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DENSE FREQUENCY SPECTRUM?

No problem with the R&S®ESMW

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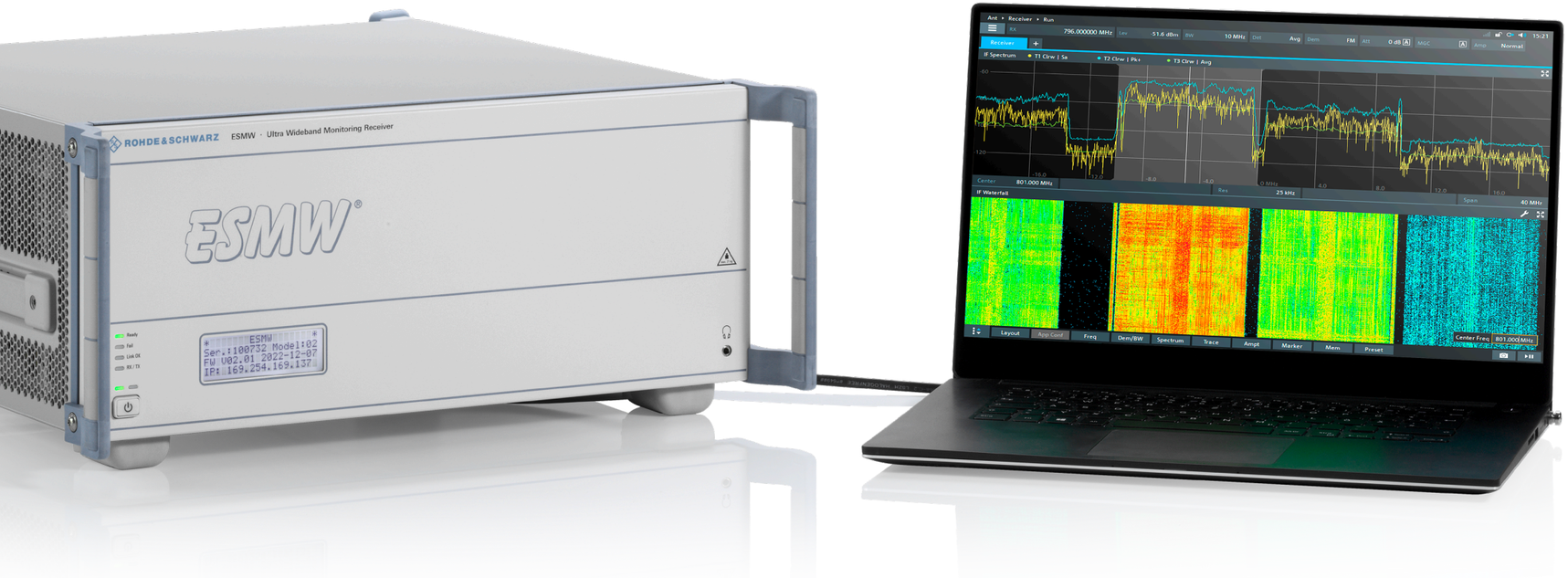

EXCEPTIONAL PERFORMANCE FOR NEXT GENERATION RADIOMONITORING

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 transportable 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 R&S®ESMW is designed for remote control from a laptop or tablet.

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.

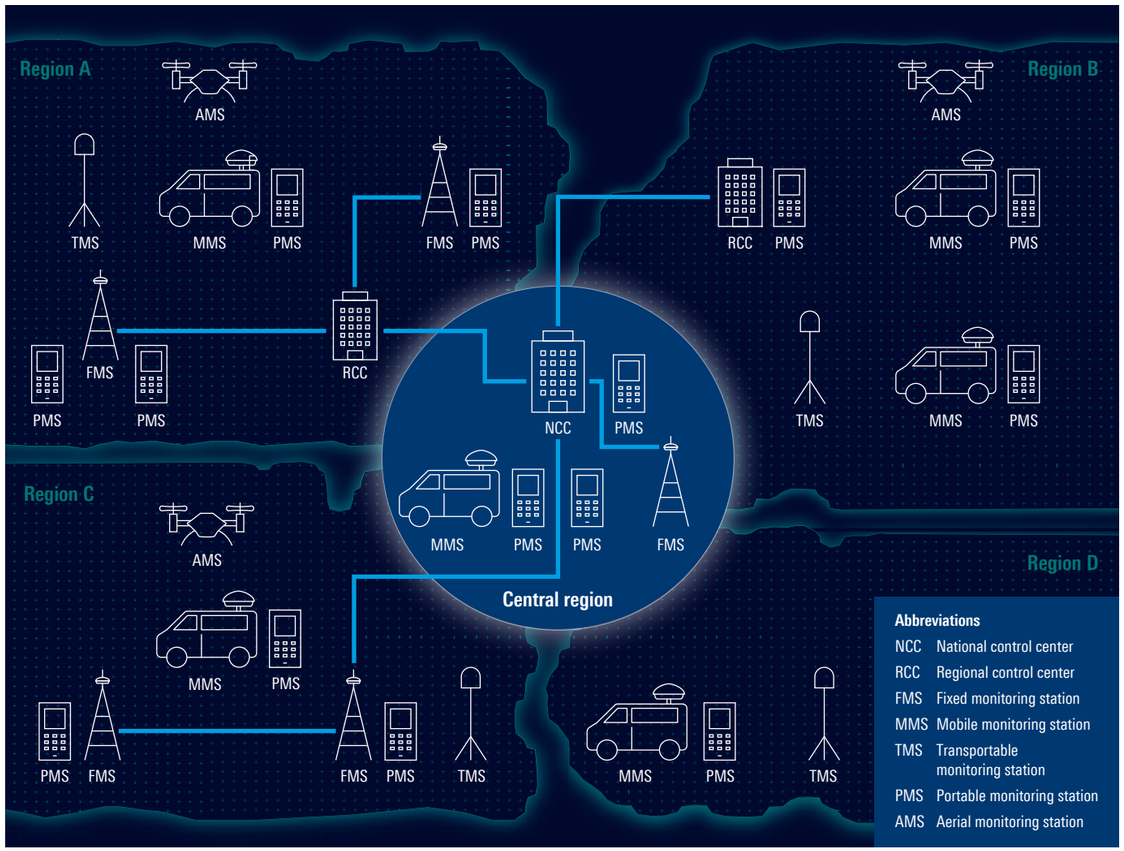

Fig. 1: Hierarchical structure of national radiomonitoring networks. Activities detected in the radio spectrum are compiled in a regional control center (RCC) and passed on to a national control center (NCC).

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 ultrawideband 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 transportable 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.

The R&S®ESMW helps regulators keep pace.

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.

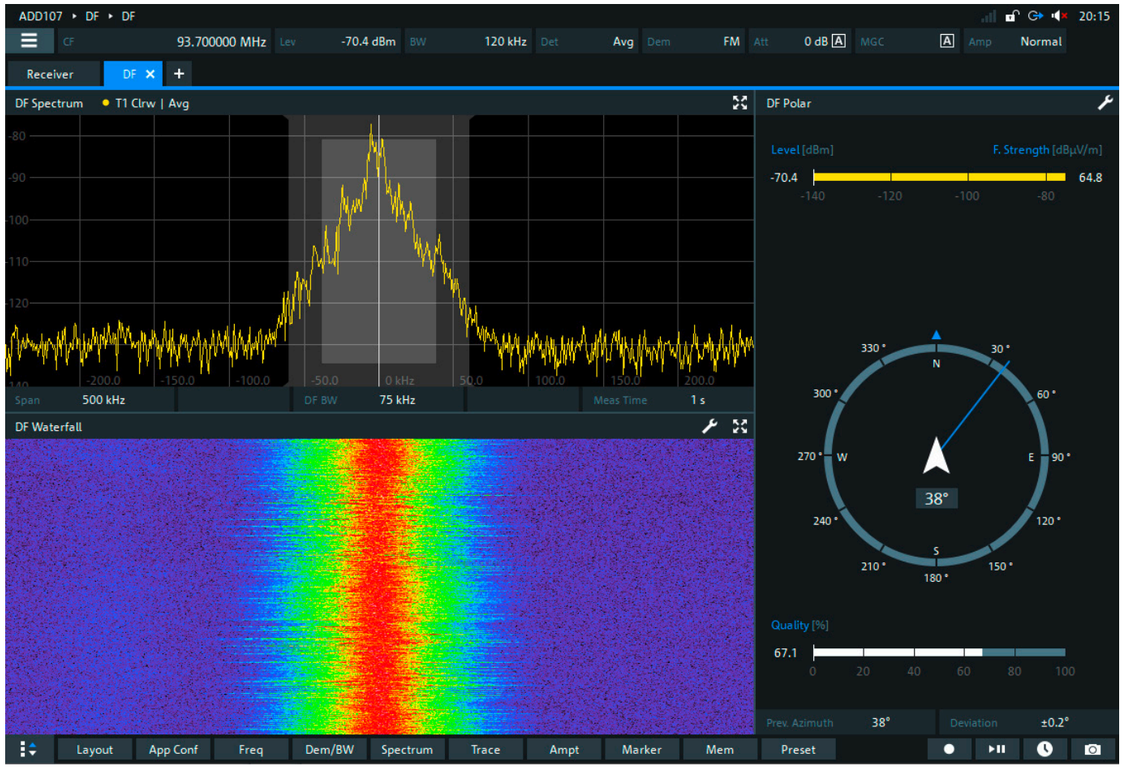

Fig. 3: The two windows on the left show the spectrum and waterfall diagram of a measured signal. With the optional direction finding functionality, the direction of incidence can also be shown as a degree value on a compass rose (right).

Fig. 2: The R&S®ESMW mounted in a 19-inch rack in a measurement vehicle.

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.

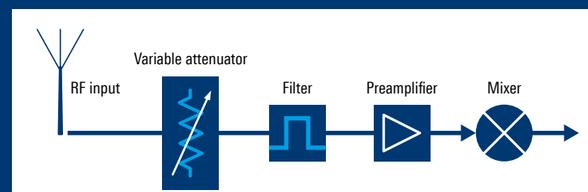

Fig. 4: Basic structure of a radiomonitoring receiver frontend.

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 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.

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 R&S®ESMW can also be expanded to include the popular direction finding function. It shows the direction of incidence for a measured signal (Fig. 4). If R&S®ARGUS software is used to control multiple measurement stations, the precise position of the signal source can be determined quickly.

The April 2024 firmware expansion gave the R&S®ESMW an integrated map display which provides automatic triangulation of stored DF results along with the current position. 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.

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.

DR. JENS STEINWANDT, ROHDE&SCHWARZ

[1] NEWS 226 (2023), page 9.

More information is available online:

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. 5: An ESUM monitoring receiver from the 1960s.

Fig. 6: 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

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

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Data without tolerance limits is not binding | Subject to change