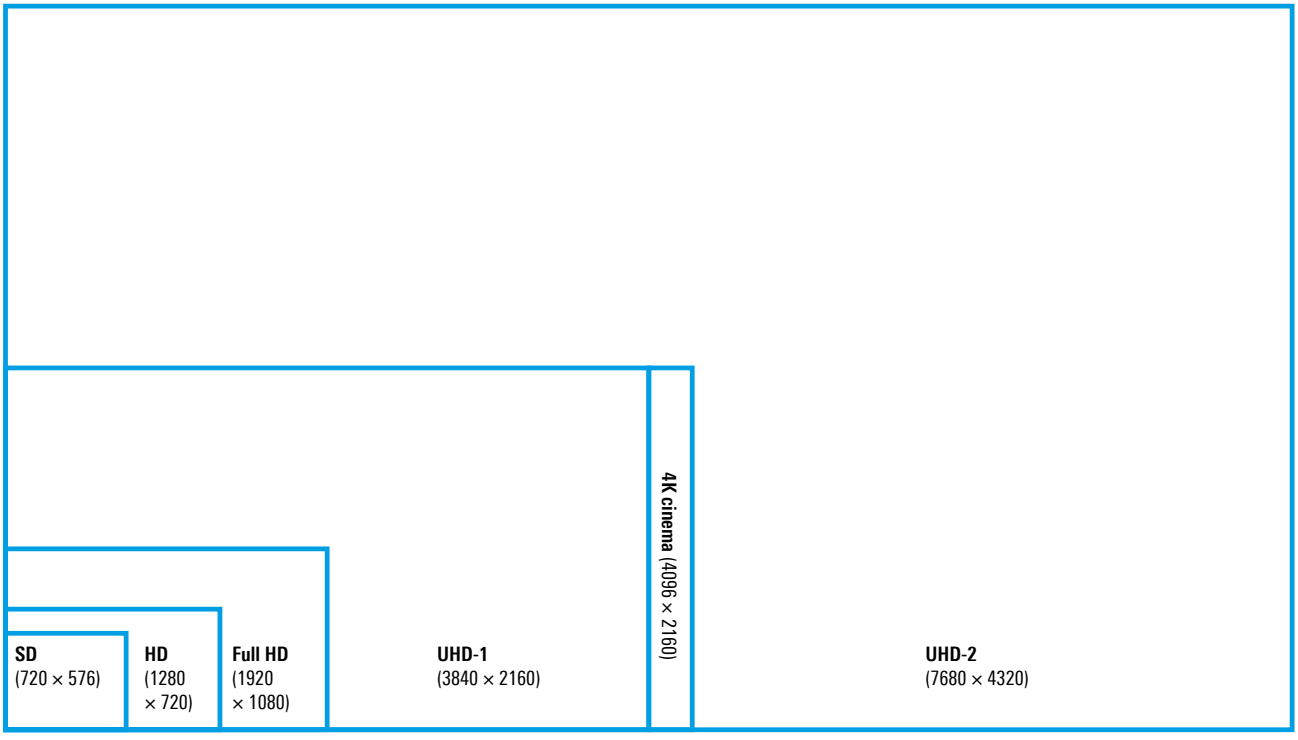


Fig. 1: Comparing pixel counts and their associated data volumes for an uncompressed full-screen picture visualizes the challenge confronting development engineers in coping with UHD.

UHD signal chain from camera to viewer

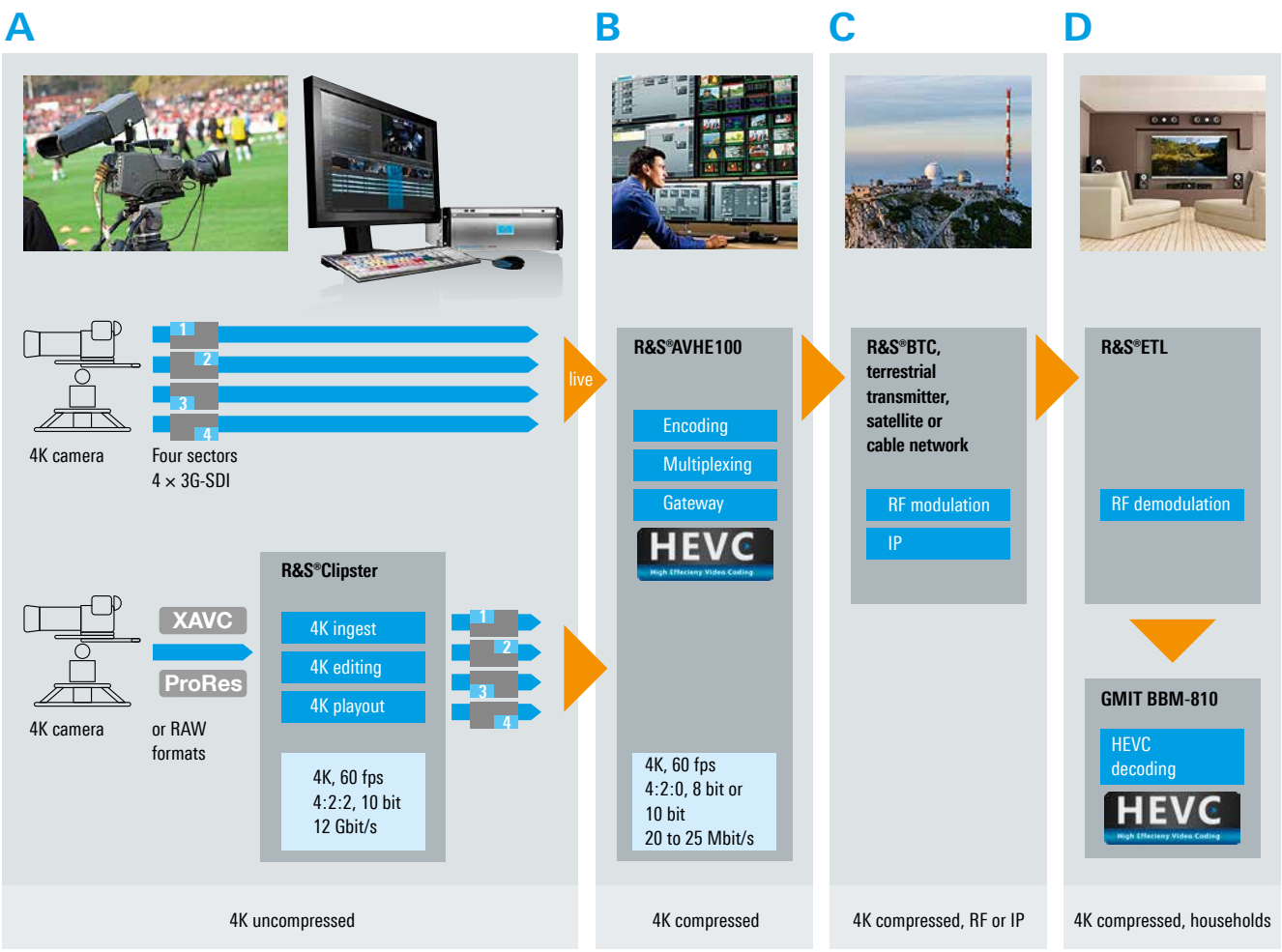


Fig. 2: Components from Rohde&Schwarz enable users to set up an entire UHDTV distribution chain.

Fig. 2 shows a simplified overall UHD signal chain from camera to viewer. Rohde&Schwarz equipment enables users to build the entire chain starting from the camera output.

The original UHD program is recorded with a 4K camera (**A**). If the broadcast is not live, the uncompressed material is then transferred to a 4K video server (ingest) and edited (e. g. changes to color subsampling and frame rates, special effects, etc.).

When the time to broadcast arrives, the signal is fed via four 3G-SDI cables to a realtime coder, which performs HEVC compression and outputs the result as a transport stream (**B**).

The transport stream is then broadcast via terrestrial transmitters (DVB-T2), sent to satellite uplinks (DVB-S2) or fed into cable (DVB-C2) or IP networks (IPTV) (**C**).

The viewer's 4K TV demodulates and decodes the signal on its own or receives it via an HDMI 2.0 connection from a set-top box (**D**).

The individual steps along this chain are described in greater detail on the following pages.

Ingest, editing and playout

As a rule, nonlive programs go through an editing, preprocessing and buffering process in the studio prior to preparation for transmission in the headend at broadcast time (Fig. 3). The current generation of R&S®CLIPSTER also accepts camera data in XAVC, ProRes and RAW formats (file-based ingest). All desired operations can then be carried out with utmost ease.

- Arranging the 4K clips in a timeline
- Color and other corrections directly on the RAW data
- Realtime reformatting of the RAW data into any commonly used file format, compressed or uncompressed
- Interoperable master format (IMF) support: ingest, processing and output (packaging). IMF is used as the standard UHDTV workflow format, as it bridges the gap between digital cinema and the world of broadcasting
- External R&S®SpycerBox Cell units (see page 9) make it possible to expand the internal R&S®CLIPSTER memory to virtually any capacity. Even Super Hi-Vision (8K) workflows are simple to implement in this way

Ingest, editing and playout

Fig. 3: R&S®CLIPSTER is a high performance universal solution for file-based ingest, digital imaging, format conversion and realtime playout of 4K signals.

B HEVC realtime coder, multiplexer and gateway

The compact R&S®AVHE100 headend processes the 4K program data into a transport stream that can be transmitted. The headend features the latest in high-performance data technology to perform CPU-intensive HEVC encoding in realtime. All of the headend signal flows are IP-based. This is a prerequisite for ensuring high integration density for all functions as well as extensive flexibility in functional structuring to meet individual requirements.

The UHDTV signal is fed from a 4K camera, a downstream control unit or a 4K playout server to the headend via four 3G-SDI cables (data rate: 12 Gbit/s). Unlike other solutions on the market that process the four HD image quadrants separately and only stitch them together into a full 4K picture at the end, the R&S®AVHE100 combines the quadrants prior to editing and works with complete 4K images after that. One advantage is potentially better picture quality, since the higher quality of the playout material ensures that the seams between quadrants remain invisible. In contrast, separate processing can lead to unclean interfaces depending on the quality of encoding. System scalability is another benefit of complete image processing; customers only purchase the computing power that they need. A typical configuration, for example, is designed for a 4K signal with 60 frames per second and very good picture quality. The hardware (processor performance) is tailored accordingly. Hardware can simply be added if requirements such as higher frame rates appear.

In conclusion, the R&S®AVHE100 performs the following functions:

- Synchronizes the four 3G-SDI signals into a single 4K image (stitching)
- Carries out color subsampling of incoming UHD signals from 4:2:2 to 4:2:0 in line with ITU UHD-1
- Performs HEVC realtime encoding with 8-bit or 10-bit color depth
- Generates UHDTV multiplex and PSI/SI or PSIP information
- Tags T2-MI packets with a timestamp pulled from the GPS signal as required for terrestrial single-frequency network (SFN) broadcasting
- Generates a transport stream via IP or ASI that is fed into the transmission network

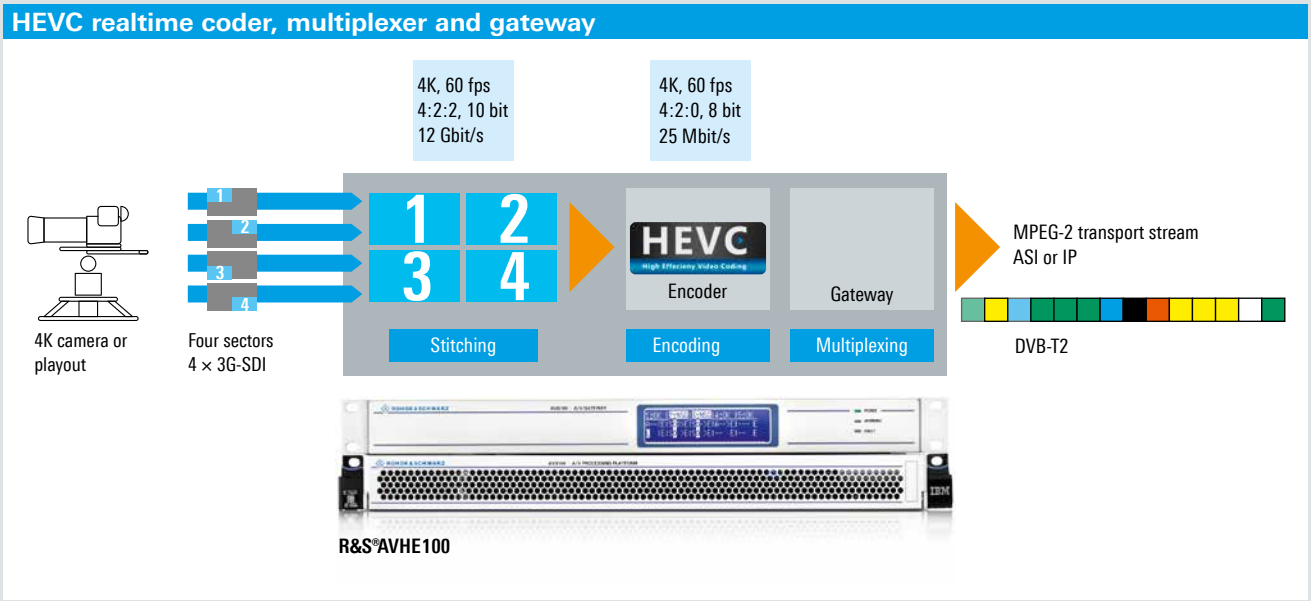


Fig. 4: The R&S®AVHE100 produces full-screen pictures by stitching the four quadrants delivered via 3G-SDI cables and compresses them in realtime using the HEVC codec (H.265). The compressed signal is then packaged into an MPEG 2 transport stream and fed to a distribution network.

C Multistandard RF modulator and transmitter

A wide range of DVB-T2 transmitters of all power classes (e. g. from the R&S®THU9 and R&S®TMU9 families) is available for terrestrial broadcasting of UHDTV programs. They are capable of receiving transport streams directly, and the first installations are in operation.

The R&S®BTC broadcast test center provides a complete test environment for UHDTV consumer electronics. It is an all-in-one solution, since it can simulate any broadcasting standard and perform both video and audio analysis at the same time. Among many other things, the R&S®BTC is a multistandard modulator equipped for the most advanced terrestrial, cable and satellite transmission technologies (Fig. 5). It features a two-path architecture from the baseband to the RF section, enabling simulation of complex scenarios such as MIMO DVB-T2. The R&S®BTC can also be equipped with an HDMI analysis module and configured as a complete solution for set-top box testing.

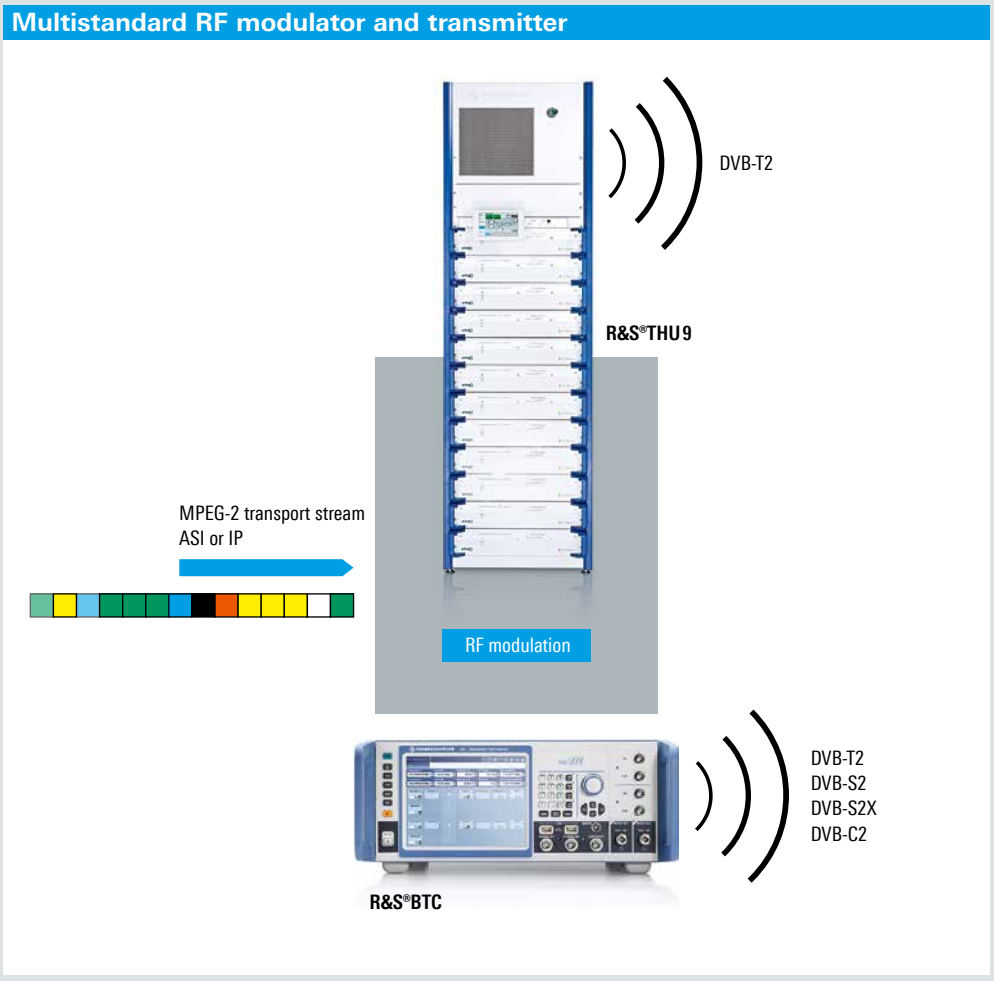


Fig. 5: The compressed UHD transport stream is sent, for example, to a DVB-T2 transmitter or (in the case of a test setup) an R&S®BTC broadcast test center, putting its multistandard modulator capabilities to especially good use.

D1 Coverage measurements with in-depth RF and baseband analysis

Reception problems annoy viewers and undermine the image of network operators. This is why network operators carry out T&M monitoring in their coverage areas and take optimization measures when necessary. Verified information on coverage quality is especially indispensable in metropolitan areas where fading and echoes are to be expected. The R&S®ETL TV analyzer delivers this information. In combination with the R&S®BCDrive drive test software and a GPS antenna, the R&S®ETL provides comprehensive location-specific analysis based on RF and baseband parameters. If desired, Rohde&Schwarz can integrate the instrument and other system components into a turnkey test vehicle (Fig. 6).

Fig. 6: The R&S®ETL TV analyzer provides detailed information on the RF and baseband (transport stream) parameters of terrestrial transmissions. The centerpiece of a coverage measurement system, it analyzes the quality of broadcast networks of all standards.

D2 HEVC realtime decoder and UHDTV quality monitoring

The UHDTV signal chain ends at the viewer's TV, which either carries out demodulation and HEVC decoding itself or uses the A/V signal supplied by a set-top box. However, another solution is required for professional monitoring. The R&S®ETL TV analyzer can handle on-site reception and demodulation. It transfers the transport stream via ASI interface to the BBM-810 broadcast multistream monitor from Rohde&Schwarz subsidiary GMIT. The BBM-810 is a server-based solution that simultaneously monitors and displays a large number of video and audio programs. It is the only solution on the market capable of simultaneously decoding up to four UHD programs, which it can receive in either uncompressed (via 3G-SDI or 10GigE) or compressed (HEVC / H.265 or H.264) format. In addition to detecting "hard" errors such as picture freeze and picture or sound loss, the BBM-810 can also carry out picture quality analysis based on PSNR and SSIM measurements (relative picture quality compared with a reference) in realtime and use it at the headend output to monitor HEVC encoding quality (Fig. 7).

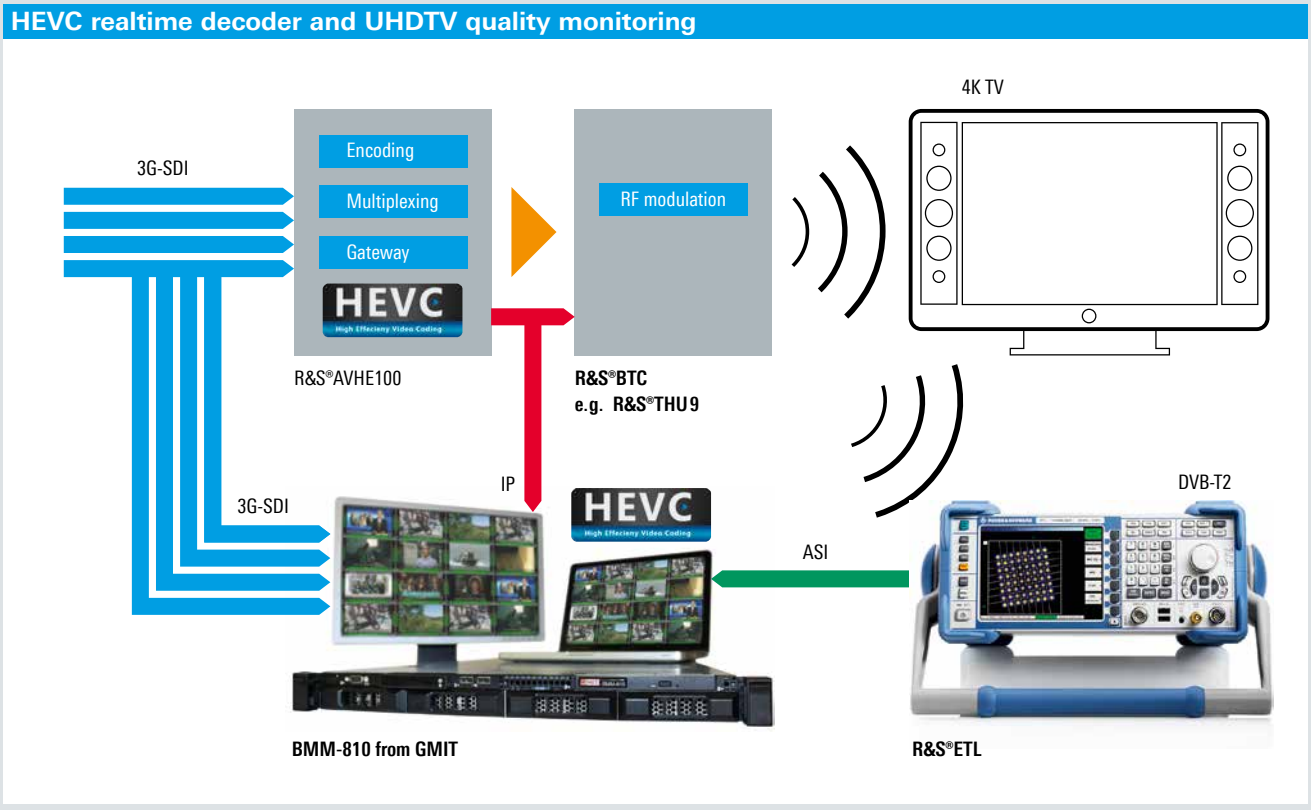


Fig. 7: The BBM-810 from GMIT can simultaneously decode multiple UHDTV programs in realtime and display them on a control monitor along with quality information. Its ability to process both compressed and uncompressed signals and carry out reference-image-based picture quality analysis makes it ideal for continuous headend output monitoring as well as temporary field measurements in tandem with an R&S®ETL.

Summary

Major globally marketable sporting events, the trend toward ever larger picture formats and the availability of 4K consumer electronics are stimulating the broadcasting industry to provide 4K program material and develop suitable broadcast infrastructures. The high UHDTV data rates, however, present broadcasters and their suppliers with considerable challenges when it comes to realtime processing and program transmission via terrestrial networks with limited channel capacity. Rohde&Schwarz products enable broadcasters to implement entire UHD signal chains, from camera output and distribution network to coverage measurements and quality monitoring.

Dr. Nik Dimitrakopoulos; Simon Roehrs

Video testers now state of the art for HDMI 2.0 6G

Version 2.0 is the next generation of the HDMI standard, and it is posing new challenges for T&M equipment. Users of the Rohde&Schwarz family of video testers are, however, taking it all in stride. New options enable them to test consumer electronics equipment and components for their protocol interoperability and – for the first time in this class – their physical transmission characteristics, too.

Protocol tests

Tests complying with HDMI Forum compliance test specification 2.0 can be performed with the new R&S®VT-B2362 HDMI CTS RX/TX 600 MHz module (Fig. 2). The new HDMI version supports e.g. UltraHD formats with deep color and 3D mode. The module can now test the TMDS protocol, which is the basis for the standard, for errors even at data rates > 340 Mcsc. In particular, testing can be performed on HF1-10ff test IDs for sources and HF2-5ff for sinks as contained in the specification (see data sheet for details). The HDMI Forum's new test IDs are also officially certified, just like the previous ones.

The module has an HDMI type A input to which sources such as set-top boxes and Blu-ray™ players can be connected. The HDMI CTS source test software option enables the compliance test IDs. After configuring the resolution, format, test sequence length, etc. for the particular test, the option tests the recorded raw TMDS data for content errors.

Fig. 1: The R&S®VTC video test center connected to a set-top box running a time domain analysis with eye diagram.

The HDMI type A output is used to test sinks such as TVs and monitors. The required HDMI CTS sink test software option (Fig. 3) generates test sequences for all relevant formats defined in the compliance test specification.

High-quality TMDS signal source

The sequences are loaded from the hard disk into the RAM and then played out with pixel-precise accuracy via an FPGA. Implementation in an FPGA offers clear advantages over commercial chipset-based solutions. It can be upgraded to meet future extensions to the standard, plus it generates signals with outstanding electrical characteristics. This also makes the generator suitable as a reference signal source for testing the physical transmission characteristics of cables, converters, etc.

Fig. 2: The R&S®VT-B2362 module offers TMDS protocol compliance testing of signals with data rates of up to 600 Mcsc.

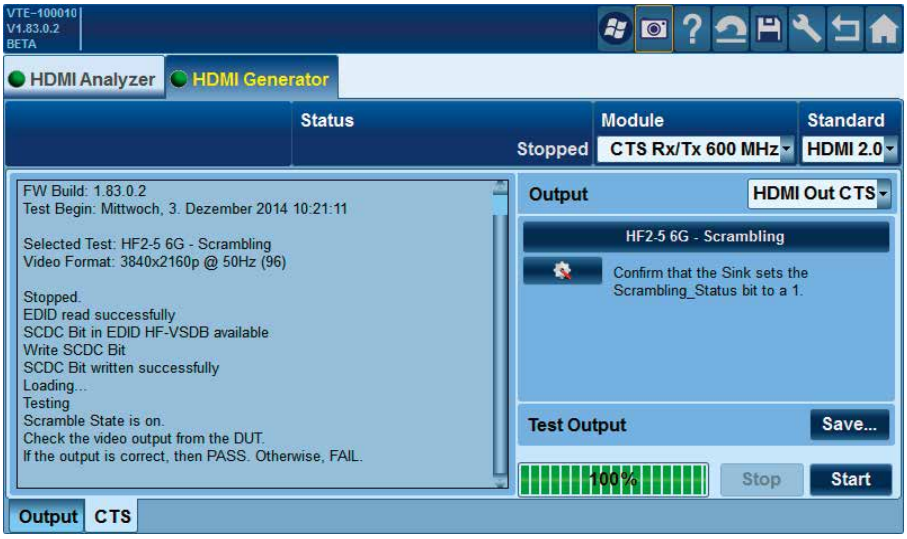


Fig. 3: Dialog for running a CTS scrambling test for sinks.

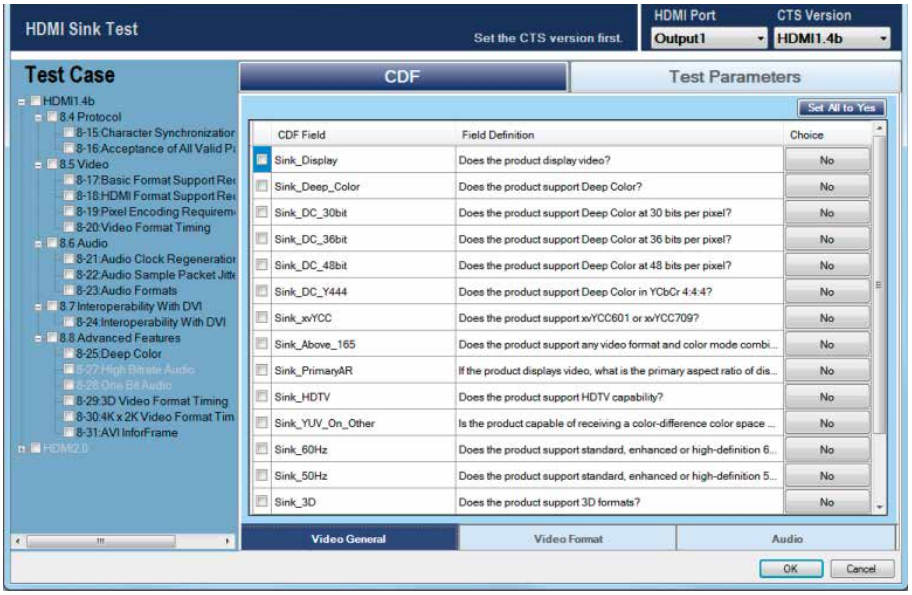


Fig. 4: Configuring a compliance test using R&S®AVBrun based on the example of an HDMI sink.

Automated tests and protocols
Compliance tests can also be called up and run individually. The R&S®AVBrun test sequencer (Fig. 4) is a very useful tool, saving precious time by running multiple tests in different formats based on the CDF of the HDMI standard. It also generates a PDF and HTML log.

Time domain analysis on HDMI sources

The R&S®VT-B2380 TMDS time domain analyzer module (Fig. 5) is an inexpensive, user-friendly time domain analysis tool with 6G support for HDMI sources. It enables users to ensure that a DUT electrically complies with the standard.

For this purpose, the R&S®VT-Z2385 HDMI type A TPA test adapter (Fig. 6) is used to connect the DUT, a set-top box or a tablet to the module via an RF cable and control lines.

A switch matrix in the test adapter allows the user to switch between the differential signals to be analyzed. EDID emulation in the adapter puts the DUT in the correct operating mode (Fig. 7).

Eye diagram analysis using subsampling
TMDS technologies typically have repetitive signals with frequencies of up to 6 GHz that can be easily captured using subsampling. The advantage over a solution that works in real time is that the test module is more compact and cost-effective.

Key parameters such as amplitude, rise/fall times, signal-to-noise ratio and bias voltage as well as possible skews can be determined from the generated eye diagram (Fig. 8). Different views such as cursor measurement, histogram and mask display offer users increased convenience.

Besides the underlying eye diagram measurements, additional optional measurements can be run based on the HDMI test specification: V_L, V_{off}, T_{rise}, T_{fall}, intra-pair/inter-pair skew and clock

Fig. 5: The R&S®VT-B2380 module combined with the R&S®VT-Z2385 test adapter (Fig. 6) offers eye diagram measurements on HDMI 2.0 sources.

Fig. 6: R&S®VT-Z2385 test adapter.

duty cycle. These are complemented by electrical measurements on the control lines (CEC, DDC, HPD, +5 V power); see data sheet for details.

Compared with the competition, the time domain analyzer is compact and easy to operate. Instead of many individual components such as EDID emulator, capacitance meter, test adapter, etc., the user gets an integrated all-in-one solution with plug-and-play characteristics.

Summary

With its new HDMI 2.0 test modules, Rohde&Schwarz meets the various demands of developers and manufacturers of consumer electronics equipment as well as chip manufacturers and test houses for 4K UltraHD equipment. Besides protocol compliance test solutions, the video testers offer users a unique, integrated and easy-to-use time domain analysis solution that in most cases eliminates the need for an oscilloscope.

Thanks to its modular design and wide range of base units, the tester family can be configured to suit individual requirements. The family comprises the R&S®VTC video test center for high-end R&D applications (Fig. 1), the R&S®VTE video tester for portable use and test system integration, and the R&S®VTS compact video tester for cost-effective applications. Besides HDMI test modules, analog video interface and MHL options are also available.

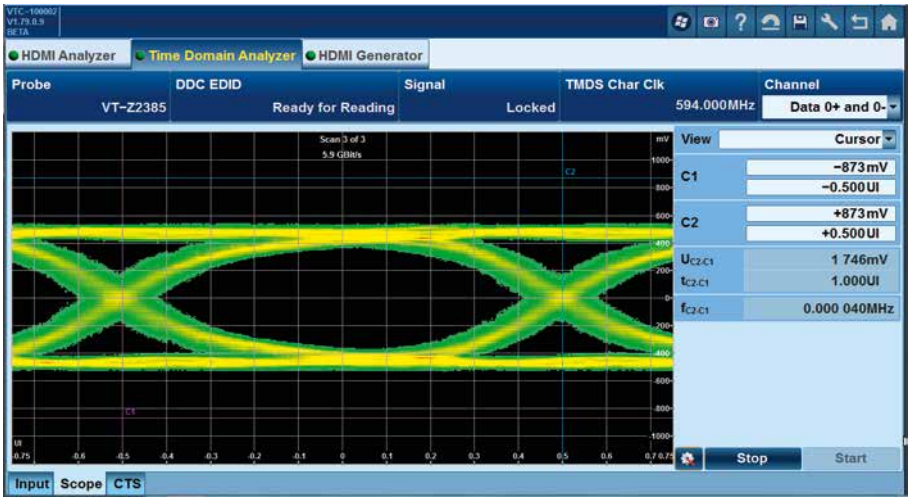
Harald Gsödl

Abbreviations

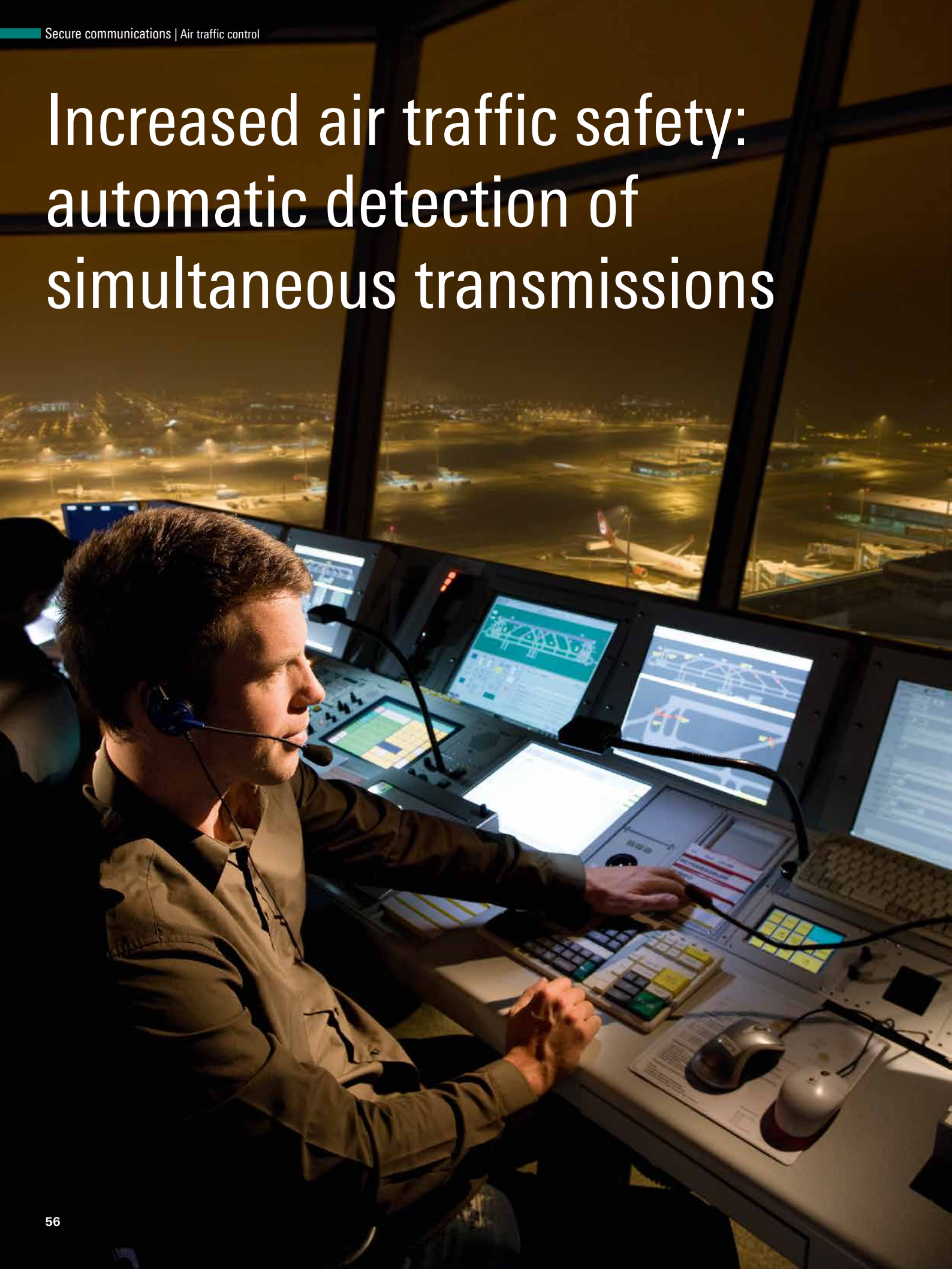
CDF	Capabilities declaration form
CEC	Consumer electronics control
CTS	Compliance test specification
DDC	Display data channel
EDID	Extended display identification data
FPGA	Field programmable gate array
HDMI	High-definition multimedia interface
HPD	Hot plug detect
Mcsc	Mega characters per second per channel
MHL	Mobile high-definition link
TMDS	Transition minimized differential signaling

Fig. 7: Menu for configuring the EDID to request a specific output format from an HDMI source.

Fig. 8: Eye diagram of an HDMI 2.0 TMDS channel with a data rate of 5.9 Gbit/s in cursor measurement mode.



Increased air traffic safety: automatic detection of simultaneous transmissions



Dangerous air traffic situations occur when important radiocommunications messages between pilots and air traffic controllers get drowned out, for example due to undetected simultaneous transmissions where multiple stations transmit at the same time. The R&S®Series4200 software defined radios are the first radios that can reliably detect these simultaneous transmissions.

DFS Deutsche Flugsicherung GmbH, the German air navigation service provider, monitors and controls around three million flights annually in Germany alone. The key tool that allows DFS to do this still remains amplitude-modulated (AM) radiocommunications. Pilots and air traffic controllers use it to exchange course and altitude information as well as starting and landing clearance. Air traffic controllers manage all the airplanes within their area of responsibility using a shared radio frequency. With all the parties using the same radio channel, two or more pilots and controllers often speak at the same time. This is referred to as simultaneous transmissions (Fig.1 and box below). Their frequency of occurrence depends mainly on the volume of traffic in the particular sector. Consequently, simultaneous transmissions occur roughly ten times as often on frequencies in high-occupancy approach sectors (e.g. at large airports) than on en-route sector frequencies.

For a long time it was considered technically impossible to detect simultaneous transmissions. Rohde&Schwarz has now developed a solution.

Simultaneous transmission

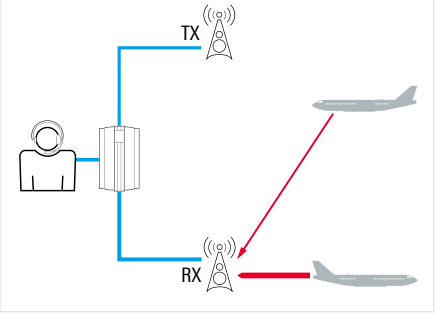
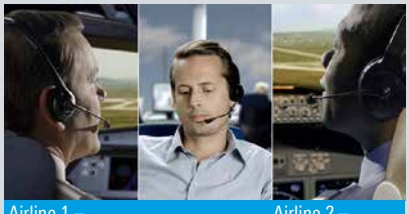


Fig. 1: The standard method of two-way communications in air traffic control (where the parties take turns transmitting or receiving on the same channel) can lead to undetected simultaneous transmissions.

The danger of undetected simultaneous transmissions

The first significant mention of a simultaneous transmission that had fatal consequences can be found in the investigation report into the airplane accident that happened in Tenerife in 1977, when two Boeing 747 aircraft collided on the runway in poor visibility. Over 500 people lost their lives. A simultaneous transmission between the tower and one of the airplanes was later named as a major contributing factor in one of the pilots making an error. The pilot assumed the runway was clear and started readying for take-off. The radio message that followed, warning of the presence of another airplane on the runway, was transmitted at the same time as a transmission from the tower. This is why neither the tower nor the pilot could hear it clearly.

Many other examples demonstrate that undetected simultaneous transmissions have led to safety-critical situations in air traffic. In Switzerland, for example, a serious airprox incident occurred at Zurich airport in 2010. Both planes were ready for take-off on different runways. The air traffic controller cleared one of the two planes for take-off, but due to similar call signs, both planes confirmed take-off clearance simultaneously and then accelerated on the intersecting take-off runways (pictures on the right). The air traffic controller was unable to hear the resulting simultaneous transmission, specifically the incorrect confirmation. Following an investigation, the Swiss Aircraft Accident Investigation Bureau recommended this safety measure: "The Federal Office of Civil Aviation should ensure that double transmission is detectable on the radio operation systems used in Switzerland."



In 2010, a simultaneous transmission led to a serious airprox incident at Zurich airport.

The solution from Rohde&Schwarz: DSiT

The detection of simultaneous transmissions (DSiT) software option for R&S®Series4200 receivers and transceivers (Fig. 2) from Rohde&Schwarz is the world's first series-production solution for detecting simultaneous transmissions in stationary radios for use in air traffic control. Based on a patent-pending smart analysis technique, the process involves performing a real-time spectral analysis of the receive signal for the presence of multiple AM-DSB transmissions (Fig. 3). The algorithm kicks in even if the level difference of both transmissions is up to 20 dB. The algorithm was evaluated in several field tests together with DFS and iteratively finely tuned. As a result, it reliably detects as many simultaneous transmissions as possible while reducing false alarms to a minimum, which is a key criterion for acceptance among air traffic controllers.

ATC radios with DSiT

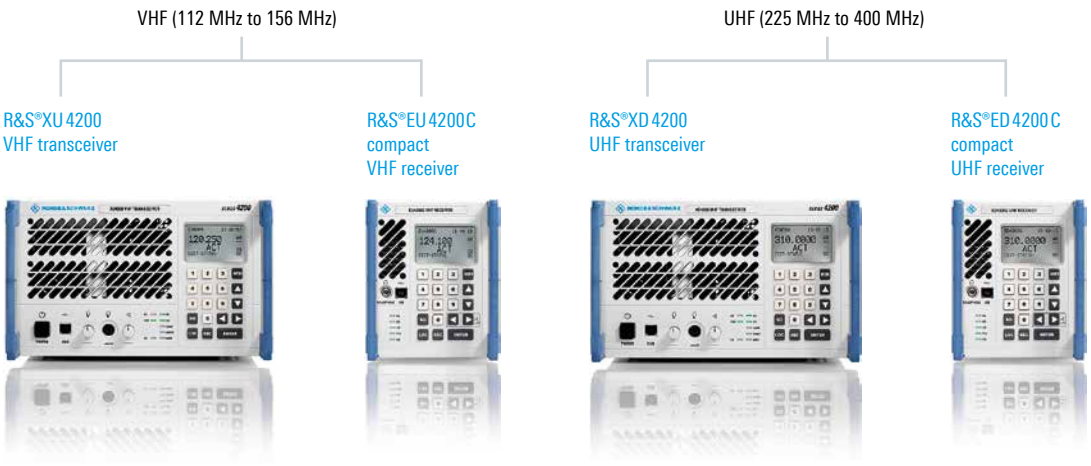


Fig. 2: These R&S®Series4200 radios support DSiT functionality.

Spectrum due to simultaneous transmission

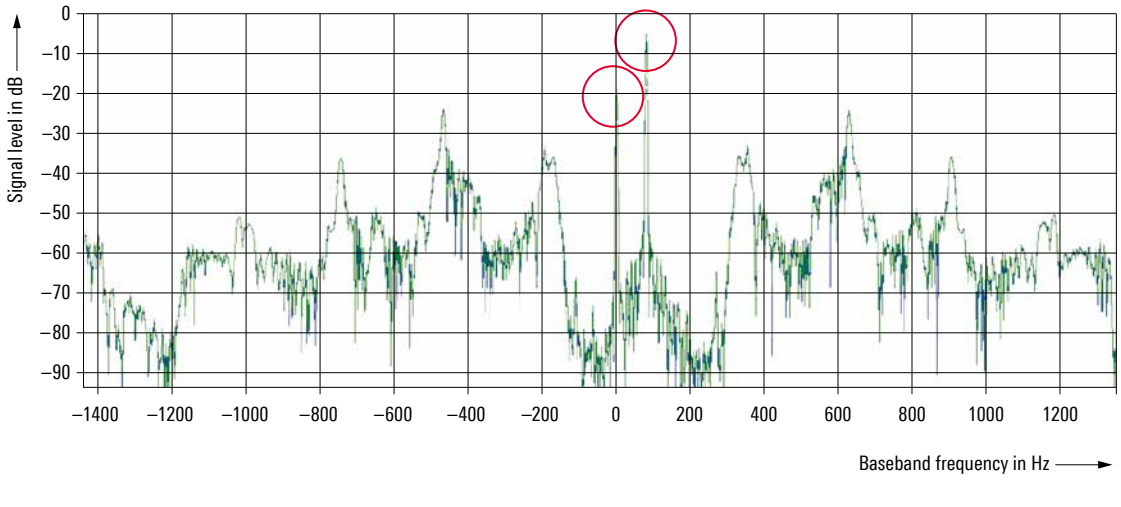


Fig. 3: Example of a spectrum with two carriers resulting from simultaneous transmission.

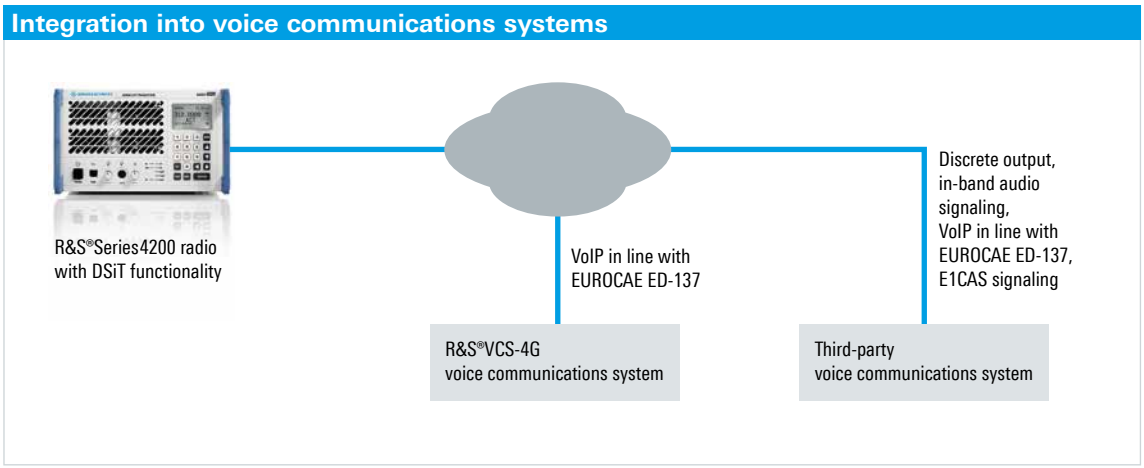


Fig. 4: R&S®Series4200 radios with DSiT integrate seamlessly into existing or new radiocommunications systems.

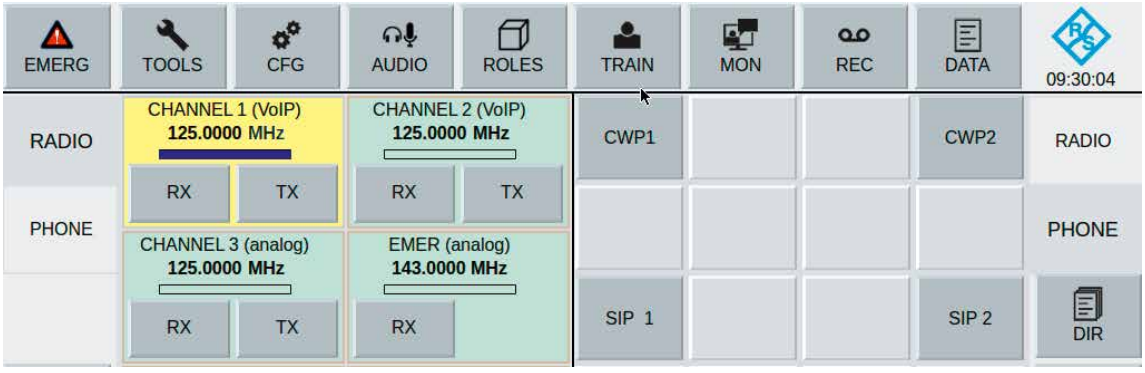


Fig. 5: Close-up of the R&S®VCS-4G voice communications system GUI: The background of the frequency information field flashes yellow to indicate simultaneous transmissions.

The occurrence of simultaneous transmissions can be conveniently signaled to the connected voice communications system in several ways. These include VoIP in line with EUROCAE ED-137, a discrete output, in-band audio signaling and E1 CAS signaling.

The stationary R&S®Series4200 receivers and transceivers can be easily integrated into existing as well as new ATC systems (Fig. 4). The voice communications system then signals the event to the air traffic controller. If the suitable software is already installed, the radios can be upgraded easily by enabling the DSiT option.

Unlike third-party systems, the R&S®VCS-4G voice communications system is already equipped to signal simultaneous transmissions visually in the GUI (Fig. 5) – a clear advantage in favor of an end-to-end solution from Rohde&Schwarz comprising R&S®Series4200 radios and the R&S®VCS-4G voice communications system.

Summary

The number of flight movements, and the need for pilots and air traffic controllers to communicate, is constantly increasing. As a result, radio channels are getting more and more congested – giving rise to the increased likelihood of simultaneous transmissions. Safe and speedy clearing of airplanes is becoming even more challenging for all air traffic control organizations. DSiT now provides controllers with a dependable assistant that will help avoid fatal communications errors caused by simultaneous transmissions.

Mathias Erhard

State-of-the-art encryption for any telephony application

Successfully established on the market, the TopSec Mobile crypto unit provides voice encryption for commercial smartphones. The extended encryption solution allows tap-proof calls with iPhone and Android mobile phones, PCs and laptops as well as calls to the company's fixed network.

The app version of this article has a video that shows how easy it is to use the TopSec Mobile.

Nowadays, companies, government authorities and armed forces want to exchange confidential information via landlines as well as smartphones. However, such calls are relatively easy to eavesdrop, making it very important to protect confidential information with strong encryption. The security solution needs to be simple and flexible while supporting everyday communications processes without undue complexity.

Encryption – a balancing act between convenience and security

A glance at the commercial products that are available or have been announced demonstrates the wide range of solutions that exist with very different features, security characteristics and even costs (Fig. 2). Due to the great diversity of requirements, application environments and possible uses of the devices, there is no dominant technical

Fig. 1: It doesn't get any simpler or more convenient: confidential calls – even via a laptop – can be made using the TopSec Mobile with hardly any additional effort. A special mobile phone is not required.

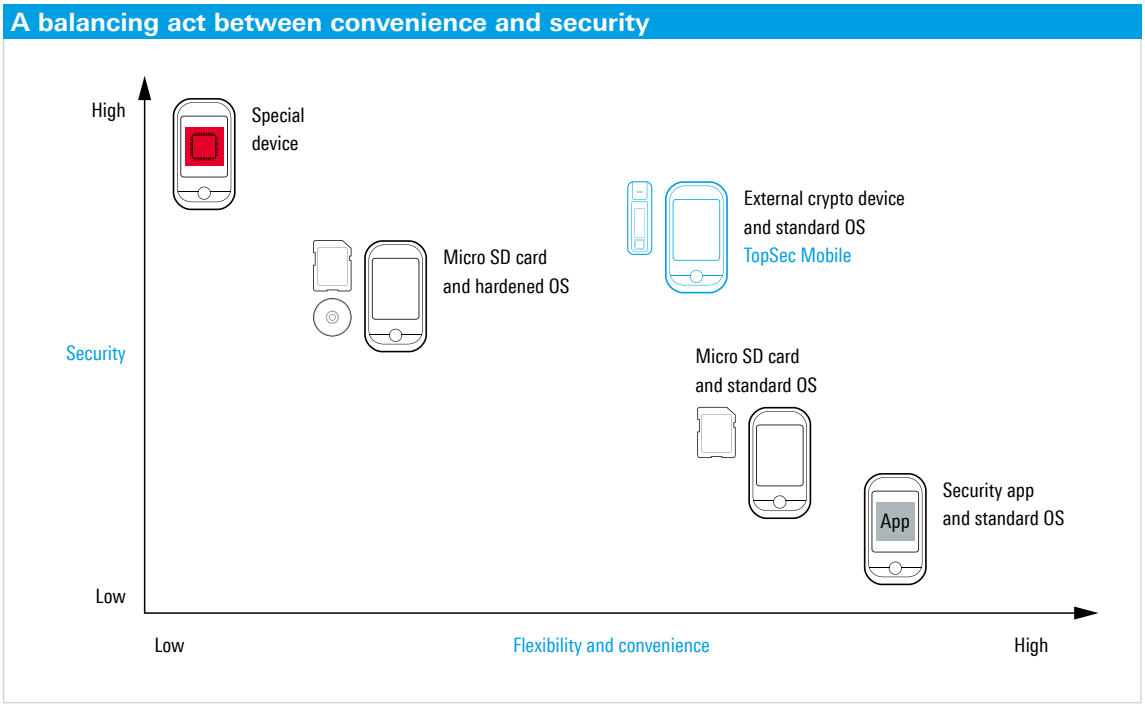


Fig. 2: The solutions that exist for tap-proof telephone calls vary widely in terms of security and ease of operation.

approach. Application-based solutions are the wrong choice if a level of security is needed that professional attackers cannot crack. To satisfy such demanding protection requirements, hardware-based encryption is mandatory. Taking this boundary condition into account, the possibilities come down to two basic concepts: specially developed, hardened crypto phones, or commercial devices with additional hardware security.

Specially hardened crypto phones ensure a high level of security but they are usually associated with trade-offs in the available functions and flexibility. These phones are costly to develop and produce and require time-consuming reworking and recertification in case of product changes.

The second concept involves voice encryption using dedicated hardware components. This includes integrated solutions that encrypt calls inside the phone on a separate smart card. However, such solutions are available for only a few types of phones. Users must choose from among these specific models. Due to the lack of a card slot, smart card solutions are not compatible with the popular iPhone.

There also exist two-device solutions where the voice encryption is performed outside of the telephone. They offer maximum flexibility in the selection of the communications devices. This is the approach implemented in the TopSec Mobile from Rohde & Schwarz SIT (Fig. 3).

Fig. 3: As a stand-alone encryption device, the TopSec Mobile connects via Bluetooth® to iPhones, Android smartphones, PCs and satellite terminals.

TopSec Mobile combines security with flexibility and convenience

The TopSec Mobile is a standalone encryption device that connects to iPhones, Android smartphones, PCs and satellite terminals via Bluetooth®. The device is used whenever a conversation needs to be confidential (Fig. 4). When making secure calls, users talk and listen through the TopSec Mobile's own microphone and speaker while the TopSec Mobile's reliable hardware encrypts the calls. This eliminates the possibility of manipulation by viruses, Trojans and other spyware that might be found on the smartphone. The voice data sent from and to the TopSec Mobile is already secured at the highest possible level when transmitted via the Bluetooth® interface. The communications device is merely used to transmit the encrypted VoIP data. As a result, practically any Android or iOS smartphone or PC with Windows 7/8 can now be easily used for highly secure voice encryption. This translates into enormous savings for teams with changing members or when a pool of devices is needed, for example. Users also like the fact that they can go on working with their preferred communications device.

In tap-proof conference rooms, situation centers and bunker facilities, mobile networks are often unavailable, or the use of mobile phones is not permitted for security reasons. In such environments, the TopSec Mobile can be used to make encrypted phone calls via existing PCs with their network connection.

Encrypted calls to the fixed network

The new TopSec Office Gateway (TSOG) turns the TopSec product family into an all-round solution for tap-proof calls (Fig. 5). The gateway supports encrypted calls between mobile phones and internal telephone sets. This safeguards the link from the TopSec Mobile to the organization's private branch exchange (PBX) against outside attacks. The TSOG receives the incoming calls from other TopSec devices and automatically decrypts them. The calls are routed to the PBX's VoIP interface and then onwards to the desired extension inside the organization.

TopSec Mobile: highly versatile voice encryption

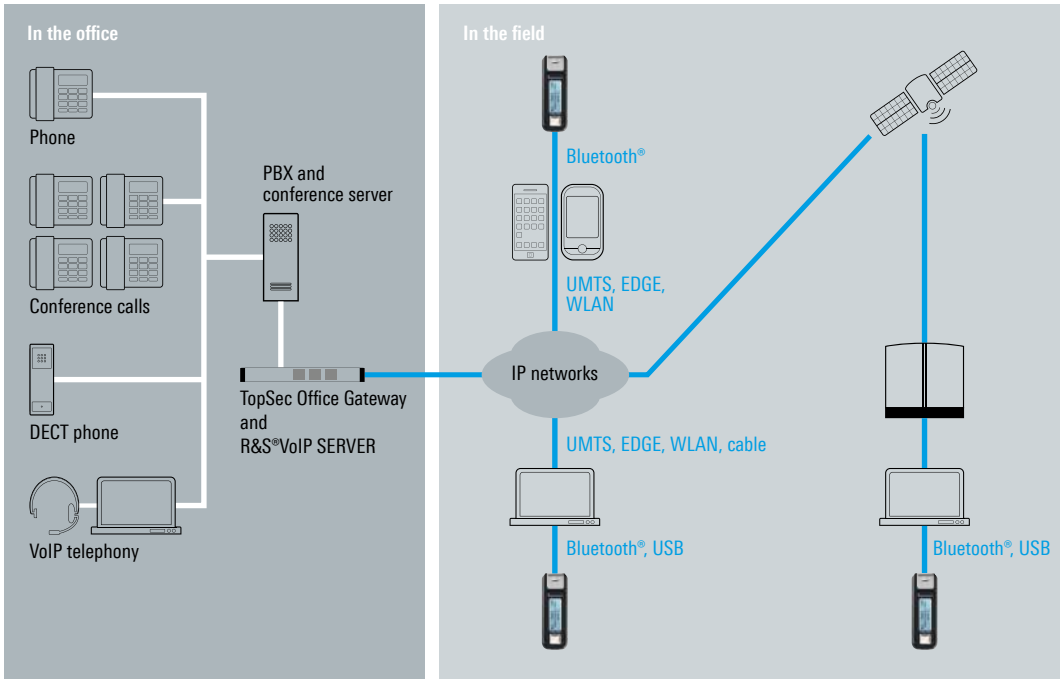


Fig. 4: The TopSec Mobile ensures reliable encryption in any application.

Fig. 5: TopSec Office Gateway: for encrypted calls from mobile phones to a company's internal PBX.

Fig. 6: The R&S®VoIP SERVER ensures top reliability along with ease of use.

Incoming calls from a TopSec Mobile are accepted by picking up the desktop phone as usual. To make an encrypted call from a fixed-network phone to a TopSec Mobile, users simply enter a variable crypto prefix. Outgoing calls are encrypted automatically when the PBX transfers the call to the TSOG and from there to the desired TopSec Mobile. The TopSec Office Gateway dramatically increases the number of parties who can be reached via a secure connection. By achieving better acceptance, the security solution becomes much more effective.

The TSOG is available as a 19" rackmount in two versions: TSOG Medium supports up to eight simultaneous calls between TopSec Mobiles and fixed-network phones while TSOG Large supports up to 32 parallel calls. Custom solutions can be developed for customers with requirements that go beyond these typical performance classes or who need top availability.

The first TSOG installations have already been deployed by European customers.

State-of-the-art encryption methods for perfect forward secrecy*

The TopSec Mobile encrypts calls using the extremely secure AES 256 algorithm. Using the 256-bit encryption, there are 2^{256} possible keys, i.e. 1.15×10^{77}. This algorithm clearly cannot be cracked within a realistic period of time. During each call setup, the encryption devices automatically agree on a new random key, which is deleted immediately upon completion of the call, thereby ensuring perfect forward secrecy.

Like with all VoIP-based encryption solutions, a VoIP server is also used with the TopSec Mobile. The R&S®VoIP SERVER comes in two versions. Also designed as a 19" rackmount, the devices (Fig. 6) handle up to 50 registered users in the Medium version and up to 1000 users in the Large version. Like in the case of the TSOG, high-performance versions can be provided on special request.

The TopSec Mobile is approved by Germany's Federal Office for Information Security for the NATO RESTRICTED classification level.

Christian Reschke

* Perfect forward secrecy ensures that the key cannot be divulged, thereby ensuring confidentiality even if the encrypted communications are recorded.

The best of both worlds – hybrid radiolocation by conventional direction finding (AoA) and TDOA

Fig. 1: The compact outdoor R&S®UMS300 monitoring and radiolocation system for ITU-compliant monitoring, direction finding and emitter location based on TDOA.

Hybrid radiolocation systems from Rohde&Schwarz combine advanced time difference of arrival (TDOA) with tried and tested direction finding based on conventional angle of arrival (AoA), benefiting from the best of both worlds. A large range of TDOA-capable devices and systems offers scalable solutions for a wide variety of tasks.

TDOA – the concept

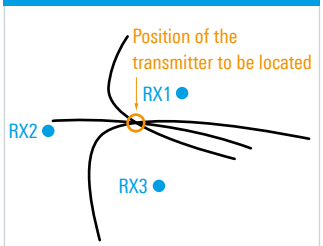
Emitter location based on time difference of arrival (TDOA) must meet the same requirements as tried and tested direction finding based on conventional angle of arrival (AoA): A sufficient number of receivers must be positioned around the transmitter to be located. Its signals, which are propagating at a constant speed, reach the receivers at slightly different times because the receivers are normally located at different distances from the point of emission. The coordinates of the transmitter, i.e. its location, can be calculated from these relative time differences.

Mathematical correlation methods are used to calculate the relative time difference of signals arriving at two receivers. This value and the geographic coordinates of the receivers provide the basis for calculating all possible transmitter positions. Transferred to a map, they would lie on a hyperbola. The calculation is then repeated for a second and, where appropriate, multiple receiver pairs. The point at which the hyperbolas intersect is the origin of the signal, i.e. the transmitter site. This intersection principle is also used for radiolocation by means of direction finders, but with the main difference that relevant transmitter sites do not lie on a hyperbola but on a straight line.

This means that a TDOA radiolocation system must consist of at least three receivers providing three hyperbolas (RX1 – RX2, RX1 – RX3, RX2 – RX3, see Fig. 2). More receivers increase accuracy. There is, however, an upper limit for receivers above which calculation time increases drastically without any significant improvement in accuracy. And there are clear parallels to radiolocation by means of direction finders, too. At least two direction finders are required; a third one increases accuracy, while five or more direction finders do not significantly improve results.

Fig. 2: TDOA location: Three hyperbolas are calculated on the basis of the relative time difference of signals arriving at three receivers. The point at which the three hyperbolas intersect is the transmitter position.

TDOA location



Since electromagnetic waves propagate at the speed of light, system accuracy in the nanosecond range is vital in order to calculate the time differences of arrival. This is why GPS receivers are used. They provide accurate timestamps, which are inserted into the baseband (I/Q) data, and the I/Q data is then used for correlation (Fig. 3). To ensure that calculations provide sensible, unambiguous results, the signals must contain a minimum of information. This is one of the reasons why TDOA is less suitable for unmodulated carrier or CW signals.

The advantages of the TDOA method are particularly revealed in densely built-up urban environments. Typical drawbacks such as reflections and multipath propagation, which create immense challenges for direction finders, are reduced by suitable TDOA algorithms. Complex signal scenarios are frequently prevalent in urban environments. These environments harbor a colorful mix consisting of many emissions; weak transmitters are frequently placed directly adjacent to strong ones, making exacting demands on the linearity, sensitivity and dynamic range of the receivers.

Hybrid TDOA/AoA location – the best of both worlds

Either a TDOA system or an AoA DF system may yield the best results, depending on the signal scenarios and local circumstances. Ideally, both methods should be available at the same time in order to combine their advantages. The new hybrid radiolocation systems from Rohde&Schwarz are ideal for meeting the requirements of both methods and offer a wide range of components for TDOA-based location: the R&S®ESMD, R&S®EB500 and R&S®EM100 monitoring receivers, the R&S®DDF255 and R&S®DDF205 direction finders, as well as the R&S®UMS300 compact monitoring and

Correcting time delays

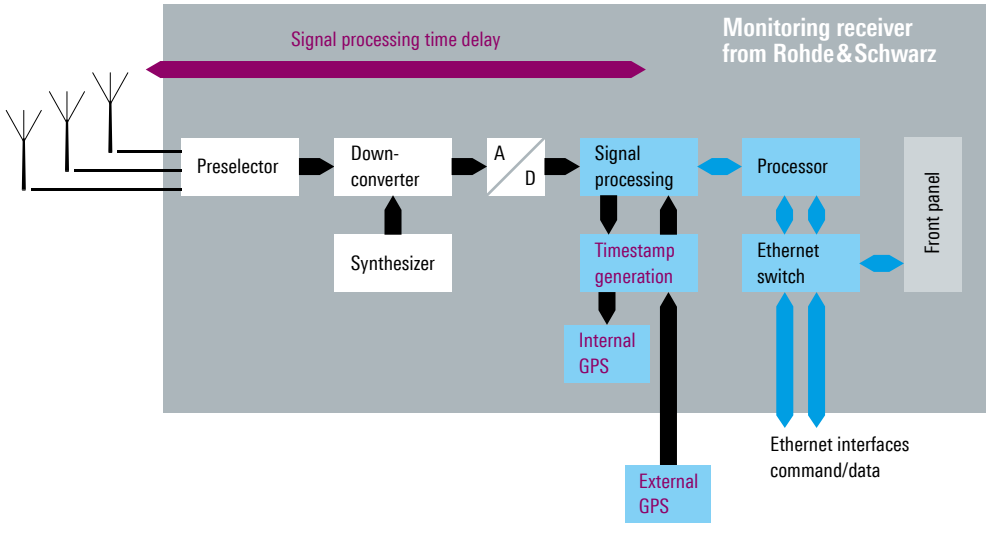


Fig. 3: Rohde&Schwarz devices measure the time delay between antenna input and signal processing. This substantially boosts location accuracy.

radiolocation system (Fig. 1) and the R&S®UMS175 compact monitoring system. To make these devices TDOA-capable, users simply have to connect a suitable GPS receiver (IGT option) and load the latest firmware. Existing devices can be easily retrofitted.

Using a sophisticated method, the Rohde&Schwarz devices calculate the signal delay between antenna input and signal processing and correct the timestamp inserted into the baseband data. This boosts time and location accuracy. In addition, this innovative concept, which is unique on the market, allows users to combine all Rohde&Schwarz devices that support TDOA in any arbitrary configuration to perform emitter location.

The measurements are controlled by the R&S®ARGUS monitoring software. Successful on the market for more than 25 years, this software has become the world standard for all regulators and similar organizations to perform spectrum monitoring tasks. TDOA location can be seamlessly integrated into the numerous measurement and analysis functions offered by this software. The first step in a conventional workflow is to scan a specific frequency band. All transmitters that were found are compared with a reference list that is typically imported from a licence database. Active transmitters that are not in the reference list, e.g. unlicensed ones, are analyzed in greater detail, identified and located. So far, radiolocation has primarily been carried out by means of direction finders. Now, users have a choice between the TDOA method or a combination of TDOA and AoA. They can also perform measurements automatically or interactively.

The R&S®MapView geographic information software is used to select the relevant sensors and display the direction finding and radiolocation results on electronic maps. The software offers a wide range of maps in various formats (free and commercial) and displays the positions of known or licensed transmitters in addition to radiolocation results (Figs. 4 and 5).

Advantages of the Rohde&Schwarz solution

Implementing an optional TDOA functionality in the latest generation of receivers and direction finders from Rohde&Schwarz has the following key advantages:

- High-quality devices ensure higher location accuracy
  High-quality, ITU-compliant devices are a must for successful TDOA location, especially when it comes to signal scenarios in large cities. High sensitivity and a wide dynamic range make it possible to accurately measure even weak signals in close vicinity to strong transmitters.

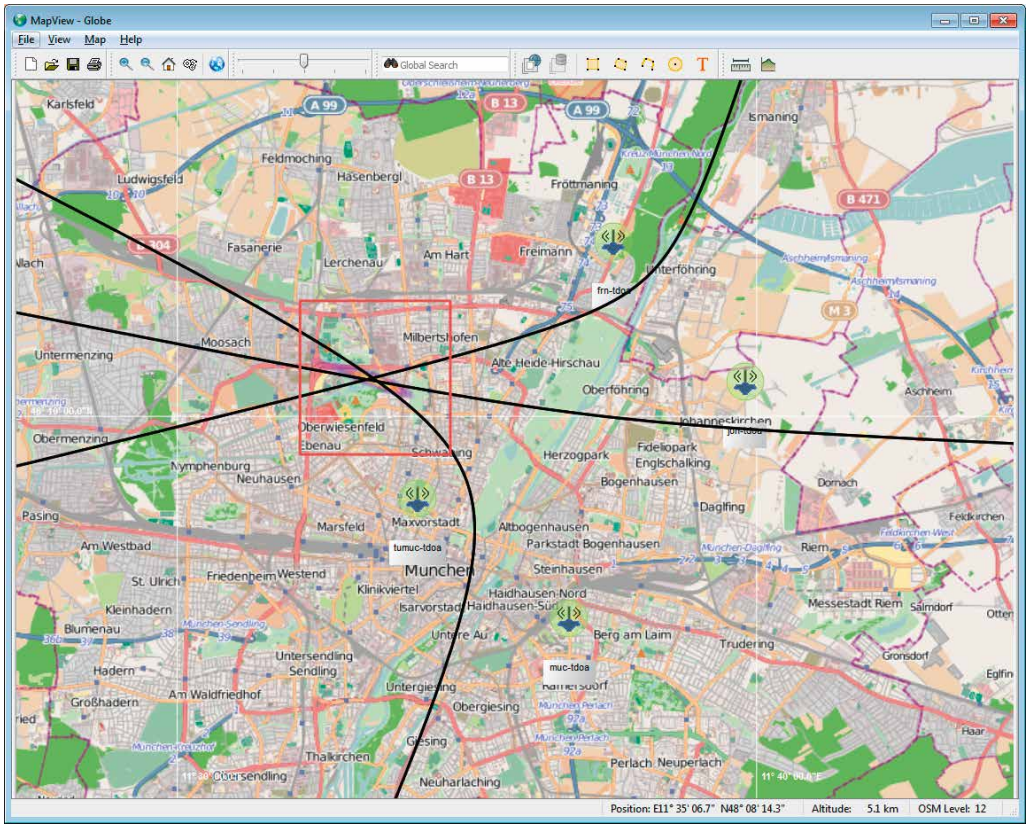


Fig. 4: Display of the TDOA results as hyperbolas and heatmap.

The accuracy of a TDOA location increases with extended signal bandwidth and a better signal-to-noise ratio (S/N). The narrower the signal, the less accurate its location. The high sensitivity of the Rohde&Schwarz receivers creates a higher S/N ratio and provides more accurate radiolocation results. In many cases, it is the high sensitivity which makes radiolocation possible at all. The high sensitivity also compensates for the bandwidth-related inaccuracy, i.e. high-quality devices locate narrowband signals with higher accuracy.

- Flexible combination of TDOA method and direction finding (AoA)

  Users can select between the TDOA method, direction finding (AoA) and the hybrid solution depending on the situation and always have the best method at their fingertips.

- In times when no radiolocation tasks have to be performed, systems can be used for other ITU-compliant measurements

  Emitter location is an important task, but experience shows that it requires only a minor portion of the time. Pure TDOA sensors are largely useless for the rest of the time. Devices and systems from Rohde&Schwarz with optional TDOA capability, by contrast, can be used around the clock for a wide range of additional monitoring tasks. All these TDOA-capable devices and systems can be configured in any combination, enabling users to select the optimum device for their main task.

- Including TDOA functionality in existing hardware obviates the need to find new sites

  It is more and more difficult to find suitable sites for additional monitoring stations. Since existing stations can be easily enhanced, there is no need to spend time and effort in finding sites and in providing the necessary infrastructure such as electricity or connection to network and communications equipment.

Summary

The basic concept of TDOA location is not new. Transmit signals with ever expanding bandwidth, compact, high-performance receivers, global coverage of highly accurate time and position information based on GPS, as well as an ever faster communications infrastructure are good reasons for believing that TDOA will now become a technological and economic success. With its large range of TDOA-capable devices and systems, Rohde&Schwarz offers scalable solutions for a wide variety of tasks. In particular, the combination of TDOA with direction finding based on conventional angle of arrival (AoA) offers the optimum solution for almost any application. This enables all transmitters to be located rapidly and reliably at any time.

Thomas Krenz

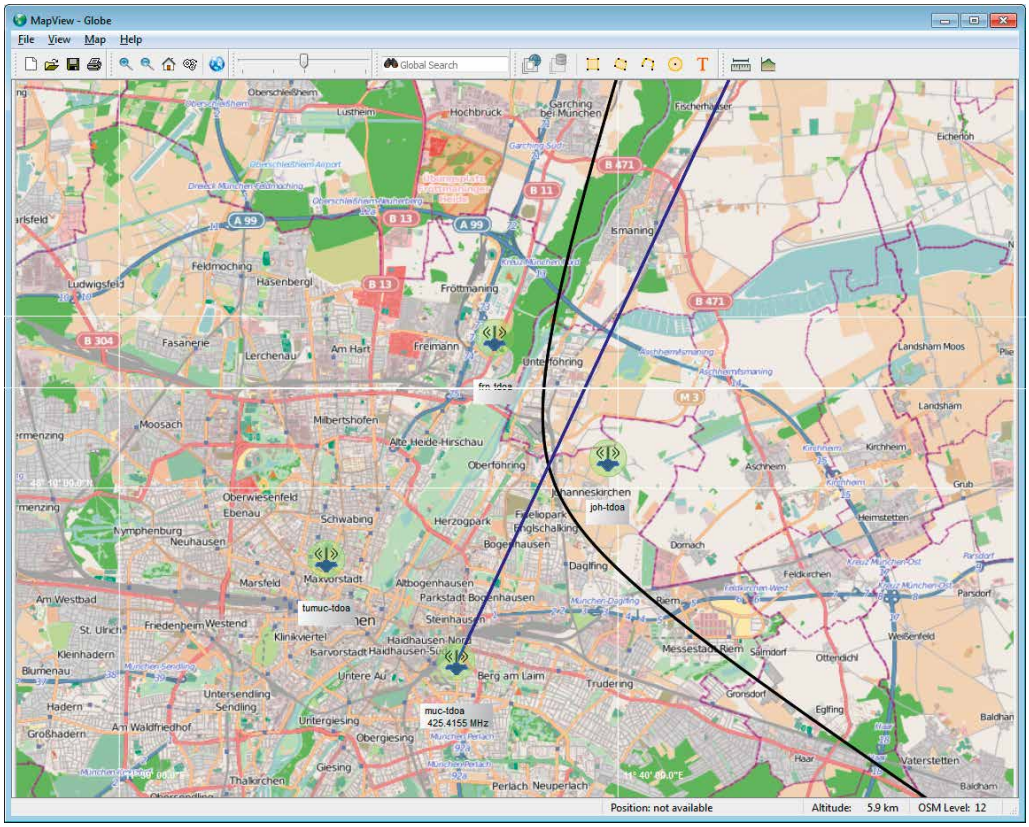


Fig. 5: Hybrid radiolocation using hyperbolas and line of bearing.

Czech air traffic control authority opts for Rohde&Schwarz solution

Air Navigation Services of the Czech Republic (ANS CR) commissioned Rohde&Schwarz to implement a fully IP-based voice communications solution. The focus is on using communications resources between airports in a failsafe, flexible manner by implementing a virtual control center that spans multiple locations. The contract covers the country-wide installation of transmitter/receiver systems – based on the R&S®Series4200 family of VHF/UHF radios – at 18 radio sites. At the same time, the three regional airports in Karlovy Vary, Brno and Ostrava will be equipped with the fully IP-based R&S®VCS-4G voice communications system.

Jan Klas (left), Director General of ANS CR, and Pavel Salanda, Managing Director of Rohde&Schwarz Prag s.r.o., at the signing of the contract.

Photo: Media Broadcast

In a pilot project, the Berlin radio tower at Alexanderplatz now transmits programs in line with the DVB-T2 standard.

DVB-T2 pilot project in Berlin with Rohde&Schwarz

In October 2014, network operator Media Broadcast launched a DVB-T2 pilot project in the Berlin region. Rohde&Schwarz participates in this project with the R&S®AVHE100 headend and latest-generation transmitters for two sites in Berlin. The R&S®AVHE100 headend system makes it possible to encode the broadcast HD programs in line with the HEVC standard. It also contains the company's headend management software, multiplexer and T2-MI gateway, which enable generation of an output stream that is compatible with DVB-T2. The pilot trial will provide for thorough, real world testing of the interaction between all components, from the studio to the receiver. This will also give manufacturers a test environment that they can use to develop compatible consumer electronics. Broadcasting of DVB-T2 programs is scheduled to start throughout Germany in 2016.

Rohde&Schwarz acquires gateprotect AG Germany

With the acquisition of gateprotect AG Germany in July 2014, Rohde&Schwarz further invested in the IT security future market and gained additional expertise in the field of network security. gateprotect AG was integrated into the Rohde&Schwarz group of companies and converted to a limited liability company (GmbH). In December 2013, Rohde&Schwarz acquired Adyton Systems, a producer of network security solutions. Both companies will be combined under the name gateprotect and focus on the development of next-generation firewalls to effectively protect enterprises and organizations throughout the world against cyber attacks.

gateprotect®
A Rohde & Schwarz Company

Rohde&Schwarz hosts ITU Academy for the second time

In November 2014, the International Telecommunication Union (ITU) again held its ITU Academy training program at Rohde&Schwarz. The purpose of the five-day workshop, entitled "Implementation of radiomonitoring systems according to ITU-R recommendations", was to train the employees of national regulatory authorities. Rohde&Schwarz experts gave presentations and provided practical demonstrations on spectrum monitoring.

On the invitation of the ITU Academy, 20 representatives from different countries came to Rohde&Schwarz headquarters in Munich.

3GPP meeting in Singapore

In October 2014, Rohde&Schwarz Singapore hosted a 3GPP meeting at its new headquarters in Changi Business Park. 137 delegates met to continue work on the specification for RF / RRM / demodulation. More than a thousand documents had to be processed for the 75 ongoing standardization projects for release 12, in which RAN4 plays a leading role. Major 3GPP specification features include LTE carrier aggregation, device-2-device, adaptive antenna systems, UE dual connectivity and small cell enhancements. Besides working on the specification, participants also had the opportunity to experience product presentations at Rohde&Schwarz.

The team also visited the Supertree Grove, artificial tree structures in the "Gardens by the Bay".

Professor Rohde becomes honorary professor in Delhi

The Indian Institute of Technology (IIT) in Delhi appointed Prof. Dr.-Ing. habil. Dr. h. c. mult. Ulrich L. Rohde honorary professor in July 2014. Professor Rohde received this honor for his many years of teaching at the highly respected institute. As an honorary professor, he will give lectures and serve as a mentor for student dissertations. His duties also include joint projects, publications in international trade journals and consulting for patent applications. Professor Rohde will also contribute to applied research at IIT in the area of RF and microwave electronics.

Rohde&Schwarz supports Smart Nation Singapore

In December 2014, Rohde&Schwarz Asia Pte. Ltd. signed a joint declaration of intent with the Infocomm Development Authority (IDA) in Singapore. The company will support Singapore as a partner on its way to becoming a Smart Nation. Singapore's technological infrastructure is to be expanded to enable e.g. an Internet of Things or a data cloud to be created. This is where Rohde&Schwarz can contribute its expertise in the field of heterogeneous networks (HetNet), quality of service (QoS) and telecommunications security. Both parties intend to work in particular on HetNet solutions and define the next generation of 5G networks.

Looking forward to working together (from left): Dr. Lim Boon Huat, Managing Director, Rohde&Schwarz Asia Pte. Ltd.; Peter Riedel, President and COO, Rohde&Schwarz GmbH & Co. KG; Professor Toh Chai Keong, Assistant Chief Executive (Engineering & Technology Group), IDA; John Yong, Director (Infocomm Security Group), IDA.

Broadcasting business field becomes broadcast and media

Rohde&Schwarz has moved broadcasting beyond just transmitters and T&M equipment. For years, the company has been expanding its product portfolio along the entire value chain. The name of the Broadcasting Division has now been changed to Broadcast and Media to reflect the new emphasis. Rohde&Schwarz is the world's leading supplier of transmitters and broadcast T&M equipment. The company has also added completely new product lines for studios. Rohde&Schwarz is currently helping the broadcast industry roll out the high-resolution 4K standard with products and solutions that cover ingest to post production, and range from audio/video headends to transmitters and T&M equipment (see also page 44).

Environmental award for Rohde&Schwarz

Rohde&Schwarz was awarded the title of ECOPROFIT company 2014 under Munich's environmental protection program. Munich-based companies develop practical measures to reduce their environmental burden and protect resources. Rohde&Schwarz achieved major energy savings in particular by changing over to LED lighting. The highest efficiency and savings, however, were achieved by including well water cooling in the cooling concept for buildings. The company's environmental measures also include the reduction of greenhouse gas emissions as well as full compliance with environmental legislation, guidelines and standards such as RoHS, REACH, WEEE and ISO 14001.

Johann Schrödl (right), Director of Environmental Management at Rohde&Schwarz, receives the award certificate from Joachim Lorenz, Health and Environment Officer at the City of Munich.

Vimperk is employer of the year once again

In the summer of 2014, the Employers' Association chose the Rohde&Schwarz Vimperk plant as its "Employer of the Year" for the second time. This year the plant won the award in the special category of "Progressive Employer of the Year in Southern Bohemia". In choosing the winner, the jury evaluated factors such as innovative strength, importance placed on employees, financial success, communications and readiness for the future. Vimperk has a workforce of 650 employees, making it one of the largest employers in the Southern Bohemia region of the Czech republic.

Konrad Bartl, Managing Director and Plant Manager, with the award.

R&S®RTE oscilloscope wins reader prize

The R&S®RTE digital oscilloscope took second place in the T&M equipment category of German trade journal Funkschau's "ITC Product of the Year 2014" readers' award. In October 2014, Deputy Editor-in-Chief Markus Kien (left) presented the award to product manager Sylvia Reitz and Guido Schulze (Director of Product Management, Oscilloscopes). Schulze said the instrument was so popular among customers "because it offers the highest sampling and acquisition rates and the largest memory in its class".

R&S®RTE among EDN's "hot 100 products"

In 2014, the R&S®RTE digital oscilloscope made it into online magazine EDN's "hot 100" list. Every year, the editors pick outstanding electronics products among thousands of new products, taking into account innovativeness, ease of use and technological significance. The products that make it into the list also have to be popular among readers, as was the R&S®RTE in 2014. The oscilloscope is ideal for testing embedded designs, for power analyses and for debugging electronic devices and components.

Teisnach plant is "Factory of the Year 2014"

The German business newspaper "Produktion", in cooperation with the consulting firm A.T. Kearney, selected the Teisnach plant as "Factory of the Year 2014" in the category "Excellence in Control of Manufacturing Depth". The jury already recognized the site in 2010 in the category "Excellence in Small Series Production". The jury was very impressed by the continuous growth in the Teisnach plant in the areas of sales, products, employees, technology and space utilization.

In addition, the exceptional control of manufacturing depth, with outstanding achievements in the areas of printed boards, precision mechanical engineering, sheet-metal work, electroplating, assembly and quality assurance, gave the plant a clear edge over the competition. The Rohde&Schwarz plant also scored points with short turnaround times in its drive toward becoming a five-day factory. The "Factory of the Year" prize has been awarded since 1992. The contest is considered the toughest and most tradition-rich benchmark for manufacturers in Germany.

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