NEWS

ROHDE & SCHWARZ

Make ideas real

90 YEARS
OF ENSURING A SAFER AND
CONNECTED WORLD

A tradition of innovation:
90 years of Rohde & Schwarz

Dense frequency spectrum?
No problem with the R&S®ESMW

Evolution of R&S®MXO Series:
more channels and bandwidth

Rohde & Schwarz represents leading-edge technology at the limits of the technically possible. Industry and government customers use our products and solutions to shape their digital and technological sovereignty –

TO ENSURE A SAFER AND CONNECTED WORLD.

COVER FEATURE

Dear Readers,

In this issue of NEWS, we are writing history. More precisely, company history. Starting on page 12, you can read the full story of how a two-man lab developed into the Rohde & Schwarz group that we know today. The occasion for looking back at our own history can be found right on the cover of the magazine: Rohde & Schwarz is celebrating 90 years of success. On page 20, President and CEO Christian Leicher explains how the paths chosen in the past continue to impact the present and where he thinks Rohde & Schwarz will be in ten years.

Innovations have always been an integral part of the company – both yesterday and today. Andreas Pauly and Dr. Andreas Werner, Executive Vice President Corporate R&D, explain what this means to Rohde & Schwarz in a joint interview on page 24. Andreas Pauly has since moved into the newly created President and CTO position. At the time of the interview, he was still speaking as Executive Vice President of the Test and Measurement Division.

It is anything but certain that companies today reach their 90th anniversary. A quick look at the statistics reveals that the average life expectancy of a German company is just over ten years, and the situation is similar in the USA. All the more reason to recognize both the expertise we have built up over decades and the experience we have gained as a valuable asset – and draw on it to develop innovative products and solutions. And you'll find plenty of those from across the whole company in this issue of NEWS.

Enjoy this issue of our NEWS magazine.

Sincerely,

Christian Reiter,
Vice President Corporate Marketing and Communications

12 A TRADITION OF INNOVATION: 90 YEARS OF ROHDE & SCHWARZ

Ninety years ago, in the midst of the Great Depression, two student friends, Dr. Lothar Rohde and Dr. Hermann Schwarz, founded a two-man company with the aim of carrying out pioneering work in the field of RF test and measurement equipment. It has since grown into a global group that has lost none of its original spirit of innovation.

36 DENSE FREQUENCY SPECTRUM?
No problem with the R&S®ESMW

50 EVOLUTION OF R&S®MXO SERIES
More channels and bandwidth.

The new R&S®EVSD1000 VHF/UHF nav/drone analyzer can be mounted under a commercially available drone such as the MATRICE 300 RTK from DJI (page 41).

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NEWS COMPACT

EXECUTIVE BOARD EXPANDED

Andreas Pauly (left) joined the Rohde & Schwarz Executive Board on October 1, 2023 and will be responsible for R&D activities in the newly created position of President and CTO. With three members, the Executive Board is now well positioned to keep the company on course for growth. Peter Riedel (right), who joined the Executive Board in 2014, will remain President and COO. He will focus more on the growing project business. Managing Partner Christian Leicher (center) will continue to head the Executive Board as President and CEO.

With Andreas Pauly, Rohde & Schwarz has bolstered its top management team from within the company's own ranks. The 53-year-old joined the Test and Measurement Division in 1996. In 2003, he qualified for his first management position and in 2015 he was appointed Vice President Signal Generators, Audio Analyzers and Power Meters. Two years later, he became Executive Vice President of the Test and Measurement Division, which he kept on track for success and diversified to withstand market fluctuations. Christina Gessner will take over his position. This means the Test and Measurement Division will remain in the hands of a deserving manager from within the company's own ranks. Christina Gessner has been with Rohde & Schwarz since 2004.

KIEL SITE EXPANDED

The Rohde & Schwarz Kiel site mainly handles large-scale naval projects and its rapid growth is a testament to the company's success in this field. The site was expanded in the summer 2023 as a naval competence center to cope with the growth. New and much larger premises were acquired in the Wissenschaftspark Kiel (Kiel Science Park). High-ranking politicians and representatives of the German armed forces and industry attended the official opening ceremony in late August, including the Minister-President of Schleswig-Holstein, Daniel Günther.

A team of around 60 employees will focus on system engineering, software development and integration of communications systems and electronic support measures for the self-protection of naval vessels.

Much like the Hamburg location, Kiel is also close to German naval bases. The location provides ideal conditions for close, long-term collaboration. Rohde & Schwarz intends to expand its workforce in Kiel soon.

The town hall tower is a Kiel landmark. The Rohde & Schwarz location in the Science Park is about three kilometers to the north.

ARDRONIS LOCATE COMPACT FOR DRONE DETECTION OVER LARGE AREAS

The ARDRONIS drone counter system has been expanded to include the Locate Compact version for wide areas. Like other ARDRONIS versions, the system uses antennas and direction finders to detect drones. Budgets quickly become an issue since large surveillance zones require multiple antennas and direction finders. With a sensibly limited range of functions, the Locate Compact version can be used to cost-effectively set up large-scale surveillance zones. The main applications include airports, large industrial plants and military facilities. The system is semi-transportable but can also be set up and operated by a single person. Moreover, it is suitable for short-term surveillance and monitoring, such as when protecting political VIPs during state visits or monitoring military positions, thanks to its quick set up and disassembly.

The system locates and identifies drones based on their wideband video signal and automatically recognizes transmission technologies such as DJI Lightbridge, DJI Ocusync and Autel Skylink that most commercial drones use to transmit live video to pilots. Rohde & Schwarz is continuously updating its radio signal and video signal database to make sure that drone detection can keep pace with technological advancements. A jammer can also be added for countermeasures. The ARDRONIS Locate Compact is a standalone system, but can also be integrated into anti-drone systems with multiple sensors via an open interface.

The ARDRONIS anti-drone solution was launched in 2016. With more than 200 systems sold, it now protects facilities and infrastructure around the world from unauthorized fly-overs by mini and microdrones. Even high-ranking conferences, such as the G7 Summit, are regularly protected by ARDRONIS.
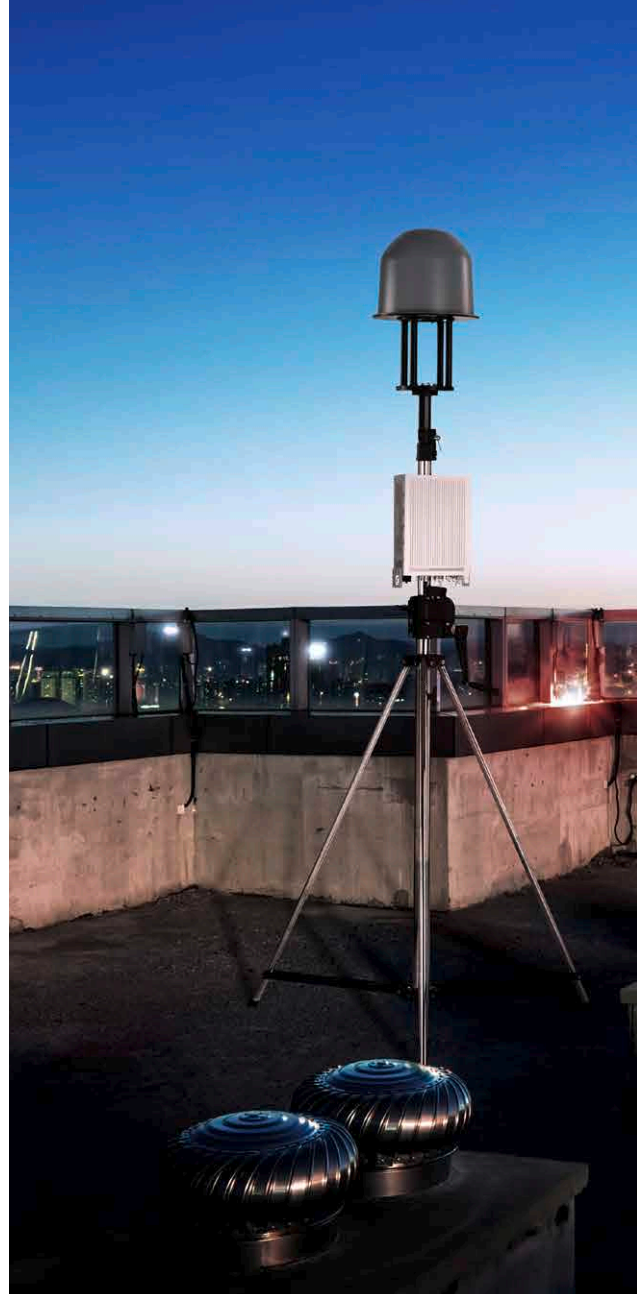
ARDRONIS Locate Compact overview

- ▶ Detection alarm for radio signals even before the drone is in the air
- ▶ Complete 360° surveillance
- ▶ Detect, classify and identify both unmanned aerial vehicles and remote-controlled devices
- ▶ Detection based on FHSS, analog and digital video signals
- ▶ Direction finding based on analog and digital video signals
- ▶ Location and tracking with triangulation (requires multiple ARDRONIS systems)

You can find more information on the ARDRONIS Locate Compact on the Rohde & Schwarz website in the drone counter section.

MAJOR ATC PROJECT SUCCESSFULLY COMPLETED

The German Air Navigation Service Provider DFS and Rohde & Schwarz have successfully completed the RASUM (Radio Site Upgrade and Modernization with 8.33 kHz) modernization project. Over several years, ATC radio technology was modernized with state-of-the-art equipment at more than 100 DFS transmitter sites throughout Germany. Rohde & Schwarz modernized some 4000 airborne radios and was responsible for the technical planning and overall integration of the radio sites. RASUM is also a milestone for the aeronautical radiocommunications business at Rohde & Schwarz: the 10,000th R&S®Series4200 radio was delivered during this project and is now in use at the DFS Feldberg-Taunus transmitter site.

This large-scale project began with EU Regulation 1079/2012, which required air navigation service providers in Europe to convert their radio systems to 8.33 kHz channel spacing. Existing devices without support for the new channel spacing had to be replaced. DFS took this commitment as an opportunity for thorough modernization of its technical infrastructure, which Rohde & Schwarz supported from start to finish as part of the RASUM project.

UHF transmitter from the R&S®Series4200. This globally popular equipment family is also used at DFS.

PROFESSOR ROHDE RECEIVES DOUBLE HONORS FROM THE IEEE

The Institute of Electrical and Electronics Engineers (IEEE) counts 40 societies among its members. Prof. Dr.-Ing. habil. Dr. h.c. mult. Ulrich L. Rohde has now received the Distinguished Industry Leader Award 2023 from two of those societies at once. The IEEE Antennas and Propagation Society (AP-S) honored him this year for his scientific contributions and leadership role in the field of antennas and associated communications systems that have led to the development of state-of-the-art antenna products for industrial, military and aerospace applications. For his contributions and leadership in the field of radios and in the field of T&M instruments that have led to the development of state-of-the-art communications systems and their use in industry, the IEEE Communications Society recognized him with a second award.

Prof. Rohde has been recognized by the Institute of Electrical and Electronics Engineers (IEEE) with both the IEEE Communications Society Distinguished Industry Leader Award 2023 and the IEEE AP-S Distinguished Industry Leader Award 2023 (pictured).

CONTROL OVER 300 QUBITS – WITH A SINGLE SYSTEM

Having demonstrated the basic operability of quantum computing systems, research and development is now focusing on improving performance. The number of qubits per system is expected to increase from the current 10 to 1000 qubits in the near future – and 100,000 in the longer term. To make that a reality, research laboratories need systems with more microwave control and measurement channels that require high-precision synchronization for correct control and readout of the qubits. In addition to upscaling qubits, the second major area of research on the path to high-performance quantum computers is effective quantum error correction. Control systems must be capable of extremely fast signal processing as well as real-time capability in the range of only a few hundred nanoseconds.

The Quantum System Hub (QHub) from Zurich Instruments can connect up to 56 instruments in a precisely synchronized system network. Adding or removing instruments is simple with plug&play. Automatic calibration routines eliminate the need to manually set propagation delays and keep synchronization stable for several weeks without manual recalibration. One QHub controls up to 448 microwave measurement channels for maximum latency of just 550 ns across the entire system

network for control of quantum computers with over 200 tunable or 300 fixed frequency qubits. Low latency enables advanced error correction mechanisms directly in the QHub. An integrated FPGA provides the necessary computing power. The QHub is run with either LabOne® Q control software from Zurich Instruments or can be integrated into existing control software using a Python interface.

Find more information about QHub on the Zurich Instruments website.
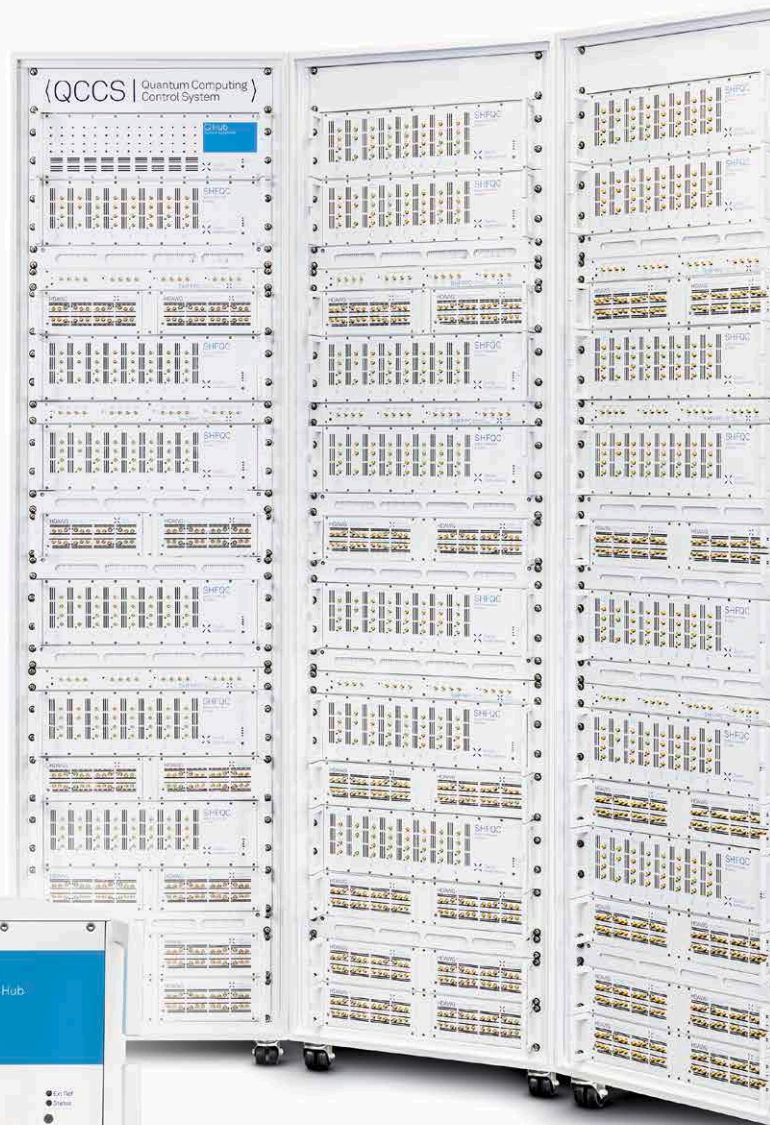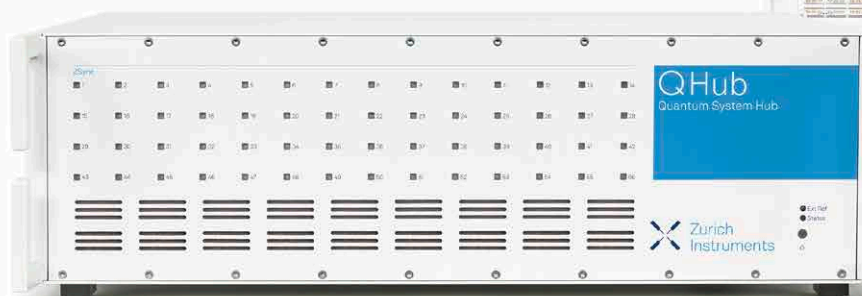
© Janos Radler, Zurich Instruments AG

PROFESSOR ROHDE NAMED HONORARY FELLOW
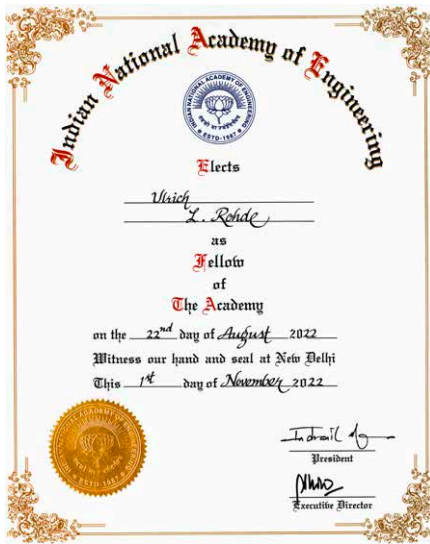
Prof. Rohde is a Fellow of the Indian National Academy of Engineering (INAE).

In December 2022, the Indian National Academy of Engineering (INAE) conferred its Honorary Fellowship on Prof. Dr.-Ing. habil. Dr. h.c. mult. Ulrich L. Rohde.

The Academy announced accordingly: "Taking note of Dr. Ulrich L. Rohde's outstanding contributions to engineering and also his dynamic leadership in the engineering domain that have immensely contributed for the faster development of India, the Indian National Academy of Engineering (INAE) Council has decided to elect Dr. Rohde as a Fellow of the INAE at its recent meeting under the special provision of Rule 37(g). Dr. Rohde is only the third foreign fellow elected by the INAE, Professor David Jeffery Wineland and Philip Knight were the only others.

The INAE was established in 1987 and is a "peer" body of distinguished engineers and technologists. The Academy covers the entire engineering profession and fosters the promotion and advancement of the practice of engineering and technology and their applications to problems of national importance. The Academy is also a Member of the International Council of Academies of Engineering and Technological Sciences (CAETS). As on date, INAE has 889 Indian and 94 Foreign Fellows on its rolls."

ITU RECOMMENDS INTERACTIVITY TEST

The International Telecommunication Union (ITU) has approved the Rohde & Schwarz interactivity test as a standardized test procedure and included the test in the ITU-T G.1051 Recommendation. The procedure evaluates the smooth and lag-free provision of interactive services in mobile networks. Latency, transmission rate and packet error rate are collected under load conditions that simulate a video call in a network connection. A point score evaluates the interactive capabilities for a specific use case. Compared to previous methods, the interactivity test provides more detail and makes it easier to identify data transmission bottlenecks.
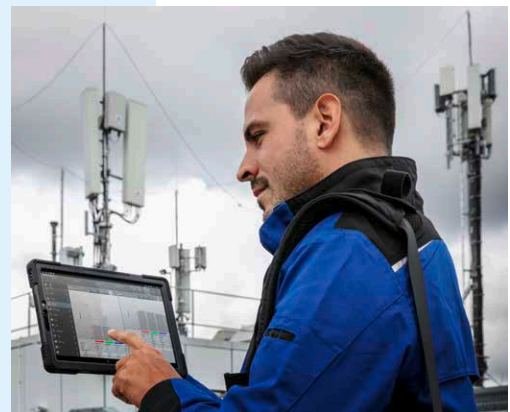
The ITU has approved the Rohde & Schwarz interactivity test as a standardized test procedure for mobile network testing solutions.

1500 SQUARE METERS FOR ASIC DEVELOPMENT

Rohde & Schwarz has expanded its development site in Duisburg. Site manager Bastian Nagel from the Rohde & Schwarz Corporate R&D Division heads the team developing application-specific integrated circuits (ASIC) in the new labs that cover a total area of 1500 square meters. ASICs are tailored to specific tasks and are very efficient, but challenging to develop. They are key components in high-end measuring instruments and often their USP. The site expansion illustrates the commitment by Rohde & Schwarz to this important field. "We benefit from outstanding universities and research institutes nearby," says Nagel when explaining the advantages of the location. "We also have excellent connections to the rest of Germany and Europe."

Example of an highly integrated ASIC developed in-house: the MXO-EP ASIC is used in the R&S®MXO 4 and R&S®MXO 5 Series oscilloscopes.
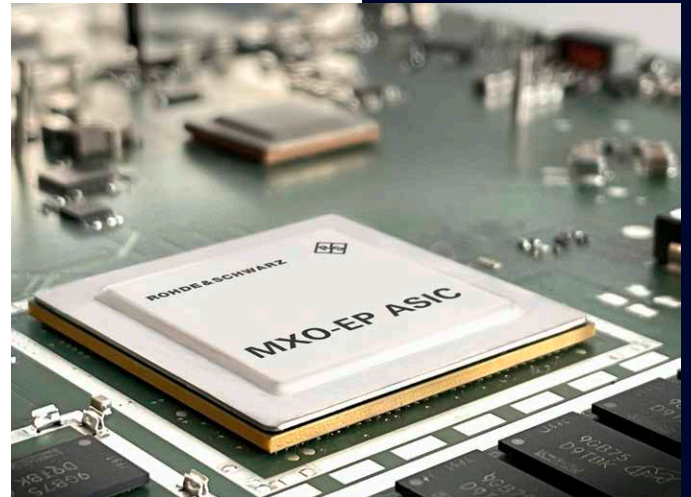
IPCEI FUNDING FOR MICRO-ELECTRONICS PROJECT

Rohde & Schwarz has been awarded funding in an Important Project of Common European Interest in microelectronics and communications technologies (IPCEI ME/CT). It is the European Union's largest semiconductor initiative to strengthen European technological and digital sovereignty. Rohde & Schwarz will receive funding to develop a new highly competitive European T&M solution for the millimeterwave range. The creation of GaN/SiC semiconductor technology will be needed for a major part of the project and will lay the foundation for developing and testing new components required for 6G, modern sensors, automotive radar applications, the internet of things (IoT) and Industry 4.0. The IPCEI ME/CT will include some 100 European projects classified by the European Commission as strategically important for its competitiveness.

Rohde & Schwarz presented its project, which is funded under the IPCEI ME/CT, at the "Microelectronics: Key to Transformation" event at the German Federal Ministry of Economics and Climate Protection (BMWK) on September 18, 2023.

Source: BMWK/bundesfoto/Christina Czybik

90 YEARS
OF ENSURING A SAFER AND CONNECTED WORLD

A TRADITION OF INNOVATION: 90 YEARS OF ROHDE & SCHWARZ

Ninety years ago, in the midst of the Great Depression, two student friends, Dr. Lothar Rohde and Dr. Hermann Schwarz, founded a two-man company with the aim of carrying out pioneering work in the field of RF test and measurement. It has since grown into a global group that has fully retained its original spirit of innovation.
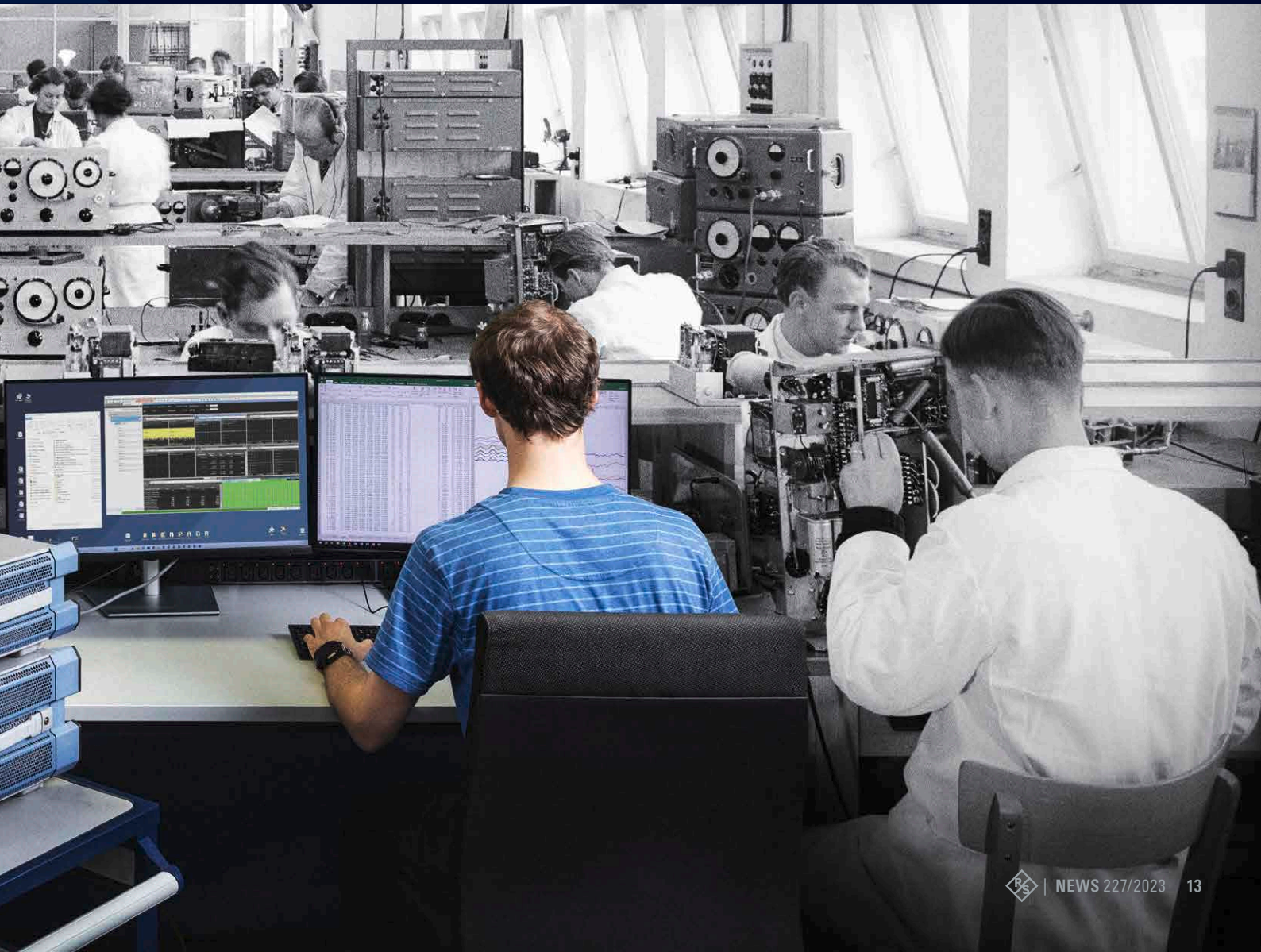
Fig. 1: The first staff photo dates from 1936. Dr. Hermann Schwarz (left) and Dr. Lothar Rohde sit in the foreground.

Jena in the late 1920s. Fellow students Lothar Rohde and Hermann Schwarz discover their fascination with the then unexplored world of RF engineering and in 1932 develop their first measuring instrument together: an interference wavemeter commissioned by the Hermsdorf-Schomburg-Isolatoren-Gesellschaft (Hescho). The instrument became a great success and encouraged the two young men to establish the Physikalisch-Technisches Entwicklungslabor Dr. L. Rohde und Dr. H. Schwarz (the Physico-Technical Development Laboratory, or PTE) in Munich, in 1933.

Since there were no potential customers in Germany in the 1930s, the young company set its sights overseas. In fact, as early as 1934, an English ceramics company came knocking and ordered a dissipation factor meter from 50 MHz to 200 MHz. This marked the beginning of an export business that is still vitally important today.

Leaving their first mark on the history of technology

In the years that followed, the PTE developed other instruments and repeatedly set new milestones that went down in the history of technology. One of these was the invention of the first portable crystal clock in 1938. Weighing in at 36 kilograms, its description as "portable" may seem somewhat fanciful from today's perspective, but it was an apt choice given the technological standards of the time, which featured crystal clocks the size of a wardrobe and weighing several hundred kilograms. Two years later, the WIP universal frequency meter followed. The instrument became PTE's first bestseller and was exported worldwide for more than twenty years.

With the beginning of the Second World War in 1939, increasing numbers of orders came from the German Navy and Air Force. But the company's production capacity was not designed to cope with that level of demand. So, in 1941,

Messgerätebau GmbH was founded. In 1944, it began production in Memmingen, some 100 kilometers to the west. This is the time when the company's name also changed, first to Rohde & Schwarz Physikalisch-Technisches Entwicklungslabor and finally, in 1945, to Rohde & Schwarz.

After the war ended, German broadcasting came to a virtual standstill and faced a difficult challenge thanks to unfavorable frequency allocation in the newly drawn-up international frequency plan of 1948. Against this backdrop, a switch from medium-wave broadcasting technology – which had been the norm up to that point – to very high frequency (VHF) technology began to be considered. Rohde & Schwarz had a certain amount of expertise in this field and was awarded a contract by Radio Munich, the predecessor of Bavarian public broadcaster Bayerischer Rundfunk, to build a frequency modulated VHF transmitter. Originally scheduled for completion on March 1, 1949, Europe's first VHF FM transmitter went into operation on February 28, 1949 – just six weeks after the contract was awarded and only narrowly beating its competitors. This marked the successful debut of Rohde & Schwarz in the radio broadcasting industry. Next came the establishment of European VHF FM transmitter chains, for which the company expanded its product range to include transmitting antennas and T&M control and monitoring equipment.

Venturing into new business fields

The mid-1950s saw the launch of the company's radiocommunications and radiomonitoring/radiolocation business fields. Both fields were promoted with the cooperation of the German authorities. In 1957, Rohde & Schwarz began supplying the German armed forces with the EK 07 shortwave receiver. By 1962, the overload-resistant device was so successful that it became the standard radiomonitoring and intelligence receiver from that point on.

Another important customer was the German Federal Administration of Air Navigation Services. The volume of air traffic increased sharply in the 1950s, so did the requirements for locating aircraft. Direction finding was needed to

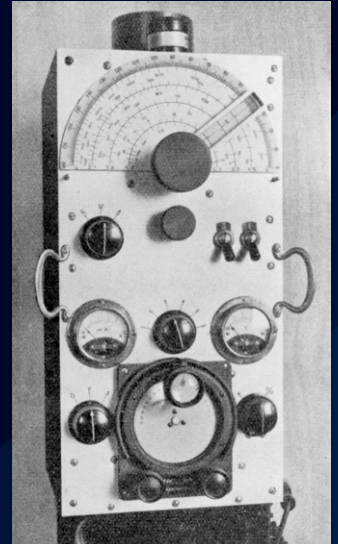## Milestones from the first twenty years of the company's history

Fig. 2: First joint project: interference wavemeter (1932).

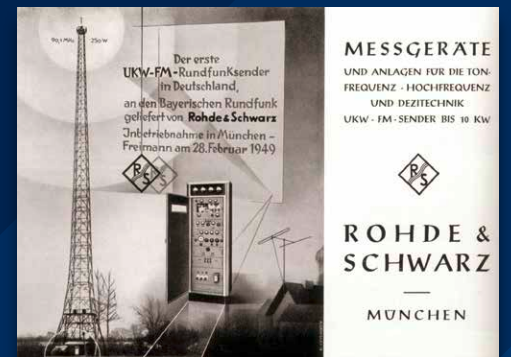Fig. 3: The first portable crystal clock (1938).

Fig. 4: Europe's first VHF FM transmitter (1949).

Fig. 5: The world's first vector network analyzer (1950).

complement radar technology. In 1953, the company first developed a manually operated rotary Adcock antenna, which was later followed by the NAP1 automatic visual direction finder, which worked according to the rotating antenna principle. In 1957, the system was put into operation at Munich Riem Airport.

Test and measurement were no less successful than these new business fields. The first vector network analyzer appeared on the market in 1950. The Z-g diagraph was used for measurements on audio broadcasting and television antennas as well as on two-pole and four-pole networks. Around this same time, the company developed the compact SWOB wideband sweep generator, whose successor was considered a standard in TV set alignment for years to come.

The boom years
The company's success was quickly reflected in employee numbers and sales figures. In 1948, Rohde & Schwarz had around 500 employees. Just six years later, the company hired its thousandth staff member. This figure had doubled by 1960, with net revenue growing by between 40 and 50 percent a year during this period.

The company also repeatedly found itself short on space. To keep up with expansion, a modern six-story facility was built on Mühldorfstrasse in Munich in 1960/1961, which still serves as the company's headquarters to this day. Production capacity in Memmingen was also expanded at the same time, and a plant in Teisnach was opened in 1969.

Successful internationalization
In the early 1970s, the company's two cofounders welcomed Friedrich Schwarz, son of Dr. Hermann Schwarz, to the Executive Board and entrusted him with the two crucial responsibilities of internationalization and financial independence. He accomplished both of these feats masterfully. In the 1980/1981 fiscal year, Rohde & Schwarz became completely independent of any financial backers, and just one year later, for the first time in its history, it sold more equipment abroad than in its domestic market. Today, the company has subsidiaries and offices in over 70 countries, and exports account for more than 80 percent of its business.

The second generation takes over
In 1985, Dr. Lothar Rohde passed away, and Dr. Hermann Schwarz died ten years later. A new era began, marked by a sharp increase in the number of electronic components and devices, and by digitalization. This opened up completely new business fields, such as electromagnetic compatibility (EMC). Rohde & Schwarz used its expertise from developing receivers to enter the EMC test and measurement market. One of the company's first projects in this field was equipping Europe's largest and most advanced EMC test facility in the Bavarian town of Greding in 1987/1988. Today, Rohde & Schwarz is at the forefront of electromagnetic compatibility testing, from troubleshooting to full conformity testing.

In 1986, the FSA marked the company's entry into spectrum analysis with a cutting-edge model that set new standards in precision,

Fig. 6: Turnover rose sharply from the 1960s onwards.

Rohde & Schwarz sales trend 1933 to 1983
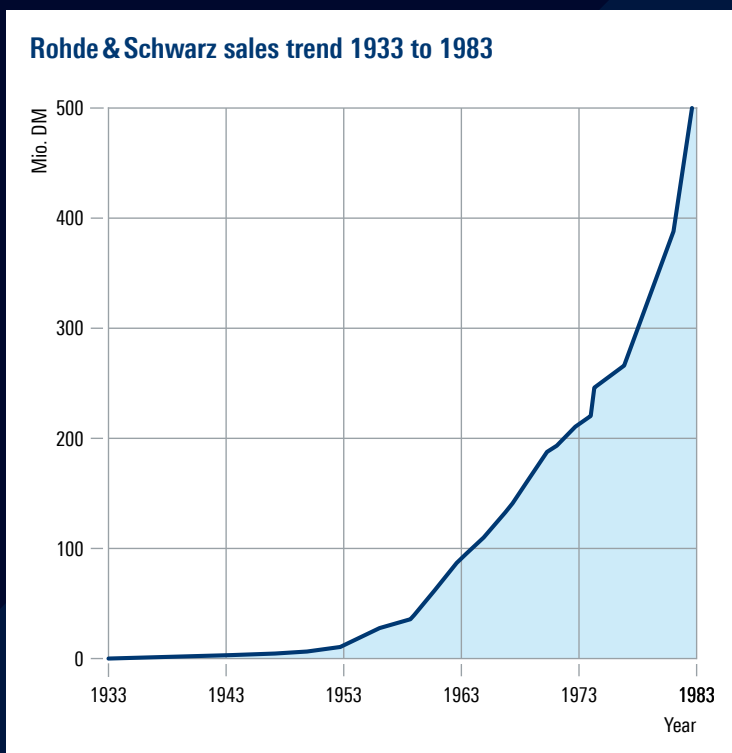
dynamic range and inherent noise. The year 1992, when Rohde & Schwarz delivered the first GSM system simulator, represented a milestone in mobile communications technology. Little did anyone suspect at the time that this instrument would prove to be of crucial importance for the expansion of mobile communications across the globe, and in particular for the GSM network that had been developed in Europe. At the time, every type of cell phone was approved using a system simulator from the Munich based company.

In the period that followed, Rohde & Schwarz continued to strengthen its position at the forefront of mobile communications test and measurement. The CMD tester had been sold more than 10,000 times by the turn of the millennium. Its successor, the R&S®CMU200, established itself as the standard solution in cell phone development and production. In the early 2000s, one out of every two cell phones

worldwide was developed or manufactured using Rohde & Schwarz equipment. This was accompanied by a renewed search for additional production capacity. In 2001, the plant in the Czech town of Vimperk opened its doors. Another plant was opened in the Malaysian port city Johor Bahru in 2011, completing the current network of Rohde & Schwarz plants.

IT security recognized as a topic for the future

The relevance of IT security increased significantly in the mid-1990s. Rohde & Schwarz recognized this trend and in 1996 acquired SIT GmbH, a specialist in high-security encryption products. In 2001, the company launched the TopSec GSM, the world's first tap-proof cell phone, which featured a special encryption system integrated directly into the phone.

Rohde & Schwarz also achieved milestones in secure communications. The R&S®M3xR software defined radio family was introduced for

Fig. 8: The R&S®CMW500 made its market debut in 2007 and was developed specifically for the production environment.

Finally, in 2019, the company launched the next generation R&S®CMX500, a future-ready solution offering 5G NR testing.

Mastering entry into new markets

In 2010 and 2014, the company succeeded in breaking into two markets that were completely new to Rohde & Schwarz. First, the company impressed customers in the oscilloscope market – a market already dominated by the competition – by introducing numerous technical innovations. In 2014, it unveiled the R&S®QPS security scanner, a world's first that made security checks much more convenient – first at airports and then in other high-security areas. For a detailed account of how the R&S®QPS came into existence, see the article on page 28.

In 2011, Rohde & Schwarz broke new ground in the transmitter industry with the pioneering R&S®THU9. State-of-the-art power transistors, a low-attenuation RF network, new concepts in signal processing and improved cooling components increased maximum transmitter efficiency to an unprecedented 28 percent. It was a strong response to broadcasters' demands for lower energy and infrastructure costs.

The technical progress continued in other business fields as well. Also in 2011, Rohde & Schwarz launched the R&S®FSW high-end spectrum analyzer. The instrument's large touchscreen was considered something of a revolution at the time. It was the first time that such a wide range of software features could be operated in a simple and straightforward way, often with the option of recording different measurement configurations on one screen. In 2013, the R&S®SMW made its market debut, marking a new generation of vector signal generators capable of effortlessly meeting the stringent T&M requirements of modern telecommunications standards. While the initial instrument's RF paths covered a frequency range of up to 6 GHz, the latest versions of the premium vector signal generator cover a frequency range of up to 44 GHz or 67 GHz with a single RF path.

military use in 1999, while in 2006, the company developed the R&S®Series4200 family of VHF/UHF radios for civil air traffic control. This was the company's response to the increased load on radiocommunications systems caused by the growth in air traffic.

The dawn of the 21st century marked the start of the triumphant advance of mobile communications and, a little later, of smartphones. In 2007, Rohde & Schwarz developed the R&S®CMW500 wideband radio communication tester for testing mobile terminals in production environments. Thanks to close cooperation with cell phone manufacturers and chipset developers, it was possible to drastically shorten the time required for testing.

New risks, new products

Rohde & Schwarz also had its finger on the pulse when it came to IT and cybersecurity. As a result, Rohde & Schwarz Cybersecurity GmbH was formed from acquisitions in 2016. This laid the foundation for securing digital communications. The product line includes high speed network encryptors as well as components for managing WAN, LAN and WLAN networks.

Cyberspace is not the only place that needs certain protective measures to counter new threats; real airspace does, too. The emergence of micro and mini drones also drove demand for reliable anti-drone systems in the mid-2010s. Rohde & Schwarz responded with ARDRONIS. To date, the system has demonstrated its worth on numerous operations, such as during the 2015 G7 Summit in Germany, as well as state visits, political assemblies, and when protecting international air shows.

The secure communications product line welcomed a new member in 2016 in the form of ELINT, an innovative system for radar signal detection and analysis. It can be used on almost any platform and in any signal environment. And finally, in 2017, Rohde & Schwarz unveiled the NAVICS® IP based integrated communications system for naval vessels. It combines both internal and external voice and data communications with cybersecurity technology from Rohde & Schwarz.

Today, the privately owned company is managed by Christian Leicher, Peter Riedel and Andreas Pauly, and employs around 14,000 people. They research cutting-edge topics such as 6G, artificial intelligence, and cloud and quantum technologies – and follow the same successful path trodden by the company's founders. For a secure and connected world, today and in the future.

EDITORS

Fig. 9: NAVICS® covers all shipboard communications and interfaces to long-distance communications systems. The Australian Cape-class patrol boats and City-class frigates of the British Royal Navy are two examples of vessels that use the system. More than 40 navies worldwide rely on Rohde & Schwarz communications technology.

INTERVIEW WITH PRESIDENT AND CEO CHRISTIAN LEICHER

"WE'VE ALWAYS BEEN DRIVEN BY INNOVATION"

Over the last 90 years, Rohde & Schwarz has grown from a two-man lab to a global company. But to this day, the focus on innovation and financial independence combined with the flexibility and reliability that comes from a high degree of in-house value creation has remained steady. The technology company will continue to pursue this path in the future.

NEWS: Mr. Leicher, you've been a managing partner for almost twenty years and, since 2016, President and CEO. How do you look back on the company's history?
Leicher: For me, there are three key elements right from the founding of the company: courage, location and technology focus. It was a courageous step for two physics students to set up their own business with just one regular customer, Hermsdorf-Schomburg-Isolatoren-Gesellschaft, especially during an economic depression.

Today, Munich is the perfect location for an ambitious technology company. When the company was founded in the 1930s, however, Berlin and Jena (where both founders studied) would have been much more suitable. But Munich had the advantage of being close to the mountains. And so, in a way, we owe our location in Munich to the love of mountain hikes that our company founders Dr. Lothar Rohde and Dr. Hermann Schwarz shared. Rohde & Schwarz would undoubtedly look very different today if they had made a different choice back then.

One key point is the focus on technology. Our founders were very different in many ways, which meant that they complemented each other well. They shared a passion for making new technologies useful. That's why one of their first employees was an engineer. Rohde & Schwarz still has that same passion today.

NEWS: What course did the founders set for the company?
Leicher: We've always been driven by innovation, put a high premium on quality, and worked closely with customers. It all came naturally. In the 1930s, RF technology and RF test and measurement were still largely uncharted territory that had to be explored with research and development. Rohde & Schwarz was in close contact with customers right from the beginning because it started as a contract developer. We continue to work just as closely with our customers today.

Very early on, the company invested in setting up its own production facilities. That makes us reliable and flexible as a company, but also gives us the best possible control over product quality. This was possible thanks to the economic recovery of the 1950s, which Dr. Lothar Rohde and

Fig. 1: The history of Rohde & Schwarz started at 36 Thierschstraße in Munich.

Dr. Hermann Schwarz capitalized on in a way that was both brilliant and forward looking. Reliability and flexibility thanks to vertical integration remain vital aspects of Rohde & Schwarz today.

Two key success factors in the company's history are a focus on financial independence and the fact that we've managed to keep it going over three generations. History is sadly awash with examples of companies that failed to transition even from the first to the second generation.

Another key point was restructuring to shift from custom manufacturing to developing products that were competitive on the global market. Internationalization was also hugely important, particularly the creation of a sales team with independently operating national subsidiaries. There are very few companies today of a similar size that have a comparable footprint of national subsidiaries.

NEWS: The focus on international markets from the 1970s onward was also a response to stagnating economic growth in Germany, the company's domestic market. How does Rohde & Schwarz respond to major changes today?
Leicher: Keeping an eye open for key technologies is essential for any technology group. Where we differ from some of our competitors though, and where our financial independence also helps us stand out, is our aim to invest in key technologies early on and build up our own

"We're continuing on our path as an independent, privately owned company and technology group."

expertise. Two current examples are quantum technology and data analytics. We consciously invested in expertise and technology in these fields by acquiring Zurich Instruments and Schönhofer Sales and Engineering GmbH. Bolt-on technology acquisitions like this are part of our corporate strategy. Our vertical integration also gives us the adaptability we need in the event of major upheavals.

NEWS: Where do you see Rohde & Schwarz in ten years?
Leicher: We will continue to develop products and solutions for a more secure and connected world. We're convinced that this approach will ensure that we're addressing future markets. As a company, we want to continue to grow sustainably with a dynamic increase in turnover from 2.78 billion euros today. We're continuing on our path as an independent, privately owned company and technology group. All the indicators look good. We're well positioned in our sales markets, and we're prepared

to make the necessary investments in future technologies. We invest a significant proportion of our revenue in research and development.

NEWS: Rohde & Schwarz has an above-average R&D quota, even for the technology sector.
Leicher: And we have to stay profitable to maintain this. Both our order intake over recent years and our growth opportunities make us confident that we can continue to make above-average investments in R&D.

The most important thing is staying relevant for our customers. This is crucial in our industry, and it is what spurs us on every day. It's the same with the job market and our own employees. We want to be an attractive employer with exciting jobs for students and seasoned professionals alike. Of course, we're also responding to the changing lifestyles of our employees to remain relevant to them.

NEWS: How does Rohde & Schwarz remain technologically relevant for its customers?
Leicher: By listening carefully to the market. We're in the very rare and fortunate position of having many customers worldwide in a broad variety of markets. We receive feedback from a diverse range of market segments, and we're involved in our customers' development projects

from a very early stage thanks to our Test and Measurement Division. This gives us a good feel for what technologies the market needs and who's currently working on what. We can also build up technological expertise by working on long-term research projects with government agencies. The entire company is also very application-oriented. We employ many application engineers who work with our customers to solve technical problems – often on site over long periods. This gives us valuable application knowledge that feeds into our product development.

"The most important thing is staying relevant for our customers."

Our involvement in standardization committees is also very important. In mobile communications, the 3GPP working groups include representatives from the entire mobile communications ecosystem – from chip manufacturers to infrastructure providers. Sharing ideas with our colleagues in these groups gives us early insight into our customers' test and measurement requirements in the coming years.

Having all this knowledge at the company is hugely important, but only half the battle. In recent years, we've changed the corporate structure to make better, more consistent use of this knowledge. The R&S®ESMW, an ultra-wideband receiver for spectrum monitoring designed for regulatory authorities, shows just how well this focus on the future can pay off. It was carefully designed to ensure that it can be expanded for future applications, and has already impressed its first customers.

NEWS: Which technical trends will be important for Rohde & Schwarz over the next few years?
Leicher: Mastering higher frequencies over 100 GHz is one of our top priorities, along with identifying applications for them at an early stage. Artificial intelligence (AI) is also important. We need to understand how our customers are using it, for example as part of smart antenna systems for 6G, and adapt our products and solutions accordingly. We also want to use AI in our own products. It already plays a crucial role in our R&S®QPS security scanner by identifying potentially dangerous objects.

Fig. 2: Signal generation and signal analysis in the D band: the R&S®FE170 external frontend extends the frequency range of the R&S®SMW200A vector signal generator and the R&S®FSW signal and spectrum analyzer to 170 GHz.

Naturally, we're also working on using big data. With Schönhofer Sales and Engineering GmbH and other partners, we're developing the AI backbone of the Future Combat Air System (FCAS). As already mentioned, I see quantum technology as a relevant future market for Rohde & Schwarz, and one that we're already serving to some extent with test and measurement equipment for quantum computer research. Quantum-secure encryption and quantum sensor technology also play a role for us.

Generally, we're seeing an increasing number of customer requests for all products that are protected against cyberattacks. Cybersecurity is a topic that we have been addressing for some time with future-proof network and security solutions. As a leading European manufacturer, we're empowering business and government to ensure their digital sovereignty. The concept of digital sovereignty has now also become particularly important in terms of national security. This will continue to be a strategic theme for us.

NEWS: You studied electrical engineering and worked in the telecommunications industry before joining Rohde & Schwarz. What makes RF technology and this industry special for you?
Leicher: There's almost no other industry that's as dynamic or innovative. The incredible rate of development in the telecommunications industry has a lasting impact on all our lives. Just look at the success of smartphones. Connectivity is also making its way into every aspect of life – think smart homes, autonomous driving and industrial IoT. And because RF technology is used for all

of these applications, we're involved in practically everything and can help drive technological progress with innovations. I find that very exciting. You can't do that in many other fields.

"Mastering higher frequencies over 100 GHz is one of our top priorities."

An essential aspect is the enthusiasm for progress and technology that I'm surrounded by every day. We need this attitude as a company – not only to develop leading edge products and solutions, but also to explain our products. After all, we deal with more than just end users, and our contact with people in less technical positions is also very important. And because you can't see the benefits of an R&S®ZNA network analyzer or all the development work that went into it just by looking at the housing, we also have to be masters at explaining the technology. This requires the right engineering culture and a love of technology. Although it's becoming increasingly difficult to maintain this culture as the company grows, I'm confident that we'll continue to succeed in this.

EDITORS

INTERVIEW WITH ANDREAS PAULY AND DR. ANDREAS WERNER

"FOR ME, INNOVATION IS WHEN A NOVEL SOLUTION HELPS OUR CUSTOMERS"

Rohde & Schwarz is one of the most innovative companies in Germany and boasts a long history of successful product developments. In this interview, Andreas Pauly and Dr. Andreas Werner explain what innovation means at Rohde & Schwarz, how the company stays innovative, and how this benefits users.
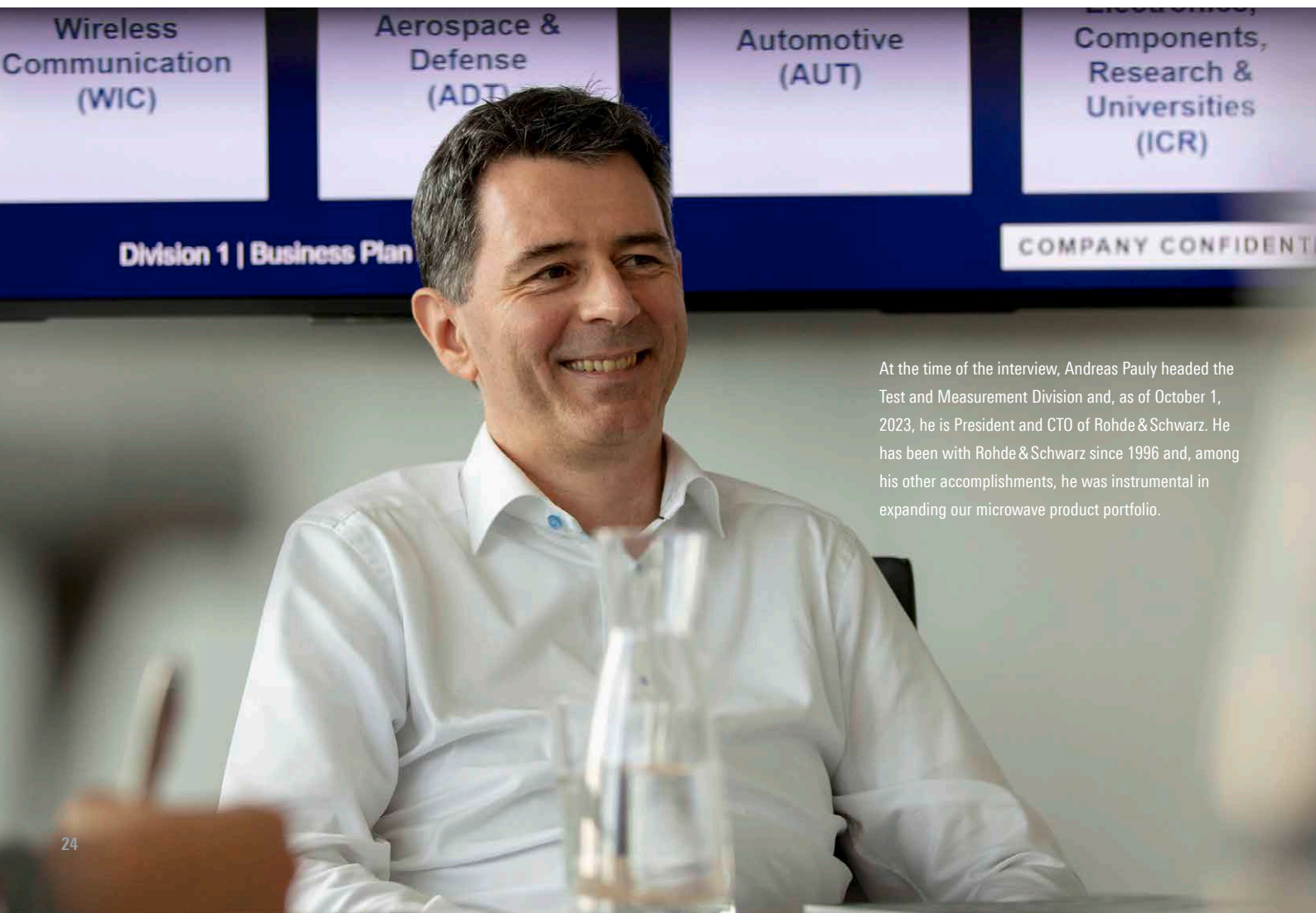
At the time of the interview, Andreas Pauly headed the Test and Measurement Division and, as of October 1, 2023, he is President and CTO of Rohde & Schwarz. He has been with Rohde & Schwarz since 1996 and, among his other accomplishments, he was instrumental in expanding our microwave product portfolio.

Dr. Andreas Werner comes from an R&D background, has been Head of the Rohde & Schwarz Chemnitz site since 2018, and became Vice President Oscilloscopes in 2021. Since July 2023, he has been Executive Vice President of the Corporate R&D Division.

NEWS: Mr. Pauly, Dr. Werner, you hear the word innovation everywhere these days, but it means different things to different people. What does it mean at Rohde & Schwarz?

Dr. Werner: For us, innovations have three pillars: they come from new ideas; they have to be technically feasible; and they have to offer added value to our customers. This means there are a few prerequisites. A product innovation, for example, requires expertise in research and development, production know-how, and an understanding of the challenges our customers face.

Pauly: The latter is at the heart of almost everything we do. From experience, I can say that as a group we are most innovative when we can talk openly with customers about their current and future challenges. The more we know about how our products are being used, the better we can align this with the expertise and experience of Rohde & Schwarz. Something new then often emerges that adds real value. For me, innovation is when a novel solution helps our customers work faster, better and more efficiently.

NEWS: Innovative products do not always have to be completely reinvented. How important is technology transfer?

Pauly: Very important. Our R&S®QPS security scanners, which you see at many airports today, came about as a result of colleagues transferring expertise from RF component measurement to imaging technology.

"We do not necessarily have to recoup an R&D investment right away."

Decades of experience in developing vector network analyzers enabled us to produce the best raw image with microwaves. Further evaluating the data was uncharted territory for us at the time, which is why we built on our expertise with acquisitions and university partnerships.

Dr. Werner: I think our security scanners are a great example of innovation. People can simply walk through them without having to stop or pose. It is convenient for passengers and saves time during security checks – in other words, it provides real added value.

NEWS: Innovation is essential if you want to be competitive on the international stage. How well positioned is Rohde & Schwarz when it comes to innovation?
Dr. Werner: We have an incredibly strong culture of innovation. Here's a good example: in our Test and Measurement Division, we are committed to offering measuring instruments needed to implement future technologies. This means we have to think far ahead and build up expertise at an early stage. This forward thinking is the bedrock our culture is built on, and it runs through all our divisions.

Today, innovation is also about having the talent to develop equipment that can be expanded modularly to ensure that products are future-proof and investments are secure. I think we are also in a good position there as well.

NEWS: Can innovations be strategically planned?
Pauly: Not in detail, but you can create a supportive environment. Employees need a certain amount of freedom and exchange between departments to be able to come up with ideas. It is also important to have an error culture that allows people to make mistakes and try out new things, as well as long-term thinking and appreciation.

Dr. Werner: This long-term thinking is really what makes us stand out as a privately owned business. It also makes us attractive as an employer. The fact that we do not plan quarter to quarter means we're not under pressure to recoup R&D investments right away. This gives our development teams the time they need to think outside the box.

Strategic planning begins when a promising idea emerges from informal discussions. That's where we step in and take the idea forward in a regulated process, integrating various teams and workshops to ensure the workload is spread out across a team of employees.

Pauly: The fact that these teams include personnel across different divisions undoubtedly also helps drive

RECOGNIZED INNOVATION

Experts rank Rohde & Schwarz as one of Germany's most innovative companies. Every year, the business magazine Capital asks around 3700 technical experts for their assessment. Out of a total of 1849 candidates, Rohde & Schwarz was chosen in the electronics, electrical engineering, automation, and test and measurement equipment category, together with Infineon, Intel Deutschland, Phoenix Contact, NXP Semiconductors Germany, and Würth Elektronik, among others. It is the second consecutive year that Rohde & Schwarz has been recognized as an innovative company.

the innovation. Design thinking challenges are another part of our innovation culture. We assign these development tasks to students from a wide range of disciplines, and this external perspective often yields interesting approaches and solutions.

NEWS: Let's talk inventions: Europe's first VHF FM transmitter in 1949, the world's first vector network analyzer in 1950, and the first GSM measuring station for digital mobile devices in the early 1990s these are just three examples from our history. What are some more recent Rohde & Schwarz inventions that stand out for you?
Dr. Werner: The digital trigger in our oscilloscopes has brought incredible precision to time domain measurements and has been crucial to the success of the R&S®RTO and R&S®MXO Series oscilloscopes. It allows users to detect even the smallest signal events in the presence of strong signals. This level of trigger precision was not previously available in the oscilloscope market.

Pauly: The new graphical user interface we introduced a few years ago was also a big hit, that has generated a lot of positive customer feedback. An instrument that is intuitive and easy to use demands minimal attention from engineers and lets them focus fully on what they are measuring. With today's highly complex test requirements, this can be a major benefit, which is why we invest a lot of effort in our user interfaces. To me, intuitive means that

everyone should be able to understand immediately how an instrument works without needing an explanation. This applies to oscilloscopes just as much as it does to our signal generators, for example. We represent the complex process of signal generation in an engineering-friendly way using block diagrams.

Dr. Werner: The challenge of creating a revised operating concept for the R&S®RTO6 was to map all the instrument functions in an ergonomically friendly way. Insights gained from usability tests with customers helped us optimize each control panel during the development phase.

NEWS: How far into the future do you need to look for new solutions?

Pauly: Often ten years or more. We have to make sure that our products and solutions are available to our customers when they need them. In 6G mobile communications, which will likely be introduced on a large scale around 2030, the roadmap for our ASIC development plan already has to be charted. But the anticipation doesn't stop there. High-end test and measurement equipment is an investment that has to be marketable for many years. Developing concepts for expandable devices, as already mentioned by Dr. Werner, also requires a solid understanding of what the future holds.

NEWS: In the summer of 2010, Rohde & Schwarz entered the oscilloscope market with great success. How was the company able to establish itself in such a crowded market?

Dr. Werner: We entered the high-end market segment based on innovations. The R&S®RTO oscilloscope provides completely new functions like the digital trigger, and also offers high measurement and processing speeds and a fast spectrum display. When the product range was expanded, R&S®ESSENTIALS welcomed the R&S®Scope Rider RTH – the first handheld oscilloscope with galvanically isolated channels and the functional range of a laboratory oscilloscope. We still have this USP today. So, our oscilloscopes brought a great deal of innovation to a well-established market. And we are seamlessly continuing this course with our latest family, the R&S®MXO Series. The MXO-EP (the ASIC developed especially for the R&S®MXO Series) is the innovative heart of these instruments.

Pauly: We also entered the oscilloscope market because it became clear to us that signal observation over the time domain is becoming increasingly important in RF and microwave T&M. Historically, we've operated in the frequency domain. But after developing our oscilloscopes, we have now also mastered the time domain. Some major suppliers in the oscilloscope market only consider the time domain. We can do both and thus deliver added value to users.

NEWS: How will the current product portfolio change going forward?

Pauly: Future applications will require higher frequencies and bandwidths. This applies to 6G, but also satellite communications and autonomous driving applications. In the future, radar systems, which today usually operate from 70 GHz to 80 GHz, will use frequencies well above 100 GHz for improved spatial resolution. We also want to move into these frequency ranges with our products.

"In the future we will use frequencies well above 100 GHz."

Developments in mobile communications also show how previously separate worlds are converging. A great example of this is joint communication and sensing (JCAS) in 6G networks. The JCAS concept envisages sensor technology and data communications that use a joint system to scan an environment with radar and transmit it to augmented reality glasses, for example. There is currently also a huge amount of convergence between satellite and terrestrial communications in 5G non-terrestrial networks. At the same time, wireless transmissions are increasingly being used for a wide variety of applications in vehicles. This means that we can combine our skills even more and continue to expand the application areas for our products.

EDITORS

R&S®QPS

A PRODUCT THAT CHANGES THE WORLD

The launch of the R&S®QPS security scanner family by Rohde & Schwarz in 2014 led to a breakthrough for millimeterwave technology in aviation security. People pleased with much faster security checks have also noticed that this technology has made the world a bit more convenient – and not just in airports.

In terms of protecting the world against terrorist attacks, the history of aviation safety can be described as a series of key events subsequent reactions. When it comes to security policies at airports, the attack on September 11, 2001 clearly marks the zero hour. In response to this, the United States founded the Transportation Security Administration (TSA).

A flawed safety net
Until then, only two technologies were used to protect people in buildings, ships, airplanes (especially since 9/11) and at major events: X-ray scanners and metal detectors. X-ray scanners can be used to screen baggage like suitcases and backpacks to detect weapons based on their shape and explosives based on the materials they are made of. To identify people carrying standard weapons like pistols and knives, passengers were required to pass through metal detectors. The attentive reader will have realized the problem already: metal detectors only trigger alarms in response to metallic objects.

The lack of technical alternatives meant that this limitation was tolerated. However, this entailed the risk that terrorists could endanger other people by using explosive belts, ceramic knives or even firearms produced with 3D printers. To provide a certain level of protection, a deterrent was put in place: randomly selected persons had to undergo a complete frisking.

On Christmas 2009, the creativity of attackers reached a new peak when, shortly before the landing in Detroit, a young man unsuccessfully attempted to detonate a bomb hidden in his underpants. He is still remembered today as the "Underwear Bomber".

Some companies tried to tackle those detection gaps with backscatter technology based on ionizing X-ray radiation. Even though these scanners only emit a tiny amount of radiated power, their introduction failed primarily due to health concerns and the fact that the scanners displayed detailed images of private areas of the person's body. More on this later.

Why millimeterwaves?

All these different issues converged to create an entirely unsatisfactory situation for security personnel. Until the late 2010s, there were no technical means to reliably detect whether someone was hiding dangerous and prohibited objects under their clothing. The spark of an idea that could revolutionize the industry ignited at a certain location in Munich, Germany. At that very location – which is the Rohde & Schwarz headquarters – a small team had been passionately working on an idea since 2007. The engineers wanted to use millimeterwaves in certain frequency bands to scan through clothing and obtain an image of the body in sufficient quality and resolution. Driven by the inventive genius Christian Evers, who played a major role in the development, they formulated a basic principle: clothing doesn't matter. What's important to

detect are anomalies on the person. The physical properties of millimeterwaves made them a perfect candidate for the technology. The spectrum from 70 GHz to 80 GHz enables precise imaging despite the presence of clothing (Fig. 1). On top of this, such radiation is not hazardous to humans since it is almost fully reflected by the skin.

Not an unknown field

At that time, other companies were already selling millimeterwave scanners that operated in different frequency ranges and were gradually being deployed in airports. But to scan the passengers, these systems used a mechanical system that guided a relatively bulky arm in a full circle around the person. With about 100 kg of steel fitted into a tight housing, the contraptions made a loud "whooshing" sound that provoked a sense of unease for many people. Furthermore, the scanners required the person to assume an uncomfortable body posture with hands raised above the head. This was not only challenging to hold but also has a negative association in many cultures (i.e. the prisoner pose, "hands up, you're under arrest!"). There were also many ethical objections.

Another scanner on the market required passengers to perform a 360° pirouette with their arms up. While this was not quite as threatening as the whooshing metal arm, the concept was still unsatisfactory for many customers and passengers, because not everyone was willing or able to turn a perfect circle at a predefined speed.

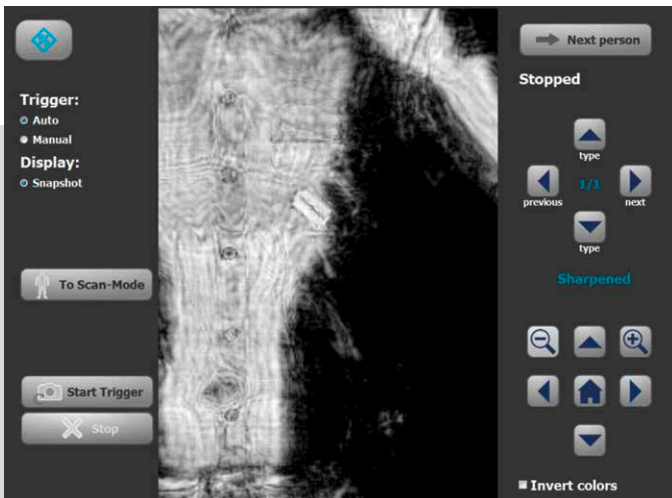Fig. 1: Display of a razor blade in a millimeterwave image.

Fig. 2: Avatar display on the first security scanner from Rohde & Schwarz, the R&S®QPS100, showing a suspicious object on the rear of the thigh.
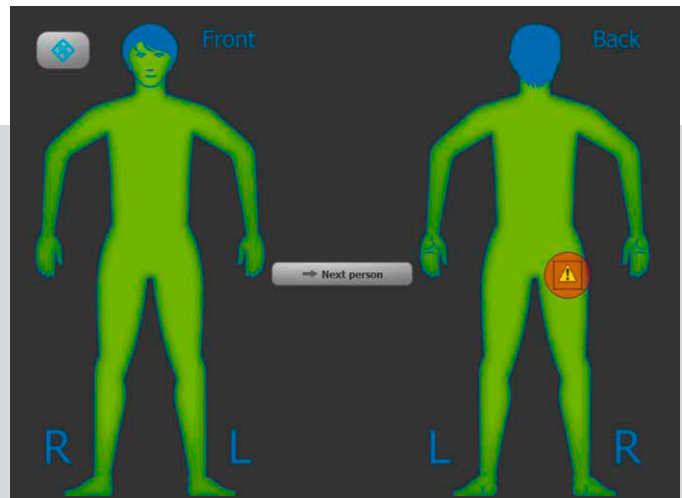
The operators were also not very fond of these systems. It took significant effort to explain to passengers what they needed to do.

Privacy protection using software

The group working with Christian Evers made it their objective to work around all these drawbacks. They didn't want to create a copycat product. Instead, they wanted to develop a solution that could meet all the security requirements, while boosting convenience for passengers and operating personnel.

Then, a new challenge arose: privacy protection became a top priority. It was strictly forbidden to display any sort of image of the scanned person. The developer team consisted of hardware experts but what they needed now was software expertise. A team of software experts was assembled on short notice in cooperation with partner universities. Their job was to correctly position and display any objects that were detected using millimeterwaves on a neutral avatar, a schematic figure on a monitor (Fig. 2).

R&S®QPS100: finally available

The first model developed by Rohde & Schwarz was the R&S®QPS100 quick personnel security scanner (Fig. 3). For ordinary people, it just looked like a two-meter high wall. The scanner's sophisticated RF engineering and other refinements were concealed (Fig. 4).

Fig. 3: R&S®QPS100 installation.

Fig. 4: Inner workings of the R&S®QPS100: signals from four antenna clusters converge at a splitter. Every cluster conceals 94 transmit and 94 receive antennas. An R&S®QPS100 consists of a total of 32 clusters.

Fig. 5: The R&S®QPS200
in an airport installation.

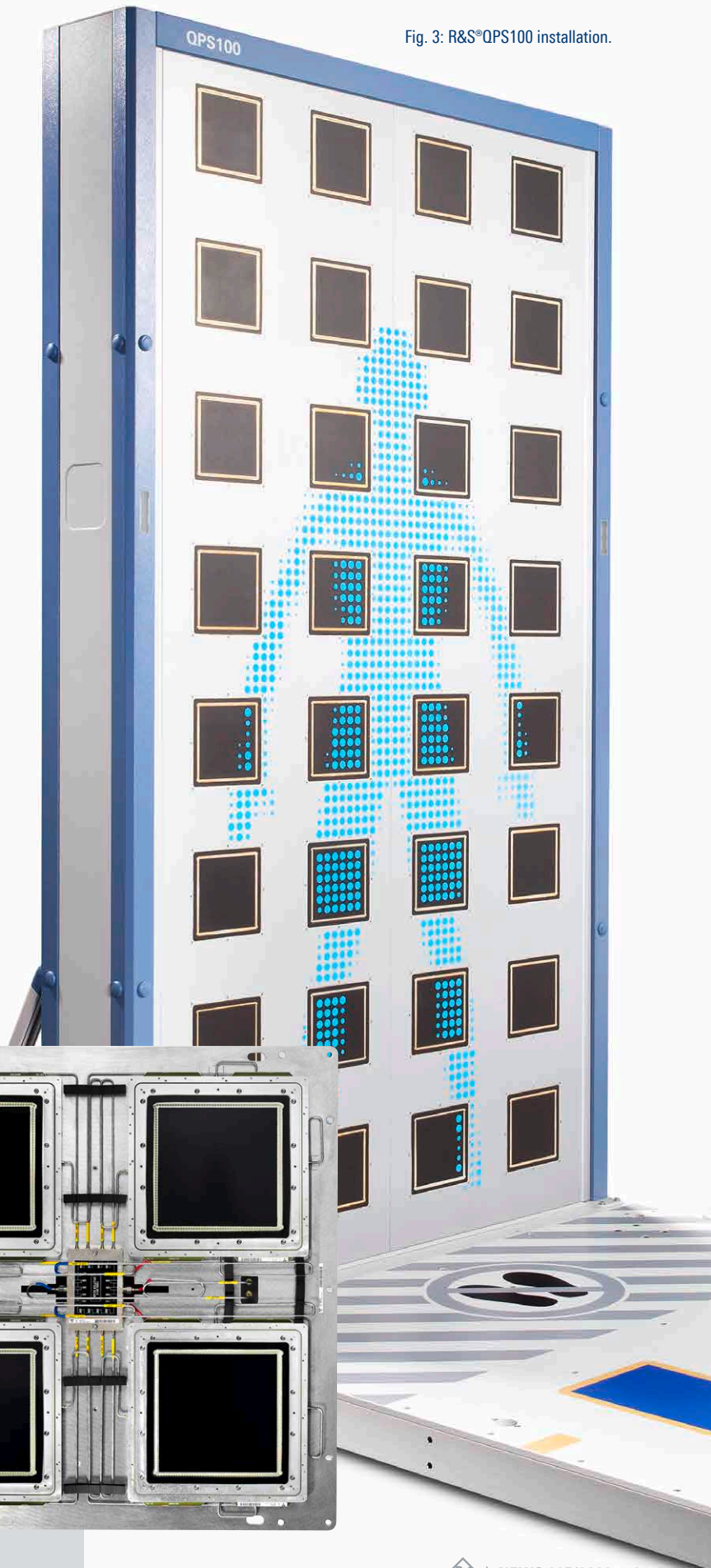As it turned out, the first challenge had nothing to do with engineering: Rohde&Schwarz was not familiar with the market or the customers. Even worse, the target customers were not familiar with Rohde&Schwarz. "Are you a startup?" was a common question during early discussions. However, visiting the company headquarters in Munich – and especially the plant in Teisnach, Germany, where the R&S®QPS is manufactured still today – quickly dispelled any doubts about the company's professionalism for even the most critical prospects.

The broader industry began to take interest in the product in a big way when it was presented during the regular meetings of European airport security officials. Certain features were highly appreciated, such as the static concept that allows unobtrusive integration into security lines, the fast processing time, and a low-stress posture with arms slightly spread that is easy to hold.

Breakthrough with the R&S®QPS200

But not all of the feedback was positive. The R&S®QPS100 required the person to turn around between scans of their front and back. One attendee at the industry conference thought that requirement would be "especially hard to explain to tourists". The appearance of the visible antenna clusters was also less appealing to non-technical people than the engineers had hoped.

Of course, we took all this feedback to heart. While the solutions we developed might look simplistic, they entailed new engineering challenges. The result was the R&S®QPS200 (Fig. 5): using two panels instead of only one, a person can be scanned in a single step. The system also got a facelift with the addition of foam panel covers without any impact on the millimeterwave propagation.

The redesign was the big breakthrough. The R&S®QPS200, with its open appearance, static scanning, easy to hold and ethically neutral posture, fast scanning process with a low false alarm and high detection rate, was superior to competing products. The customers were and continue to be very happy. There was a new, better choice in the market.

In addition to the engineering success, the customer support from Rohde&Schwarz also set new industry standards. The high level of commitment among our branch offices – not to mention the support from the service team in Teisnach and the rapid, direct assistance provided by our engineering department to end users – was a level of service that no one had ever experienced before.

Systematic refinement to the R&S®QPS201

Still, there was a lot more to do. Doubling the panels drove up system cost, while the new size of the scanner made it impossible to install in many existing security lanes. The team rolled up their sleeves once more and tackled these new challenges using experience from previous products to create the current model: the much lighter and slimmer R&S®QPS201 (Figs. 6 and 7). Another quantum leap was the use of artificial intelligence (AI) to analyze the scan results. This led to a further improvement in the detection rate while helping to reduce false alarms.

New markets, new products

The success enjoyed by the R&S®QPS series in the airport security market encouraged the team to develop solutions for other markets as well. The R&S®QPS201 is not only practical everywhere security is needed, but it can also be deployed in locations requiring protection against theft or violation of property rights. The system's impressive performance, combined with its flexible AI can be optimized for a variety of use cases. This is opening up other potential applications, such as in prisons, customs and border crossings, production facilities or for security at major events like the Munich Security Conference.

The recently launched R&S®QPS Walk2000 was developed especially with such applications in mind (Fig. 8). Old-timers may remember the film "Total Recall" from the year 1990 in which Arnold Schwarzenegger tries to smuggle a weapon through a "tunnel of truth" when landing on Mars. This concept of a security scanner that allows people to walk through without breaking their stride became the vision of the ideal security check that the industry aspired to. This vision became a reality with our acquisition of a small company that had already developed the initial concept. In the hands of the QPS team, it became a production-ready product that is now part of the Rohde & Schwarz security scanner portfolio.

Unlike its sister model, this walk-through scanner operates in the ultrawideband spectrum from 3 GHz to 10 GHz, which allows it to penetrate multiple layers of clothing. In order to enable the necessary scanning and evaluation speed, the computationally intensive image reconstruction and AI-supported evaluation are performed on an external server with high-performance graphics processing units (GPU). Based on this new approach, the R&S®QPS Walk2000 sets new standards and paves the way to a future where security and convenience will go hand-in-hand in the context of access control.

Fig. 6: The R&S®QPS201 is the latest model in the scanner family that uses the frequency range from 70 GHz to 80 GHz. The refined system design includes features like slimmed down panels.

Fig. 7: Tianfu Airport in the Chinese megacity Chengdu opened for business in 2021. Several dozen R&S®QPS201 scanners allow smooth processing of an estimated 60 million passengers a year.

When does a product become iconic?

The popularity of a product can grow so much that people begin to internalize it and see it as a symbol for an entire category. Like "Kleenex" for paper tissues and "Coca-Cola" for caffeinated soft drinks, the R&S®QPS now enjoys a similar status in the world of security scanners. On TV shows and social networks, the scanner is now being used to symbolize modern security checks.

What's next?

"You're introducing so many innovations that our purchasing can't keep up." This praise that one customer wrapped in a subtle criticism is motivating our further development efforts. There are many other airports and other markets where the R&S®QPS201 would be the perfect choice.

The systematic enhancement of our products, combined with very short innovation cycles and excellent field support, is well received by our customers and helps to raise the visibility of Rohde&Schwarz as a technology company well beyond our traditional markets.

RAINER WARTMANN, ANDREAS HÄGELE AND
HARALD JENTSCH, ROHDE&SCHWARZ

HISTORY OF THE R&S®QPS SECURITY SCANNER FAMILY

2014:
R&S®QPS100
- ▶ First scanner with multi-static approach.
- ▶ Open design, ethically neutral posture.

2016:
R&S®QPS200
- ▶ Elimination of second pose through addition of a second panel.
- ▶ Visual improvements, faster software with fewer false alarms.

2018:
R&S®QPS201
- ▶ Panels are now slimmer and lighter.
  Width of scanner reduced from 2.50 m to 1.75 m.
- ▶ Simplified maintenance thanks to optimized mechanical and electrical design, panels are slidable on the base plate.
- ▶ Use of GPUs for data reconstruction and AI for data evaluation.
- ▶ Fastest scanner on the market with the lowest false alarm rate.
- ▶ Different detection algorithms for use in other applications (e.g. property protection, prisons, customs).

2020:
R&S®QPS Walk2000
- ▶ First scanner that allows people to pass through at walking speed.
- ▶ No need to remove outer clothing (jacket, coat).
- ▶ Throughput of up to 750 persons per hour.
- ▶ Scanning in ultrawideband spectrum.
- ▶ Image reconstruction and AI evaluation using GPUs on an external server.

90 YEARS

Fig. 8: The R&S®QPS Walk2000 is shown here in a photo from the Munich Security Conference in 2023. It scans while the person is walking through – without the usual brief pause inside the machine. Moreover, the outer layer of clothing does not need to be removed.

DENSE FREQUENCY SPECTRUM?

NO PROBLEM WITH THE R&S®ESMW

More and more devices will share the radio spectrum in the coming years. The R&S®ESMW helps regulators keep pace. The ultrawideband radiomonitoring receiver for frequencies up to 40 GHz is suitable for fixed installations, measurement vehicles and portable systems and comes with 125 MHz real-time bandwidth and optional extensions of up to 2 GHz.

Redensification is well known in city planning, but mobile network providers and regulatory authorities are also well aware of the concept. The frequency spectrum has become ever denser in the past few decades. If a significant portion of the spectrum is released, such as the 2.1 GHz band after UMTS was shut down in Germany in 2021, the spectrum can immediately be used for another purpose. As in popular cities, the frequency spectrum is subject to higher occupancy density and an expansion of boundaries. Trends such as IoT and smart cities, along with research into 6G mobile communications, mean there's no end in sight.

Efficient use of expensive frequency spectrum

The prices mobile network providers are willing to pay at frequency auctions clearly illustrate the scarcity and high value of the radio spectrum. Regulators must ensure efficient use of this costly resource at the national level. They also protect license holders from interference caused by defective electrical devices as well as unregistered or incorrectly configured transmitters. In Germany, both of these tasks are the responsibility of the Federal Network Agency (Bundesnetzagentur).

The agency maintains a nationwide network to monitor the radio spectrum with specialized monitoring stations. The network uses everything from wide-range fixed monitoring stations (FMS) and mobile monitoring stations (MMS) to hand-held portable monitoring stations (PMS) for sites that can only be accessed on foot and drone-based aerial monitoring stations (AMS) that enable measurements in inaccessible locations and help improve reception of long-distance signals. Fig. 1 shows the basic structure of a national radiomonitoring network.

Fig. 1: Hierarchical structure of national radiomonitoring networks. Activities detected in the radio spectrum are compiled in a regional control center (RCC) and passed on to a national control center (NCC).

Abbreviations

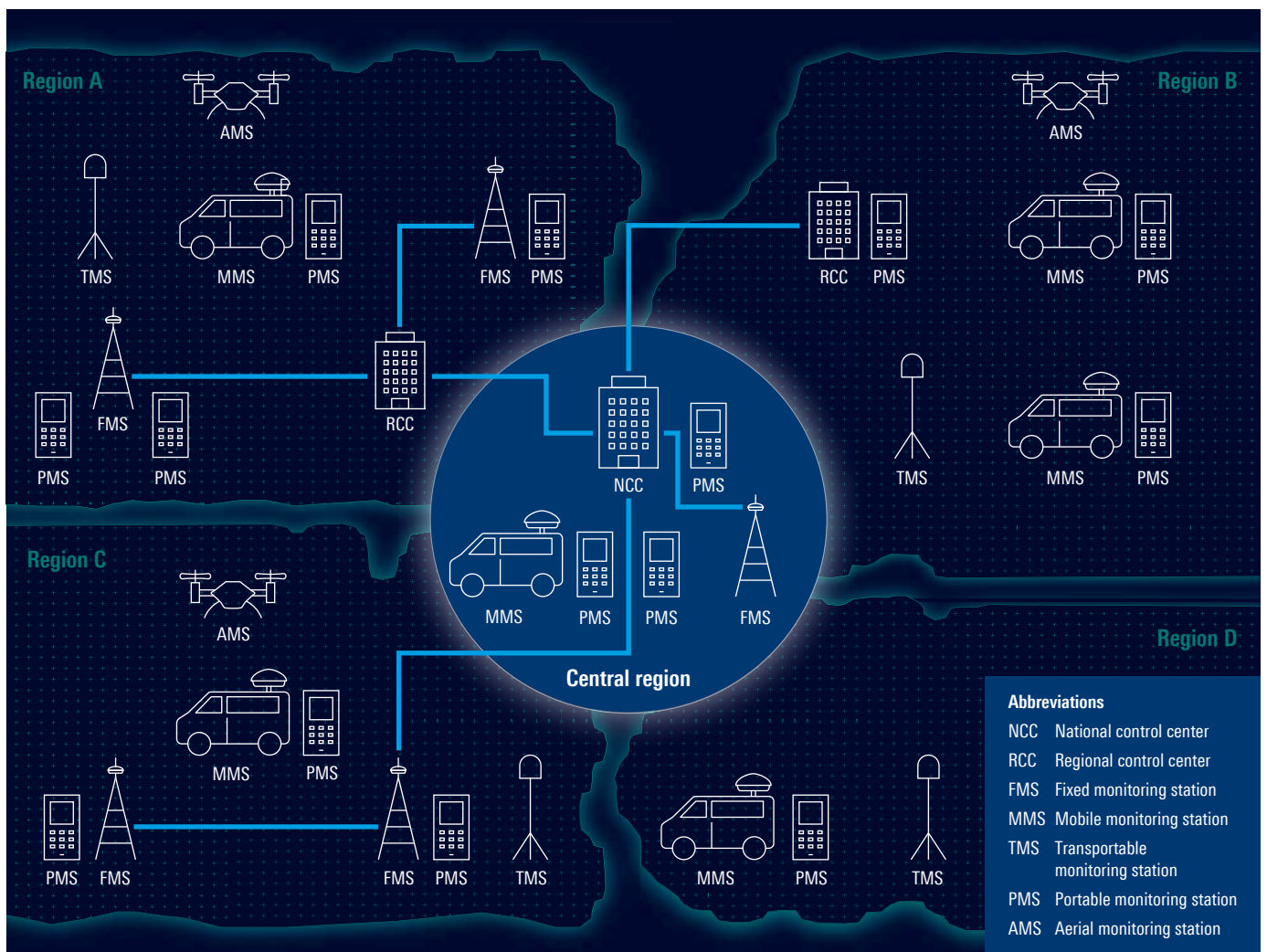|	
NCC	National control center
RCC	Regional control center
FMS	Fixed monitoring station
MMS	Mobile monitoring station
TMS	Transportable monitoring station
PMS	Portable monitoring station
AMS	Aerial monitoring station

Fig. 2: The R&S®ESMW is designed for remote control from a laptop or tablet and does not need a display.
The R&S®ESMW GUI is included in the scope of delivery.

Maintaining an overview with 5G and 6G

In the future, Germany's network of monitoring stations will face new requirements. The introduction of more complex transmission methods that utilize the spectrum more efficiently as well as the opening of ever-higher frequencies and wider transmission channels for radiocommunications make more stringent requirements necessary.

Radiomonitoring technology must keep pace so that regulators can maintain an overview of changing frequency spectrum usage. Wider frequency ranges, much larger real-time bandwidths and a higher receiver dynamic range will be needed in the future. Increasingly complex transmission methods mean new and more complicated interference scenarios can be expected in urban areas with high dynamic spectrum utilization.

R&S®ESMW ultra wideband monitoring receiver

The R&S®ESMW ultra wideband monitoring receiver from Rohde & Schwarz represents a new generation of ultra-wideband receivers for spectrum monitoring with outstanding, future-proof performance. The base unit covers the frequency range from 20 MHz to 6 GHz, making it sufficient to acquire the majority of radiocommunications currently relevant to regulators, and it can be extended to cover a maximum of 8 kHz to 40 GHz.

The base unit with the lower frequency extended to 8 kHz is suitable for fixed stations. Extension to 18 GHz or the full 40 GHz is intended for measurement vehicles or portable measuring systems due to the shorter propagation distance of higher-frequency signals. In a 19-inch rack, the R&S®ESMW takes up only four height units and weighs around 20 kilograms with a full hardware configuration.

Reliable acquisition of channels and entire frequency bands

Real-time bandwidth of up to 2 GHz makes the R&S®ESMW future-proof and enables acquisition of even extremely wideband radio channels with no blind time. This bandwidth

is being considered for 6G mobile communications. The 125 MHz real-time bandwidth of the base unit covers current radio standards for 5G mobile communications in the FR1 band (maximum channel bandwidth of 100 MHz). Monitoring the FR2 band (400 MHz channel bandwidth) or the upcoming Wi-Fi 7 standard (320 MHz channel bandwidth) is possible with the 500 MHz or 2 GHz extensions. This large real-time bandwidth enables seamless reception of individual channels and the entire frequency band in a radiocommunications service.

Short-duration signals down to 75 ns can be reliably acquired with accurate signal level, as long as they lie within the real-time bandwidth. And even outside this range, extremely fast spectrum scan speeds of up to 2.6 THz/s ensure that even larger frequency ranges can be captured in near real time and reliability monitored.

ITU compliance

The R&S®ESMW also has advanced RF characteristics that are vital for the future. The hardware far exceeds the recommendations from the

Fig. 3: The R&S®ESMW mounted in a 19-inch rack in a measurement vehicle.

International Telecommunications Union (ITU). As a specialized agency of the United Nations, the ITU sets general guidelines for worldwide use and monitoring of radio frequency spectra and standardizes spectrum monitoring measurement procedures. The R&S®ESMW fully complies with key ITU recommendations.

Easy to upgrade

The R&S®ESMW is the successor to both the R&S®ESMD (up to 26.5 GHz) and the R&S®ESME (up to 18 GHz). It is backwards-compatible and has the same interfaces and SCPI commands to minimize setup times when upgrading existing installations. Over 2500 R&S®ESMD and R&S®ESME units are deployed worldwide in more than 90 countries.

If hardware is configured for future applications during procurement, functions needed later on can be activated with a software key, eliminating the need for hardware upgrades and keeping the device constantly available.
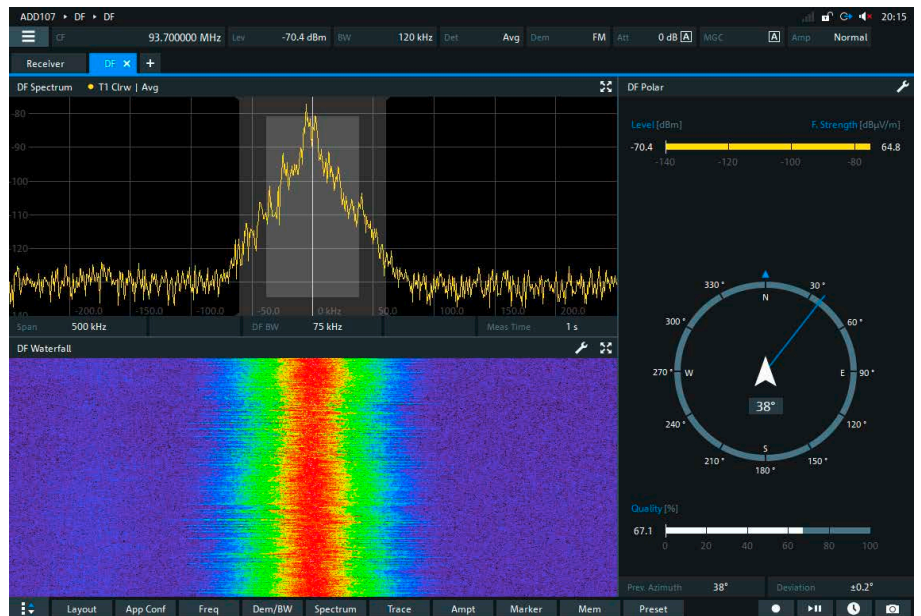

Fig. 4: The two windows on the left show the spectrum and waterfall diagram of a measured signal. With the optional direction finding functionality, the direction of incidence can also be shown as a degree value on a compass rose (right).

Position data and direction finding upgrade

The integrated GNSS module automatically adds position metadata to measurements, simplifies documentation and is a useful addition to any base unit. The module can also be conveniently activated with a software key.

The latest firmware update to the R&S®ESMW, in September 2023, also included the popular direction finding functionality known from previous models. It shows the direction of incidence of a measured signal (Fig. 4). If R&S®ARGUS control software is used with multiple measurement stations, the exact signal source position can be determined quickly.

WHY RADIOMONITORING RECEIVERS ARE NECESSARY?

Regulators use specialized radiomonitoring equipment to track down interference. The equipment is optimized for the reception and localization of interference in unknown signal environments over large frequency ranges. Radiomonitoring receivers such as the R&S®ESMW provide real-time acquisition, spectrum scan speed and receiver dynamic range. The dynamic range is needed for detecting and localizing weak intermittent interference signals between strong commercial transmissions.

The R&S®ESMW integrates both a high-performance A/D converter and a set of sophisticated preselection filters to block the signal environment outside the band of interest, preventing internal generation of interference products from overloading the A/D converter with strong signals outside the band of interest. In the signal band, automatic attenuation adjustment allows signals to pass unattenuated in a weak signal environment and attenuates signals in a stronger signal environment. These characteristics distinguish radiomonitoring receivers from spectrum analyzers (closely related in terms of measurement technology), which are used in relatively controlled, lab-type environments and require precise measurement accuracy.
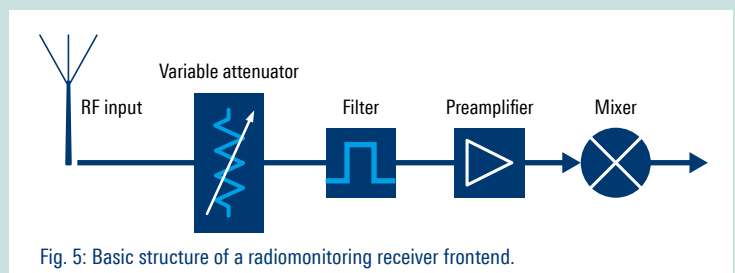

Fig. 5: Basic structure of a radiomonitoring receiver frontend.

Further device functions in the pipeline
The R&S®ESMW will be upgraded with additional interference hunting capabilities, including short-term wideband I/Q data recording and replay for up to 2 GHz bandwidth and time domain analysis with gated spectrum function (important for identifying interference in 5G networks and future 6G networks). The gated spectrum function is already available in the R&S®PR200 portable monitoring receiver [1]. The current direction finding functionality will be enhanced by an integrated map display with automatic triangulation. For measurement vehicles, spectrum trace recording with position information will be introduced for easy recording, replay and evaluation of the spectrum environment along the travel route.

[1] NEWS 226 (2023), page 9

DR. JENS STEINWANDT,
ROHDE & SCHWARZ

THE HISTORY OF SPECTRUM MONITORING AT ROHDE & SCHWARZ

Regulation of the frequency spectrum has a long, technology-driven history. Early on, Rohde & Schwarz supplied measurement equipment for spectrum monitoring and established several technological milestones.

Fig. 6: An ESUM monitoring receiver from the 1960s.

Fig. 7: The R&S®ESMD wideband receiver was launched in 2008. It is now used in over 80 countries.

1960s: The ESUM monitoring receiver was a pioneer. National regulators used it to monitor the VHF and UHF spectrum for both civil and military purposes. It quickly became a standard solution in the defense sector.

1980s: Measurement process automation gained importance in radiomonitoring. The Rohde & Schwarz ESP search receiver could scan nearly 1000 frequency channels per second over a frequency range from 10 kHz to 1.3 GHz or 2.5 GHz. In the mid-1980s, the company entered the market for high-quality portable receivers with the R&S®EB100, which was a best-seller and was replaced in 1999 by the equally popular R&S®EB200.

2000s: Rohde & Schwarz presented the first VHF/UHF direction finding antenna for receiving both vertically and horizontally polarized signals, significantly improving the localization of illegal transmitters. Another two technological highlights were the R&S®PR100 portable monitoring receiver for frequencies up to 7.5 GHz and the R&S®ESMD wideband monitoring receiver with integrated direction finding functionality.

2020s: The R&S®PR200 portable monitoring receiver with additional time domain analysis and the R&S®ESMW ultra wideband monitoring receiver with up to 2 GHz real-time bandwidth were introduced as successors to the R&S®PR100 and the R&S®ESMD.

90 YEARS

NEW HIGH FLYER ON THE HORIZON

Rohde & Schwarz developed the R&S®EVSD1000 VHF/UHF nav/drone analyzer to evaluate the behavior of terrestrial navigation and air traffic control communications systems. The new signal level and modulation analyzer is easily mounted on commercially available drones for precise, repeatable results.

Civil air traffic control (ATC) requires accurate and reliable navigation systems to ensure public safety and minimize delays. Airport executives also want lower operating costs.

Airport terrestrial flight navigation systems must be inspected regularly to ensure safe airport operations. Special requirements also apply to test equipment for landing and route navigation systems. The International Civil Aviation Organization (ICAO) included the requirements in a flight inspection standard, and the latest version covers drone based measurements.

Advantages of drone based measurements
Conventional inspections typically involve manual vehicle based ground measurements and flight measurements with specially equipped aircraft.

Runways are often shut down for ground based measurements, causing delays and revenue losses. For technical reasons, measurement results are also difficult to reproduce when they are only made in the near-field region.

A more efficient approach uses leading-edge drone technology with automatic, high-precision flights along predefined routes with fixed waypoints. When equipped with advanced battery technology, drones can have relatively large payloads, longer flights and longer measurement times.

Rohde & Schwarz added the R&S®EVSD1000 to its broad range of ground based and airborne measurement instruments, including the R&S®EVSG1000 and R&S®EVSF1000. The R&S®EVSD1000 has ideal weight and mechanics for use with drones and is an alternative to ground measurements.

The R&S®EVSD1000: every detail tailored to drone applications

The R&S®EVSD1000 has a very low noise figure and narrowband filters for outstanding receiver sensitivity. The analyzer performs high-precision signal analysis even with low signal levels. Its wide dynamic range and steep-edged preselection filters can reliably suppress potential interference sources, such as FM transmitters and radiotelephony signals. The R&S®EVSD1000 has high intermodulation suppression and interference resistance for reliable measurements even when near transmitting antennas.

One hundred recordings a second make R&S®EVSD1000 drone-based measurements accurate, reliable and highly reproducible. The results are comparable to those of conventional flight and ground inspections. You can also add time and location stamps to measurements with an accessory GNSS module (R&S®EVSD1-Z6) and the R&S®EVSD1-Z7 GNSS antenna. All results are stored in the device but can be streamed to a different storage location via data link (R&S®EVSD1-Z5 option), ensuring that no data is lost and providing seamless real-time measurements and easy documentation of results.

The lightweight R&S®EVSD1000 can be attached to almost any mid-sized drone with a quick-release clamp – no tools required. The ILS/VOR antenna (R&S®EVSD1-Z3) weighs just 150 g and can be mounted above or below the drone on a short mast to reduce interference from the drone motors.

Fig. 2: The R&S®EVSD1000 VHF/UHF nav/drone analyzer is a signal level and modulation analyzer for fully ICAO-compliant, highly accurate measurement of instrument landing systems (ILS), ground-based augmentation systems (GBAS), and VHF omnirange (VOR) ground stations. It also combines many other functions in a single device, including spectrum, audio and time-domain analysis.

Drone based systems for faster, more accurate and more reproducible measurements

Excellent performance and a wide range of accessories make the R&S®EVSD1000 ideal for air navigation service providers (ANSP). By using commercially available drones, measurements can be faster, more accurate and more reproducible, which was once only possible when done by hand or with a vehicle. It also reduces organizational workload and costs, since no runways need to be closed down. Longer intervals between flight based measurements are possible if authorities classify the measurements as highly reproducible and their data closely match those from flight measurements.

KLAUS THEISSEN, ROHDE & SCHWARZ

Fig. 3: The R&S®EVSD1-Z9 transportation case is a roller trolley with enough room for all components: the receiver, the batteries, up to six wooden propellers and the antenna. Only the drone is transported separately.

FROM THE FIRST AUTOMATIC DIRECTION FINDER TO A COMPREHENSIVE ATC COMMUNICATIONS SYSTEM

Rohde & Schwarz launched the NAP1, its first automatic direction finder, in 1955. It was used by air traffic controllers to aid radar location. This was followed, in 1959, by the launch of the NP4, the first direction finder to use the Doppler effect. Rohde & Schwarz also provided the Frankfurt Airport with the first aircraft noise monitoring system in the Federal Republic of Germany.

After German reunification, Rohde & Schwarz developed the first tactical air navigation (TACAN) receiver for German air traffic control in 1995. The R&S®ETS200 allowed continuous monitoring of RF level and azimuth for the first time.

In 1996 Rohde & Schwarz launched the R&S®EVS200, the first mobile device for monitoring terrestrial radio navigation systems at airports and field stations. Airports and armed forces used it to monitor instrument landing systems (ILS), VHF omnirange (VOR) stations and three vertical marker beacons. It even allowed for frequency searches of the relevant bands.

Most recently, in 2020, Rohde & Schwarz unveiled its cutting-edge CERTIUM ATC communications system, which set new standards. The IP based turnkey system contains all the necessary components — from the microphone to the antenna, to analysis and management software and services. High-speed encryption also prevents unauthorized access to data. The new R&S®EVSD1000 VHF/UHF nav/drone analyzer is part of the CERTIUM ecosystem and is the latest member of the CERTIUM ANALYSIS product family.

More information is available online:

Fig. 4: The R&S®EVS200 mobile unit was the first to allow analysis of terrestrial ATC systems on foot or with vehicles time.

90 YEARS

READY FOR THE FUTURE WITH
HIGH SPEED ENCRYPTION

When public authorities and institutions exchange data, it often involves sensitive information that requires special protection to prevent unauthorized access. Encrypted connections are normally used for this purpose. Unfortunately, encryption frequently leads to lower transmission speeds. To get around this problem, the German federal state of Saarland uses the high speed R&S®SITLine ETH solution from Rohde & Schwarz Cybersecurity throughout its networks. The company's product portfolio has now been extended to include a solution for 2 × 100 Gigabit Ethernet.

Public authorities in Germany may only transport sensitive data containing personal or confidential information with the classification RESTRICTED using encryption within a national network. The German Federal Office for Information Security (Bundesamt für Sicherheit in der Informationstechnik, BSI) recommends the Advanced Encryption Standard (AES) for such data transfers. Among the different state authorities, Saarland has assumed a leading role in Germany in terms of compliance with this recommendation.

For example, Saarland now uses the R&S®SITLine ETH encryption solution from Rohde&Schwarz Cybersecurity to transfer confidential data. This high speed solution meets the BSI's standards without any noticeable impact on the transmission speed. Saarland has collaborated with IT security expert Rohde&Schwarz Cybersecurity and its partner T-Systems and is the first German state to implement a flexible, comprehensive and state-of-the-art encryption system for its public authorities. Saarland uses the solution for police communications as well as for its IT service center that supports public authorities at some 190 different locations.

Layer 2 encryption provides protection without compromising speed

Secure transmission between multiple locations is best implemented by means of encryption on layer 2 (the data link layer in the OSI reference model), since this does not affect the transmission speed. R&S®SITLine ETH encrypts Ethernet transmissions at near line speed, packet by packet, on the way to the receiving device. Especially when it comes to business-critical real-time applications, connections with extremely low latency are the key to smooth operation.

High speed encryption that meets confidentiality requirements

As a layer 2 encryptor, R&S®SITLine ETH from Rohde&Schwarz Cybersecurity protects sensitive data, emails and documents against espionage and manipulation during transmission. This allows public authorities and companies to protect Ethernet transmissions within fixed networks as well as microwave and satellite links. The devices are approved by the German BSI up to the RESTRICTED, EU RESTRICTED and NATO RESTRICTED classification levels.

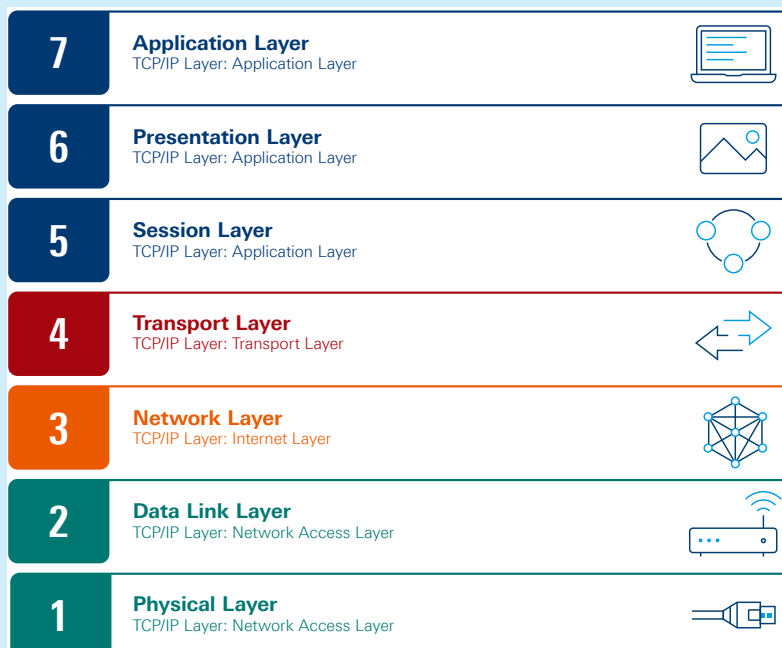| 7 | **Application Layer** TCP/IP Layer: Application Layer | |
6	**Presentation Layer** TCP/IP Layer: Application Layer	
5	**Session Layer** TCP/IP Layer: Application Layer	
4	**Transport Layer** TCP/IP Layer: Transport Layer	
3	**Network Layer** TCP/IP Layer: Internet Layer	
2	**Data Link Layer** TCP/IP Layer: Network Access Layer	
1	**Physical Layer** TCP/IP Layer: Network Access Layer	

Fig. 1: Encrypted transmissions take place on the data link layer (layer 2) or are routed via the network layer (layer 3).

Fig. 2: R&S®SITLine ETH-XL is easy to integrate and encrypts at line speed.

This makes the product family particularly suitable for public authorities and institutions as well as for critical infrastructure operators and companies under supervision of industrial security.

First network encryptor for 2 × 100 Gigabit Ethernet duplex connections

Rohde & Schwarz Cybersecurity has now expanded this high speed product family with the R&S®SITLine ETH-XL – the first network encryptor with two 100 Gbit/s interfaces. This solution covers the 10 Gbit/s to 100 Gbit/s range, making it suitable for central locations within critical infrastructure and data centers. Network teams can integrate the devices into their existing IT landscape using a central management system with an intuitive user interface.

Quantum computing requires new cryptography approaches

In order to continue supporting secure encrypted communications in the future, there are some other important considerations. New approaches and encryption techniques must be developed in response to advances in quantum computing. The problem is that quantum computers will soon be fast enough to break current encryption algorithms and present a risk to data traffic. Some research organizations are therefore developing post-quantum cryptography (PQC). PQC uses algorithms that, based on current knowledge, even quantum computers would be too slow to break. PQC can run on existing networks and systems, making it suitable for widespread deployment on the internet, within corporate networks and for emails.

However, PQC alone is not sufficient for high-security applications of public authorities, for example. In this case, quantum key distribution (QKD) is a complementary solution. Since QKD is based on physical laws and not on mathematical algorithms, computing power is immaterial. This makes QKD particularly future-proof. However, it is cost-intensive and not practical for every application.

Rohde & Schwarz Cybersecurity provides its cryptographic expertise and experience for the design and implementation of secure devices and systems in PQC and QKD research projects. When developing present-day encryption solutions, the company's team of experts always takes future security issues into account as well. R&S®SITLine ETH-XL is therefore QKD-ready. Customers who integrate this solution now are well prepared for the quantum future.

ESTHER ECKE,
ROHDE & SCHWARZ CYBERSECURITY

WLAN OPTIMIZATION AT THE PUSH OF A BUTTON

Up to now, optimal wireless network configuration was a complicated manual task for which administrators of large IT systems had little time. LANCOM ARC 2.0 relieves them of most of the burden and shows the entire WLAN environment at a glance.

WLAN networks with several hundred access points are common on large company sites, schools, universities, hospitals or sports facilities. The networks are usually set up and then rarely adapted as conditions change, since doing so is a lot of work. Administrators must manually align parameters, such as the channel width and transmission power for wireless channels to create the optimal configuration, while also taking into account overlaps with nearby external networks. Configuring WLAN networks is time-consuming and worsens the current shortage of IT specialists for system operators.

Controlled automation

The LANCOM Active Radio Control™ 2.0 (ARC 2.0) can now independently handle WLAN recalibration. ARC 2.0 is cloud-based, self-learning WLAN optimization software for medium-size and large networks that automatically determines the best possible WLAN configuration for an existing network under complex conditions and visualizes the current state and the expected state after optimization. Proposed configuration changes can be checked at the push of a button before roll out. The IT manager also retains control of the automation process.

Optimization for actual resource requirements

ARC 2.0 optimizes in three steps: scanning the WLAN environment, analyzing data and calculating the optimal WLAN configuration.

Step 1: Scan

All supported devices are switched to scan mode for two to five minutes and their radio environments are measured. Even though WLAN infrastructure is not available during this phase, the time invested pays off. Access point capacity utilization is effectively measured in normal operation, creating an excellent database for computing the optimal WLAN configuration.

Step 2: Analysis

Data is analyzed in the LANCOM Management Cloud (LMC). The analysis differentiates between the 2.4 GHz, 5 GHz and 6 GHz frequency bands and whether the WLAN devices are part of the internal system or serve as access points for external networks. Multi-BSSID detection prevents duplicate counts for LANCOM devices such as the access point in Fig. 1, since WLAN access points are often

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Fig. 1: The LANCOM LX-6500E Wi-Fi 6E access point supports parallel operation in three frequency bands (2.4 GHz, 5 GHz and 6 GHz) for an aggregated transmission rate of 8.4 Gbit/s.

assigned multiple BSSIDs. The current state and the expected optimization effect are visualized in Fig. 2. For a better overview, the individual frequency bands can be displayed separately on the dashboard.

Connecting lines show channel conflicts that are especially relevant to transmission capacity. Conflicts occur when a device transmits in the operating channel of another device

and are shown as connecting lines between the channels. Channel conflicts usually do not cause significant problems, but they can reduce network transmission capacity.
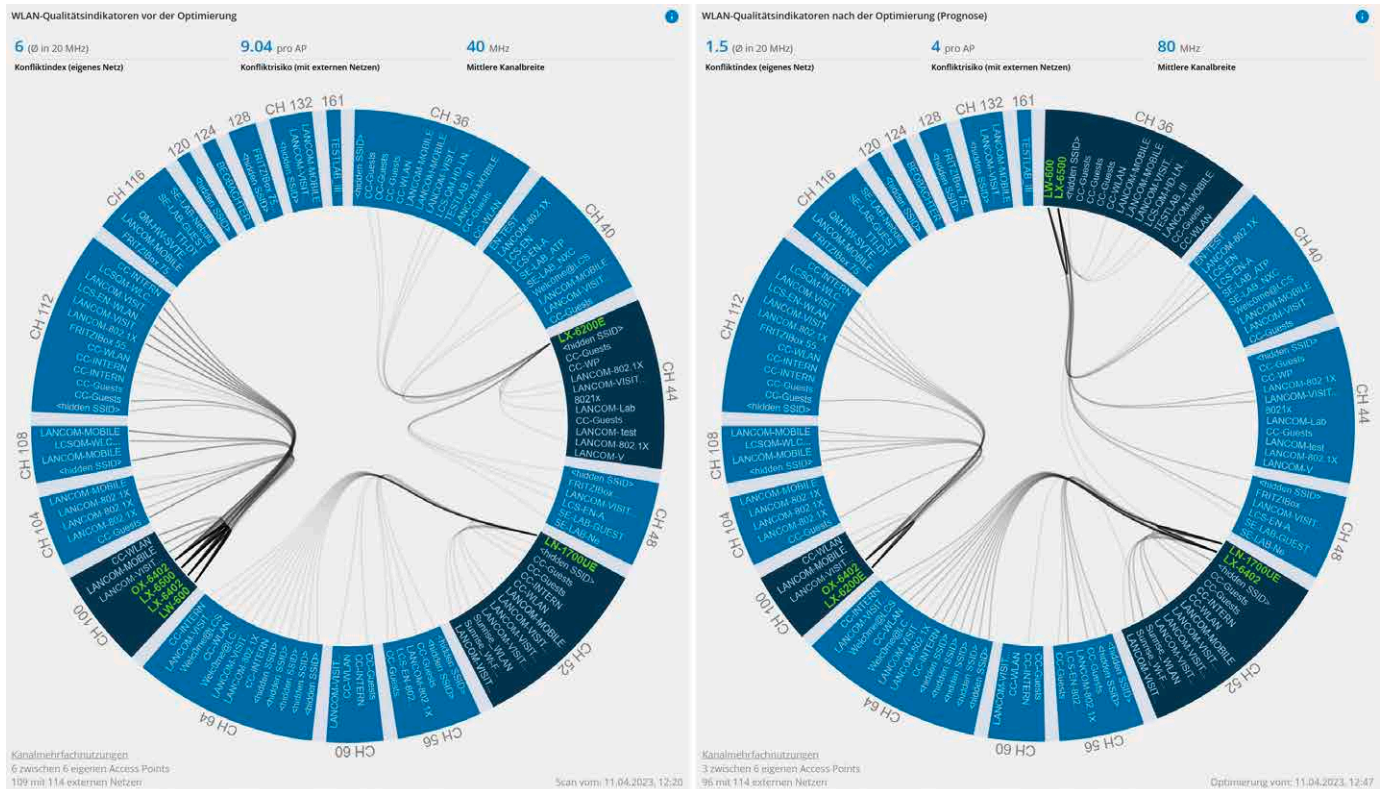
Step 3: Optimization
One WLAN optimization goal is creating a configuration with minimal channel conflicts. In Fig. 2, the optimized solution has just 99 channel conflicts instead of 115. Further

optimization goals arise from measured usage behavior, since ARC 2.0 independently recognizes access point capacity utilization and assigns conflict-free (or at least low-conflict) channels to access points with high data traffic.

The administrator can also make individual adjustments, such as changing access point priorities, excluding individual devices from automatic transmission power adjustments or not optimizing specific channels. Various optimization schemes for low and high access point densities are also available. An algorithm specifically developed for ARC 2.0 performs the optimization.

Fig. 2: Pie chart of the WLAN environment detected by the scan (left) and the forecast WLAN environment after the calculated optimal device configuration is applied (right). Each pie segment represents a channel (dark blue for internal network access points, others in light blue). The network names for internal network access points are shown in green; external networks in gray. Connecting lines show channel conflicts.

WLAN-Qualitätsindikatoren vor der Optimierung

6 (Ø in 20 MHz)
Konfliktindex (eigenes Netz)

9.04 pro AP
Konfliktrisiko (mit externen Netzen)
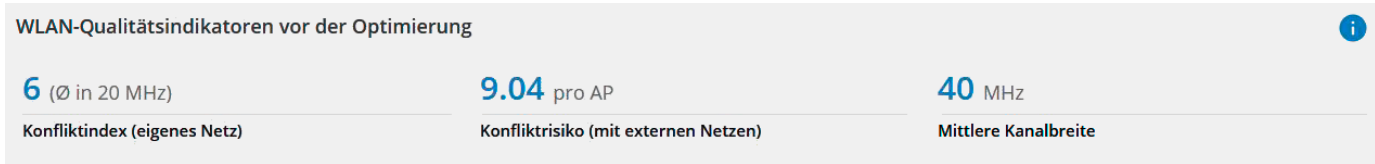
40 MHz
Mittlere Kanalbreite

Fig. 3: Three quality parameters indicate WLAN optimization potential. The lower the conflict index and conflict risk, the better. The average channel width should be as large as possible.

Optimierungsergebnis

✓ ARC-Index: 100%
Zusammenfassung Optimierungsergebnis

Fig. 4: The ARC index is on the dashboard next to the WLAN optimization pie chart.

At a glance

Along with the high level of automation by ARC 2.0 for the first time in professional WLAN management, the software includes a key feature. Three quality parameters appear above the pie chart on the dashboard for a quick overview of the overall network status : conflict index, conflict risk and average channel width (Fig. 3) .

The conflict index shows channel conflicts between internal network devices, while conflict risk covers channel conflicts with external networks. A fourth parameter, the ARC index, shows whether the full optimization potential is being exploited.

One hundred percent means the optimization scheme has achieved its theoretical maximum, taking into account all general conditions and user-defined limitations. If the ARC index is below 100 percent, a different optimization scheme will generate better performance.

ARC 2.0 is part of the LMC

While the previous version was integrated in the LANCOM operating system (LCOS), ARC 2.0 can be used as an optional function in the LANCOM Management Cloud (LMC). ARC 2.0 remains true to the concept of smart network optimization and simplifies WLAN management and WLAN optimization in many installations, from office, school or hospital WLAN systems to large-scale systems in industrial facilities, stadiums and event arenas.

ECKHART TRABER, LANCOM SYSTEMS

AN INNOVATION DRIVER IN EUROPEAN NETWORK TECHNOLOGY

For over twenty years, the Rohde & Schwarz subsidiary LANCOM Systems has been developing professional network technology for business and administration. From the start, love of innovation helped withstand strong competition from Asia and North America, and the company was quickly on the same technological footing. The world's first access point with integrated VPN was launched in the company's founding year (2002), followed by the first dual-band Wi-Fi® access point just one year later. LANCOM had another world premiere in 2008 with a business VPN router with UMTS/ADSL2+ and integrated theft protection. Developing outdoor access points for wideband internet expansion in 2010 attracted the attention of the German federal government. The CC routers for highly secure site networking were awarded the highest possible security certification for commercial routers by the German Federal Office for Information Security (BSI) in 2013 and embody the high LANCOM security standards. Current challenges in network technology – large-scale digitalization and a shortage of IT specialists – have prompted LANCOM to offer the LANCOM Management Cloud, an integrated solution for the efficient management of all network areas, and the recently launched LANCOM Trusted Access, a cloud-managed VPN client for secure connection of mobile workstations.

90 YEARS

EVOLUTION OF THE R&S®MXO SERIES

The new R&S®MXO 5 Series oscilloscopes add more channels and higher bandwidths to the R&S®MXO Series. It is the first 8-channel oscilloscope from Rohde & Schwarz and simplifies power sequence measurements, compliance testing for automotive Ethernet and EMI precompliance testing.

Fig. 1: A normal sine signal can conceal many spectral elements. The four simultaneous spectra shown here can be set at different spans and ranges to examine various frequency details.

The R&S®MXO Series was launched in September 2022 with the R&S®MXO 4 Series, a 4-channel instrument with up to 1.5 GHz of bandwidth. The new R&S®MXO 5 Series has up to 2 GHz of bandwidth.

Fastest oscilloscope in the world
It is the first 8-channel oscilloscope from Rohde & Schwarz and the world's first 8-channel-oscilloscope that achieves 4.5 million acquisitions per second and 18 million waveforms per second across multiple channels. Engineers can now accurately capture intricate signal details and infrequent events.

Powerful EMI testing features
The R&S®MXO 5 Series captures up to 99 % of real-time signal activity. The very short blind time between

acquisitions is ideal for EMI and harmonic testing. The 45,000 FFT (fast Fourier transforms) per second are groundbreaking and help to efficiently debug designs across various applications, ranging from power conversion to automotive analysis.

The R&S®MXO 5 Series is a powerful instrument for EMI diagnostics in product design phases. Debugging in the design phase helps avoid costly redesigns during preproduction.

Power sequencing made easier
Power sequence verification is one of the first applications that comes to mind when one thinks of more channels. When a device under test (DUT) has more power rails than available measurement-channels, repeated measurements or a second oscilloscope are needed. Either way, the measurements need to be synchronized to get a complete picture of power timing, and more channels make synchronization much easier.

The R&S®MXO 5 Series has many uses in automotive-related measurements. The oscilloscope supports automotive Ethernet and USB compliance testing along with the basic triggers for automotive buses and decoding. When designing electric drive trains, current and high voltage probes are often needed. Here, the number of available measurement channels often impose limits, but the R&S®MXO 5 Series has enough current for eight active probes at the same time.

Sustainable performance
Up to 90 percent of the CO_2 footprint for electronics comes from power usage over their lifespan. Remotely controlled T&M equipment often has to be on for that whole time. To save energy, the R&S®MXO 5 Series automatically turns on when electric power is switched on.

R&S®MXO 5 SERIES KEY SPECIFICATIONS

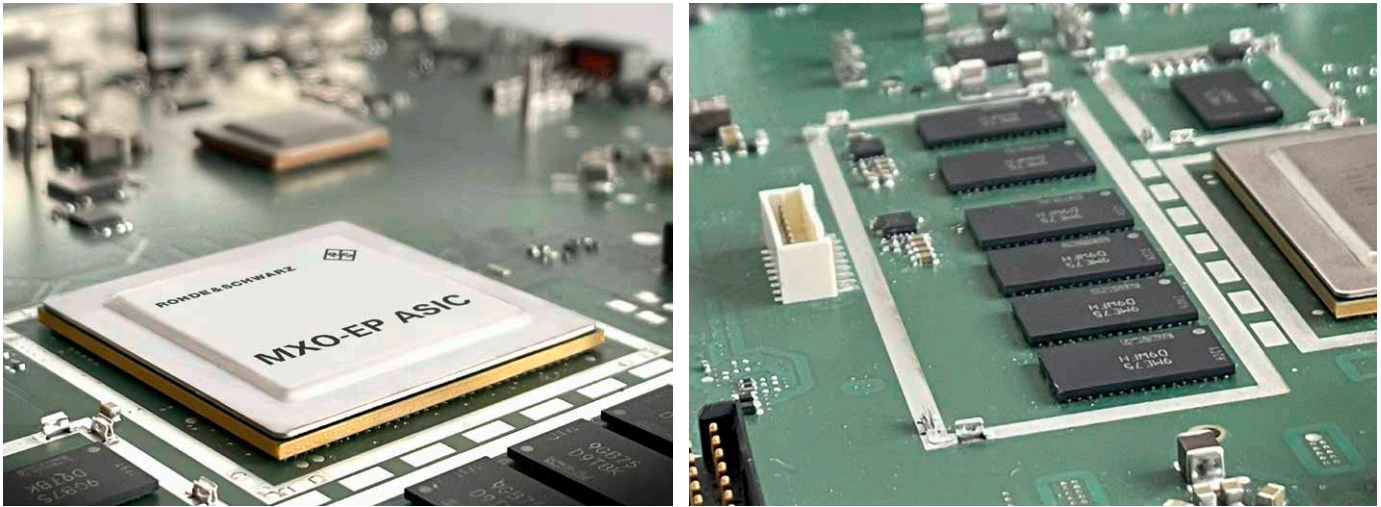| Channels	4	8
Bandwidth	350 MHz, 500 MHz, 1 GHz, 2 GHz	100 MHz, 200 MHz, 350 MHz, 500 MHz, 1 GHz, 2 GHz
Max. sampling rate	5 Gsample/s	5 Gsample/s, 2,5 Gsample/s (> 4 channels)
Record length	500 Mpoints/channel	
Vertical resolution	12 bit ADC, up to 18 bit in HD mode	
Acquisition rate	4.5 Mwaveforms/s	
Display	15" full HD	
Operating system	Linux	

Fig. 2: A look inside reveals a custom made 200 Gbit/s ASIC: the MXO-EP with strong signal processing power (left) and a generous memory block (right). The R&S®MXO 5 Series has two ASIC sets for the fastest acquisitions in the world.

Combined with a smart socket system, the oscilloscope can be powered down when there is no activity and remotely reactivated as needed.

Compared to other oscilloscopes in the same class, the R&S®MXO 5 Series reduces standby power consumption by an impressive 40 percent, making it highly energy-efficient and cost-effective.

Largest standard memory

Each of the eight channels has 500 Mpoints of acquisition memory, or more than five times the standard memory of other scopes in this class. The segmented memory can be used to capture signals separated by inactivity, which is useful for scenarios such as laser pulses, serial bus activities and RF pulses for signal capture over long observation periods of up to 10,000 segments.

The standard history mode can easily access previous acquisitions. All the measurement and analysis tools are available, including serial bus decoding and automatic measurements. An upgrade is available for 1 Gpoints of memory (channels interleaved) and 1 million segments for even longer time spans.

Record every detail precisely

The 12-bit A/D converter (ADC) on all input channels has precise vertical resolution with 4096 quantization levels at all sampling rates, so that all signal details are captured without compromise. The hardware has 18-bit architecture with HD mode to further enhance ADC resolution. Improved resolution does not compromise the sampling rate as in the ERES or HiRES modes. Instead, a moving average filter eliminates aliasing noise components and maintains high resolution for precise capturing and triggering.

The oscilloscopes are sensitive down to 500 µV/div without any reductions in bandwidth. At 1 mV/div, the scopes have low noise of 130 µV even at full 2 GHz bandwidth.
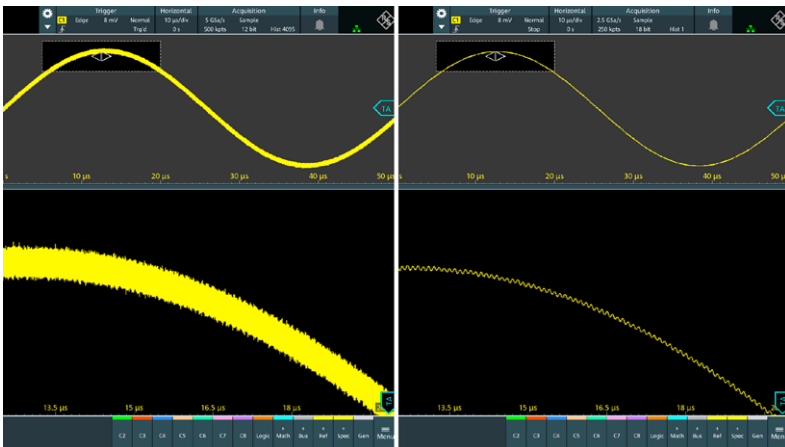

Fig. 3: 12-bit captures can have a lot of noise (left). 18-bit HD mode uses an additional filter to make higher resolution capture more meaningful than just noise (right).

Precision and accuracy are further enhanced with the Rohde & Schwarz patented digital trigger architecture with controllable trigger sensitivity and sample based event detection. An offset of ±2 V at higher sensitivity vertical scales simplifies voltage ripple measurements.

Adapting to your work style

Lab benches are always short on space. The R&S®MXO 5 Series has a 153 mm × 445 mm footprint and is 314 mm high, all while only weighing 9 kg, making it very compact and portable. The optional VESA mounting plate can be used to save even more valuable space.

The incredibly low noise level of just 25 dBA at a distance of 1 m from the front of the instrument (about as loud as soft whisper) makes the scope suitable for office work-stations. Working remotely with the oscilloscope is also incredibly easy. The webserver gives users a simple con-nection to control and observe waveforms on a standard web browser. To keep the R&S®MXO 5 Series secure, a removable M.2 memory stick is available to physically store instrument information in a secure location. In secure labs, M.2 cards can be inserted or removed as needed.

Get the big picture faster

The R&S®MXO 5 Series is a versatile, day-to-day instru-ment that provides engineers with in-depth analysis of their designs. With at least 100 MHz of bandwidth, the R&S®MXO 5 Series covers entry level applications where more channels are needed for faster insight.

The R&S®MXO 5 Series also comes standard with a deep memory of 500 Mpoints per channel to record long events with high sampling rates and with the vertical resolution required in power integrity measurements. The 12-bit ADC with 18-bit HD mode provides even more precision to help accurately quantify power ripple with excellent noise per-formance. Fast acquisitions with hardware accelerated measurements also allow speedy accumulation for statisti-cal correlation of results.

CHUN SOONG WONG, ROHDE & SCHWARZ

ROHDE & SCHWARZ AND OSCILLOSCOPES

In 2010, Rohde & Schwarz entered the oscilloscope market. This is recent compared with to the company's long tradition of RF technology but that didn't keep Rohde & Schwarz from shaping the industry with innovations. After a promising start in 2010 with the world's lowest noise input stage in a 4 GHz scope and the first ASIC that captured 1 million waveforms a second the compa-ny's RF expertise helped it launch an oscilloscope in 2012 with an integrated spectrum analysis function for effective RF debug-ging – unique since scopes usually work in the time domain.

The R&S®Scope Rider RTH, from 2015, was another milestone. The handheld oscilloscope is just as powerful as a benchtop scope. In 2017, Rohde & Schwarz introduced 10-bit ADCs in entry level oscilloscopes. Two years later a real-time deembedding function followed that let scopes trigger on a deembedded signal for improved accuracy. In 2022, the R&S®MXO 4 Series was the industry's first oscilloscope capable of capturing 4.5 million waveforms per second.

Fig. 4: The first and the latest oscilloscope from Rohde & Schwarz: The R&S®RTO1000 (left) and R&S®RTM1000 (center) are both from 2010 and the recent R&S®MXO 5 Series (right) from 2023.

90 YEARS

EMBRACING AI:
HIGH SPEED INTERFACE COM-PLIANCE TESTING AND BEYOND

High-speed-cable testing can take several days and require substantial effort. The Rohde & Schwarz automated compliance test solution reduces this test time to mere minutes.

The internal and external high speed interfaces face rapidly increasing performance expectations. The launch of leading-edge chatbots such as ChatGPT from OpenAI, Microsoft's Bing Chat or Google's Bard are driving the trend. Since these chatbots rely on high-performance computing, hardware vendors introduced a modularized computer with three goals: increased data transfer and storage capacity, improved maintenance quality and lower operational costs. A crucial challenge is managing these huge data quantities on high speed cables where they are transferred from module to module and server to server.

High speed technologies: IEEE 802.3 and PCIe
External cables, especially direct attach copper cables (DAC), often follow high speed Ethernet computer network technologies, such as IEEE 802.3 100 Gigabit Ethernet that can support rates of 100 Gbit/s. The inner data traces and cables use peripheral component interconnect express (PCIe) technology. PCIe 6.0 supports rates up to 64 giga-transfers per second (GT/s). Internal cables and data traces are used to connect the host processor to nearby peripherals and add-in cards, such as display cards or network interface cards (NIC).

Testing high speed cables
High speed cables are constructed of lanes, which are basically copper wires organized as differential signal paths. IEEE 802.3 cable verification requires testing the transmission (THRU) of each lane and crosstalk for all neighboring lanes: near-end crosstalk (NEXT) and far-end crosstalk (FEXT). For more information, see [1].

When higher data rates are needed, the number of lanes in a cable also increases. Manual testing is repetitive, time consuming and error prone. The main cause is the increased number of reconnections and measurements with a 4-port vector network analyzer (VNA). Testing can take up to several days for each cable, such as eight-lane QSPF-DD/OSFP cables, where users must perform 256 manual measurements and cable reconnections.

A further challenge is postprocessing data collected in line with the standard to determine whether a cable passes or fails. The ever increasing complexity and variety of the metrics in various standard specifications make for a heavy workload. IEEE 802.3 defines the channel operation margin (COM) and effective return loss (ERL) as metrics. Excursion metrics for integrated return loss (iRL) and NEXT/FEXT component-contributed integrated crosstalk noise (ccICN) have been introduced for PCIe.

Time efficient turnkey solution
Rohde & Schwarz has developed an automated test solution for high speed cables to relieve test engineers of time consuming and repetitive tasks. The solution combines the precision and performance of an R&S®ZNB vector network analyzer with the R&S®OSP open switch and control platform and the R&S®ZNrun VNA software suite for faster, easier and more reliable measurements.

The R&S®ZNrun cable test client and newly introduced R&S®ZNRUN-K4xx compliance test automation options make for a straightforward test procedure with three

simple steps: set up, calibrate and measure. Each step is optimized to minimize calibration and measurement times.

The R&S®ZNrun cable test client configures switches, performs all required measurement steps and postprocesses all measurement data in line with the COM, ERL, ccICN, iRL and other standard specifications. The solution automatically generates a comprehensive test report, with an overall pass/fail grade for the cable under test, saving lots of time, minimizing human error and letting users focus on analyzing results.

Test plan generation

The VNA and switch platform are often controlled and programmed separately. When an Rohde & Schwarz VNA is extended with R&S®OSP switches, only the VNA has to be controlled. The R&S®OSP switch matrix is automatically detected as a port extension and is controlled by the VNA. R&S®ZNrun cable test client flexibly defines the number of lanes in the test plan and maps the cable connector pins to the physical ports in a multiport VNA system, making the compliance-testing GUI much easier to operate.
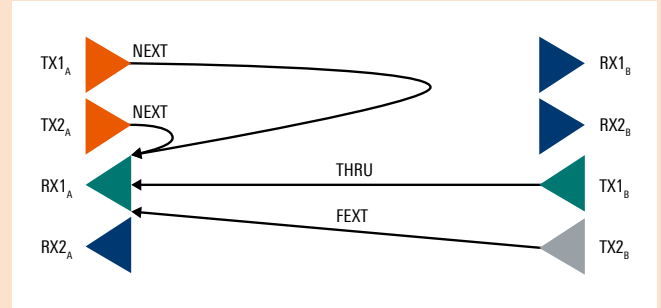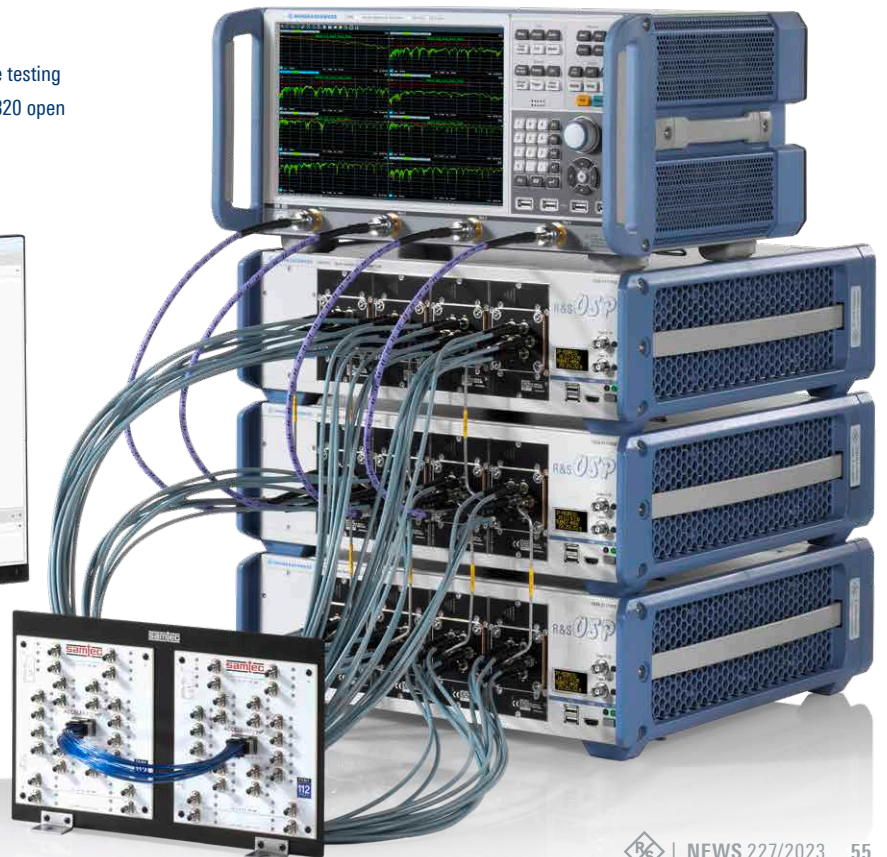

Fig. 2: High speed cable with 2 lanes and corresponding measurements: through (THRU) and crosstalk from transmit neighbor lanes to victim lane (NEXT, FEXT)

Unique time-optimized calibration

The calibration algorithms in the Rohde & Schwarz compliance test solution are optimized for maximum speed and minimum cable reconnections, saving effort and time. The proprietary Rohde & Schwarz guided and user-friendly calibration wizard drastically decreases the overall measurement time. Calibrating a 48-port setup for testing QSFP-DD/OSFP 8 lane cables can be done in 45 minutes or less, instead of two working days.

Fig. 1: Rohde & Schwarz solution for automated high speed cable testing with the R&S®ZNB vector network analyzer and three R&S®OSP320 open switch and control units controlled by R&S®ZNrun software.
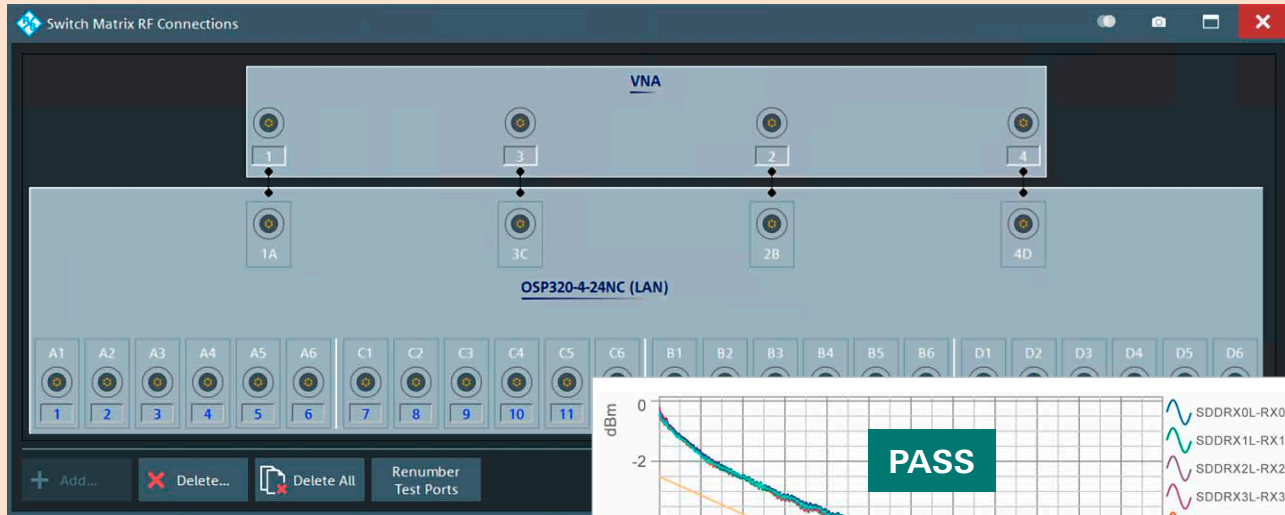
Fig. 3: The VNA firmware from Rohde & Schwarz automatically detects the R&S®OSP switch as a port extension. In this example the 4-port VNA behaves like an 24-port VNA. This feature is adopted by R&S®ZNrun cable test client.
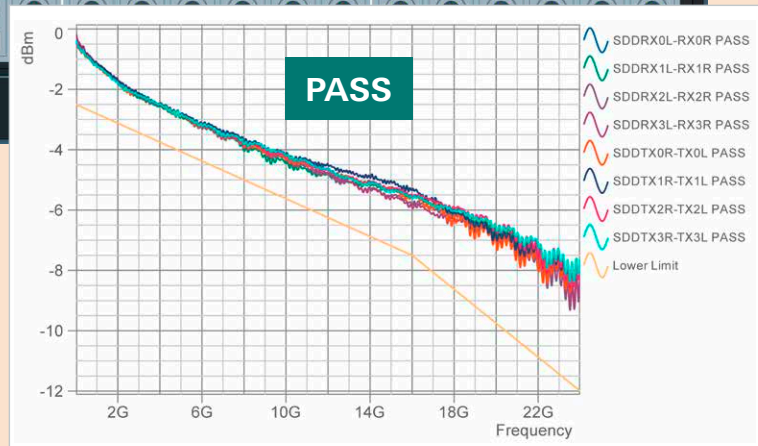
Fig. 4: Measurement results for insertion loss as displayed in the automatically generated report.

Automated postprocessing and report generation

After calibration, all measurements can be done with the push of a button. If a test item is not needed, it can be deselected. R&S®ZNrun follows the test sequence and performs all the measurements. When the measurement is finished, the raw data touchstone files are collected and the signal integrity parameters are postprocessed. Afterwards, the final compliance report is automatically generated, including result tables, diagrams and the overall pass/fail result.

Beyond compliance testing

Apart from fully automated compliance tests, R&S®ZNrun can perform fully customized tests and postprocessing. Limit lines can be modified, while measured lanes and metrics can be selected in line with customer preferences. For a quick, initial evaluation of the cable, measurement steps can be deselected. Initial plausibility measurements are often done before starting a full compliance test, where the frequency range and sweep time can use custom settings.
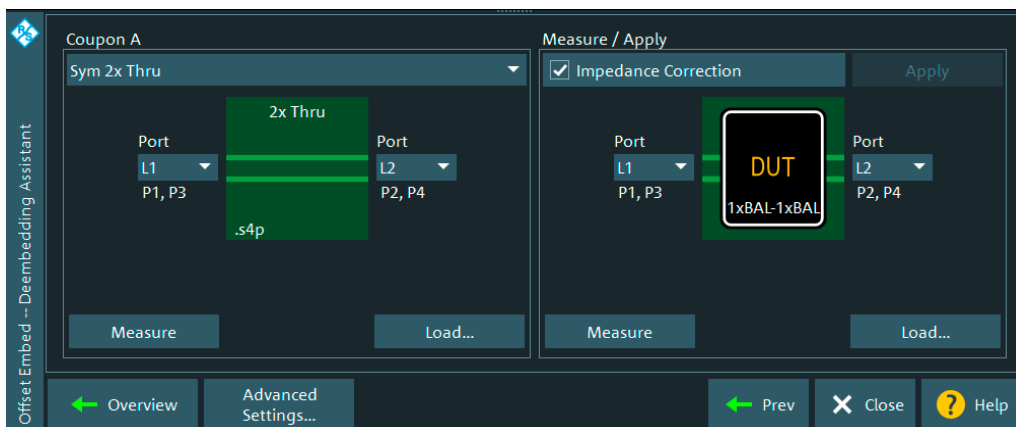

Fig. 5: Flexible and easy-to-use deembedding assistant in a Rohde & Schwarz vector network analyzer.

Deembedding-assistant for test fixture removal

In general, high speed cables under test are plugged into test fixtures to create a coaxial connection linking the VNA ports to cable connector pins. The most important part is the accurate deembedding of all test fixtures. R&S®ZNA/R&S®ZNB-K2xx options include the highly flexible deembedding assistant in VNA firmware to configure single-ended or balanced fixtures and coupons for lead-in and lead-out traces. The impedance correction function in the deembedding algorithm also helps eliminate the multi-reflection effect from mismatched fixtures to greatly enhance the accuracy and confidence in test results.

Future challenges

Higher data rates and higher lane density in high speed interfaces are clear trends in AI data centers and infrastructure. This increases the challenge of dealing with crosstalk and interference in high speed interface designs to enable easy and precise multiport testing. Rohde & Schwarz has a turnkey solution with the VNA automation software suite for compliance testing and moving beyond compliance to characterizing both internal and external high speed cables. Currently, new technologies for next generation specifications such as IEEE 802.3dj/df up to 1.6 Tbit/s and PCIe 7.0 up to 128 GT/s are emerging, so stay connected and stay tuned.

[1] Donahue, C., 2021: Method of implementation (MOI) for IEEE up to 100 Gbps interface channel test.
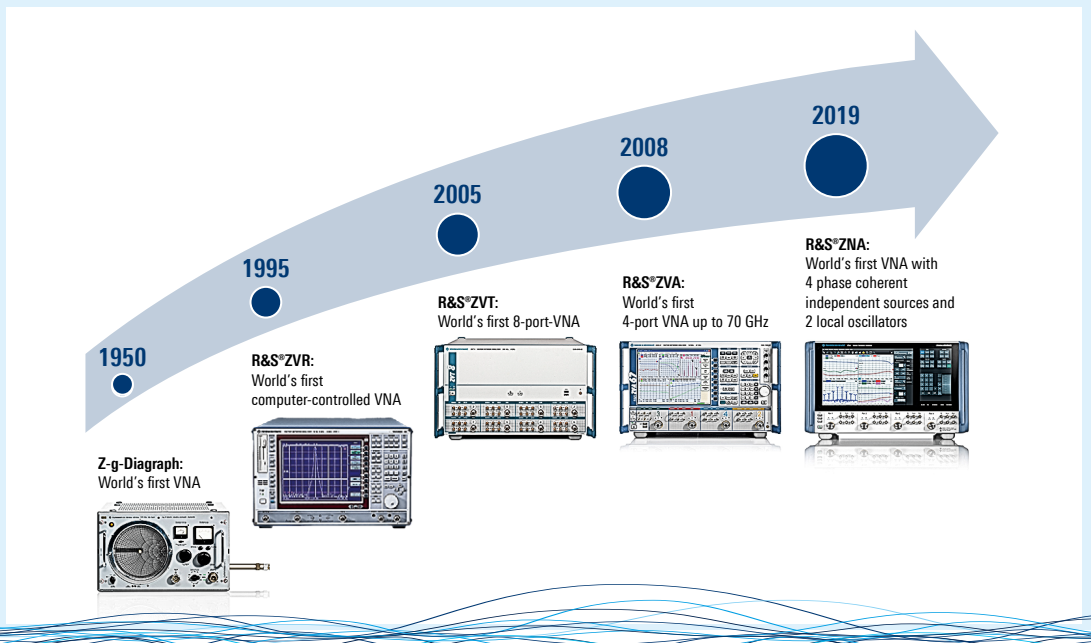
LILIA SMAOUI AND BRYANT HSU, ROHDE & SCHWARZ

PIONEERING NETWORK ANALYSIS SINCE 1950

Rohde & Schwarz is a pioneer in network analysis and launched the world's first vector network analyzer (VNA) – the Z-g-Diagraph – in 1950, followed by several scalar network analyzers, such as the popular SWOB5, in 1979. In 1995, Rohde & Schwarz launched the R&S®ZVR, the first computer controlled VNA with state-of-the-art hardware and software. More game-changing solutions followed, including the R&S®ZVT in 2005, the first VNA with 8 ports. In 2008, the company unveiled the first 4-port VNA up to 70 GHz: the R&S®ZVA. It was the first VNA capable of measuring nonlinear differential components, mixers with system errors corrected by magnitude and phase, and group delay on converters.

In early 2019, Rohde & Schwarz presented the R&S®ZNA high-end VNA. Along with outstanding RF performance, it offers exceptional features that include four phase locked independent sources and two local oscillators.

Fig. 6: Milestones in network analysis at Rohde & Schwarz.

1950
Z-g-Diagraph:
World's first VNA

1995
R&S®ZVR:
World's first computer-controlled VNA

2005
R&S®ZVT:
World's first 8-port-VNA

2008
R&S®ZVA:
World's first 4-port VNA up to 70 GHz

2019
R&S®ZNA:
World's first VNA with 4 phase coherent independent sources and 2 local oscillators

90 YEARS

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RESILIENT, SUSTAINABLE AND READY FOR THE NEW BUSINESS MODEL

Broadcast networks need to be failsafe, sustainable and future-ready.
The R&S®TH1 high-power transmitter meets all of these requirements.
It features unrivaled efficiency and improved failsafe performance.
And it already has the hardware needed for 5G Broadcast.

Even in this age of streaming, broadcast technology is still important in our modern information society. In Germany, for example, 90 % of people still watch conventional linear television at least occasionally. 5G Broadcast is a standardized technology being lined up that will finally enable transmission of broadcast signals to mobile devices, too. Along with increased audience reach, broadcast network operators will also gain a foothold within the 5G ecosystem.

However, 5G Broadcast is of interest to more than just media professionals and broadcast network operators. The capacity limits of mobile networks and a growing general awareness of sustainability are also creating tailwinds. Whereas live streaming of major events requires an individual

Fig. 1: The pump unit is integrated into the base of the R&S®TH1 transmitter's 19" rack, which has a height of 2 m. Additional transmitters can be added as rackmounts.
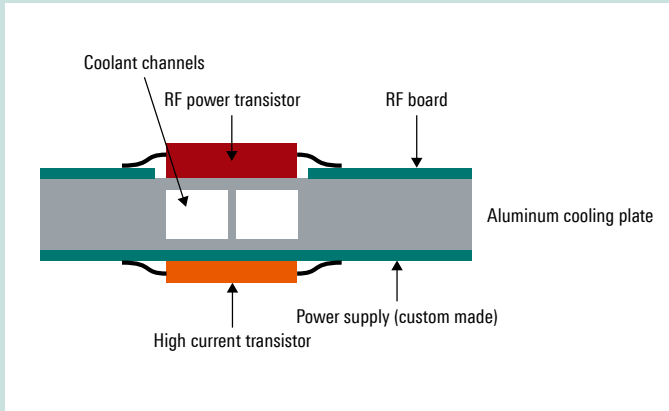
Fig. 2: In the transmitter module, the two components with the highest power loss, i.e. the RF power transistor (dark red) and the high current transistor (orange), are close to the coolant channels (white).

point-to-point data connection for every single viewer, which consume vast amounts of data and energy when added up, 5G Broadcast uses multicasting to reach every 5G-ready device in the coverage area with a single transmit signal – and thus resembles a classic broadcast signal. The data load in the network and the signal quality on the consumer device are not affected by the number of receiving devices. End users do not even need a SIM card and no mobile data is consumed when viewing programming on the go.

Bridging the gap until 2030 with the R&S®TH1
It will be some time before a 5G Broadcast network with full coverage enters operation. Most forecasts are suggesting that 2030 is realistic. The R&S®TH1 high-power transmitter

offers broadcast network operators an interesting perspective for such a scenario. The transmitter supports the current DVB-T and DVB-T2 standards while already including the necessary hardware, such as a software based exciter, for a smooth transition to 5G Broadcast in the future. In the meantime, operators will benefit from significantly lower energy and maintenance costs, failsafe performance and a significantly lower carbon footprint.

### Efficiency for sustainability and low operating costs
The R&S®TH1 is the first member of a new family of liquid-cooled transmitters from Rohde & Schwarz. It transmits in the UHF band from 470 MHz to 700 MHz. Rackmounts support modular configurations with between 1.2 kW and 9.6 kW transmit

power – and even up to 14.3 kW on request. MultiTX configurations allow up to four transmitters in one rack. Depending on the transmission method and configuration, the efficiency at the system level can be up to 47 %, which is double that of typical transmitters. Energy costs for the R&S®TH1 are also around 15 % lower than the most efficient transmitters currently available. This has a positive impact on operating costs and the carbon footprint. If a typical transmitter network with ten transmitters, each with 6 kW transmit power, were retrofitted with the R&S®TH1, this would save around 5000 tons of CO_2 in ten years. This would reduce the carbon footprint by more than half, allowing broadcast network operators to make their own sizable contribution to the European Green Deal [1]. The situation is similar for operators in the USA, where the government has set comparable environmental goals.

A transmitter that takes care of itself
The radio and TV broadcasting industry requires strictly failsafe transmitters. Transmitter installations are often in remote locations that are not easy for maintenance technicians to access, the operator's reputation is at stake and there can be penalties if specified signals are not broadcast.

Fig. 3: In standard transmitter configurations (left), the exciter redundancy is lost if the control unit fails. By virtually distributing the control tasks (right), the redundant exciters can both monitor each other.
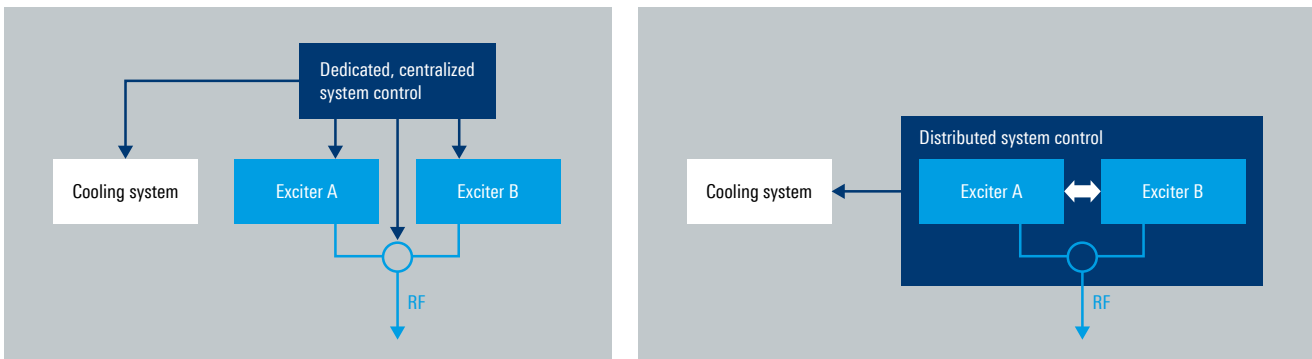
Network operators are thus forced to choose between highly redundant transmitters and frequent maintenance, both of which come at a certain price.

The R&S®TH1 sets new standards for failsafe performance and minimizes maintenance work: the transmitter has an inherently robust design and continuously monitors itself. In the event of a fault, the intelligent maintenance support informs the service team of the exact location of the fault and its urgency. Rackmounts can be exchanged when the transmitter is still in operation and are ready for operation without any further configuration. The software automatically transfers the transmitter configuration and the licenses.

To minimize maintenance, liquid cooling keeps all transmitter modules at the optimum operating temperature and prevents hotspots. Liquid cooling also provides another benefit: since heat is not removed via exhaust air, a smaller ventilation system can be installed in the transmitter room, saving additional costs.

Improved failsafety thanks to a virtual control unit

One innovative feature that ensures improved failsafe performance is the virtual control unit. If one exciter fails, the virtual control unit automatically switches over to the redundant exciter. This job is normally handled by a dedicated control unit that is also responsible for other control and monitoring tasks. However, this design concept gives the transmitter a weak point: a single point of failure. This problem can be avoided with a virtual control unit that runs
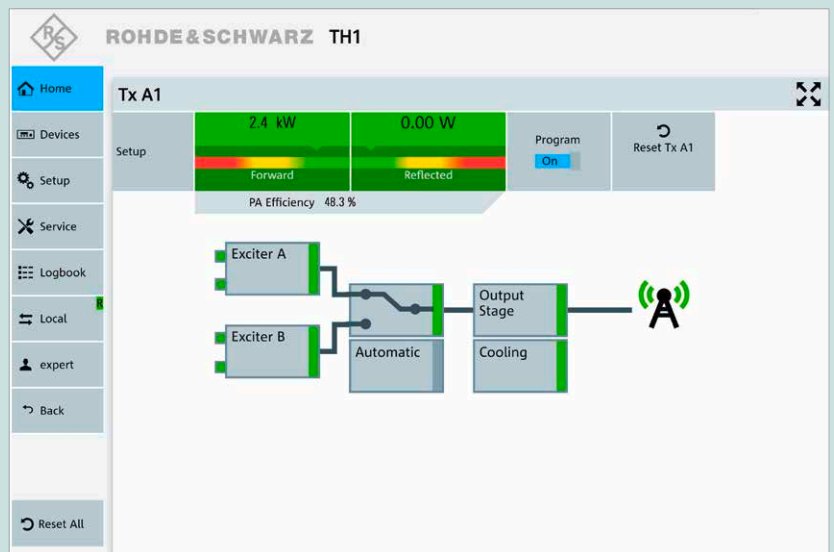

Fig. 4: The maintenance monitor shows the general system status in the overview menu. Thresholds can be set for the transmitter's forward and reflected power to enable automatic warning messages (yellow region) and fault messages (red region).
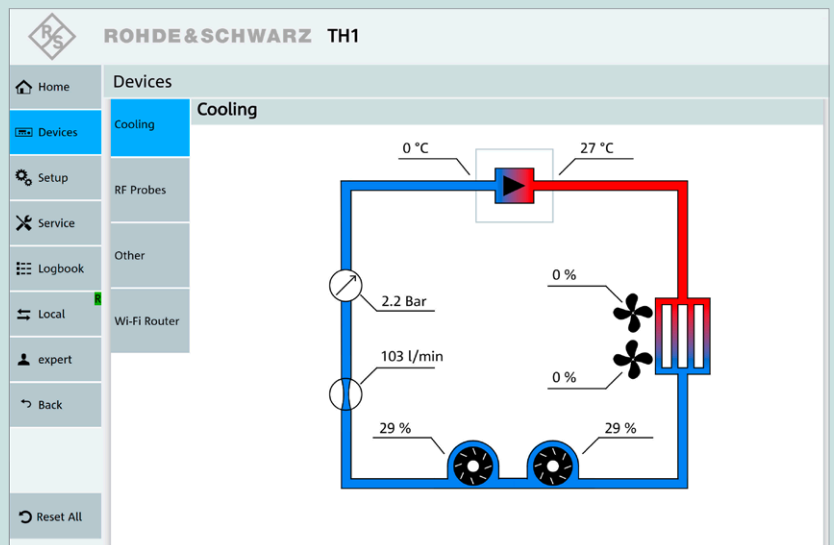

Fig. 5: Submenus contain various details on the condition of individual subsystems. Here, the liquid cooling status is shown.

on redundant hardware that is distributed between the two exciters. For remote monitoring purposes, the transmitter continuously records its own output power, signal quality, pressure and temperature of the cooling liquid and other operating parameters. All these parameters can be displayed on site or queried remotely via an HTML5 web interface.

Future viability included

Along with DVB-T and DVB-T2, the R&S®TH1 high-power transmitter will soon also support the ATSC 3.0 and ATSC standards used in North America as well as ISDB-T.

EDITORS

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[1] As part of the European Green Deal, the European Union has committed itself to reducing CO_2 emissions by at least 55 % by 2030 compared to 1990 levels. In 2020, the total emissions amounted to around 3.4 billion tons of CO_2 equivalents – 32 % below the 1990 level of 4.5 billion tons.
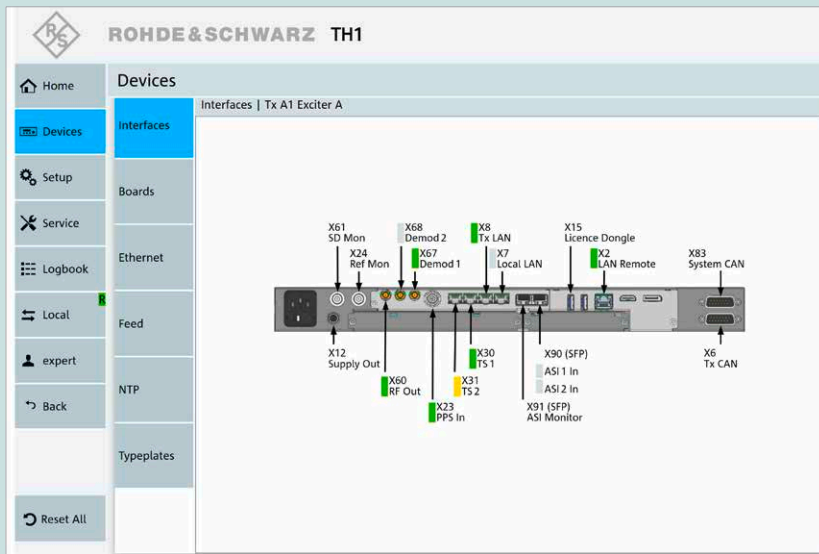
Fig. 6: Maintenance monitor view for the interfaces of a single unit: exciter A.

For further details and use cases for the R&S®TH1 high-power transmitter, see the webinar "How broadcast network operators can shape a sustainable and connected future" on the Rohde & Schwarz website.

BROADCAST TRANSMITTERS AT ROHDE & SCHWARZ

February 28, 1949: Europe's first VHF FM transmitter enters operation in Munich, Germany. For Rohde & Schwarz, this day marks a successful entry into the communications engineering and broadcasting sector. However, for Friedrich Zaekel, Technical Director at the contracting authority Radio Munich, a promise had been broken. Transmission was scheduled to begin simultaneously with a broadcast in Hanover one day later.

To make up for this, company co-founder Dr. Lothar Rohde went on a media offensive along with an American TV team to congratulate Radio Munich for its pioneering achievement. Faced with so much publicity, the Radio Munich director finally came around to a positive point of view. The official starting date for VHF radio in Europe was then set to March 1, 1949.

Fig. 7: R&S®THUevo transmitter in One World Trade Center.

At Rohde & Schwarz, the broadcast business took off quickly. By 1950, the company had a large portfolio of transmitters ranging from 250 W to 10 kW and was manufacturing its own transmit antennas. In its broadcast and media business field, the company now covers the entire value chain from studio equipment to transmitters, including broadcast T&M equipment. Due to their top performance and reliability, Rohde & Schwarz transmitters are now installed in over 100 countries. One notable example is the UHF transmitter facility at the One World Trade Center in New York (Fig. 7). An impressive 106 kW transmit power is delivered by an array of R&S®THU9evo transmitters – the most powerful TV transmitter ever constructed based on semiconductors.

Fig. 8: Rohde & Schwarz advertises its commissioning of the first European VHF FM broadcast transmitter. In the ad, the company modestly puts the spotlight on the German premiere.