R&S®RAMON
Radiomonitoring Software
For radiomonitoring and radiolocation systems

ROHDE&SCHWARZ

Radiomonitoring & Radiolocation

Product Brochure | 04.00

R&S®RAMON Radiomonitoring Software

At a glance

The R&S®RAMON software modules are used as core components in advanced radiomonitoring and radiolocation systems. The R&S®RAMON software covers a broad scope of functions: It can be used to control the equipment connected to a computer, to store and analyze the data delivered by the equipment, to control and monitor the information flow in a networked system comprising multiple workstations or system sites, and to simplify routine tasks by translating them into fully automated sequences.

Systems using the R&S®RAMON software are intended for specific spectrum monitoring tasks, government authorities entrusted with public safety and security missions and for the armed forces. They are delivered as complete, turn-key systems and support a wide range of tasks, including:

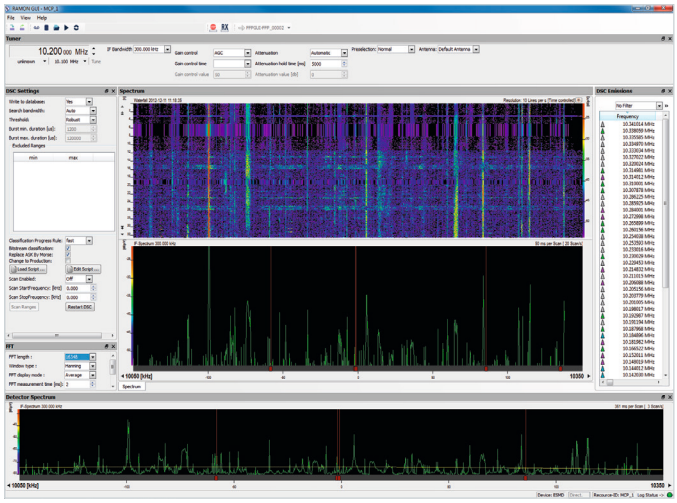
- Collection of information as a basis for political decisions
- Border protection (prevention of contraband trade and illegal border crossings)
- Personal and property protection
- Location finding of interference signals
- COMINT/CESM for military missions

Systems based on R&S®RAMON include Rohde&Schwarz radiomonitoring and radiolocation equipment as well as IT components, communications systems and the modular R&S®RAMON software, which provides the interface to the user.

Rohde&Schwarz also offers special software modules developed for military use, e.g. in communications electronic countermeasures (CECM) systems. These modules are subject to export control regulations, and are described in a separate product brochure. They can be used in systems in combination with the R&S®RAMON radiomonitoring software.

Key facts

- Integrated radiomonitoring and radiolocation software from single-operator to nationwide distributed systems
- High probability of intercept
- Highly automated monitoring process – automatic storage of all radio activities to create a basis for information analysis
- Easy networking of radiomonitoring and radiolocation systems with R&S®RAMON software providing adaptation to a variety of communications systems and data transmission bandwidths
- R&S®RAMON systems flexibly integrate as subsystems into customer's radiomonitoring and radiolocation systems



R&S®RAMON graphical user interface (GUI) of the R&S®CA120 multichannel signal analysis system: wideband tuner spectrum and list of emissions delivered by a detector for conventional radio signals.

R&S®RAMON Radiomonitoring Software

Benefits and key features

Full scope of functionality – all from a single source
- Complete portfolio of hardware and software components
- Support of complete workflows from planning to reporting
- Full range of services (project management, system engineering and user training)

▷ page 4

High probability of intercept
- Detection of low probability of intercept (LPI) emissions
- Storage of LPI signal characteristics and comparison with stored signal profiles to enable emission identification

▷ page 5

Flexibility and scalability
- Reconfiguration, expansion or updating of existing systems to include new scenarios
- Flexible sharing of sensor equipment
- Remote control capability

▷ page 5

Remote control
- Remote control capability via wired or wireless communications links
- Use of simplex or full-duplex communications links
- Adaptation to available bandwidth

▷ page 6

Interference hunting
- Mobile DF system for use on commercial vehicles
- Automatic target location in urban environments

▷ page 7

Propagation calculation with R&S®PCT
- Determining the radio coverage for optimum site planning
- Planning the communications links for subsystem networking

▷ page 8

Automation of radiomonitoring sequences
- Combining radiomonitoring functions into complex, fully automated sequences
- Time-controlled radiomonitoring tasks in unattended systems/subsystems

▷ page 9

Evaluation support and radio network detection
- Automatic detection of radio traffic and radio networks
- Display of electronic situation picture
- Re-identification of radio networks by means of emitter database

▷ page 10

Workflow control
- Defining and tracking of orders and reports
- Clear-cut hierarchical structure

▷ page 12

Integration into existing systems
- Expandable, future-oriented solutions thanks to open interfaces

▷ page 14

Turnkey, customized system solutions
- System integration into almost any type of mobile platform
- Planning, installation and putting into operation of stationary systems

▷ page 15

Full scope of functionality – all from a single source

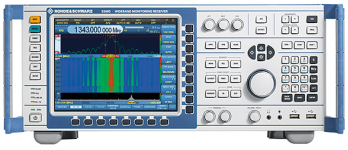
Rohde&Schwarz has been a developer, producer and supplier of complete, turnkey radiomonitoring and radiolocation systems for more than three decades. The company is among the few manufacturers in the world to provide single-source solutions, i.e. it offers the complete portfolio of components (hardware and software) and services (project management, system engineering and user training) that are essential for the successful operation of such systems.

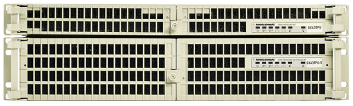
This includes an extensive range of antennas (from 100 Hz to 40 GHz), sensors for radiomonitoring and direction finding/radiolocation as well as signal analysis components. The system software comprises a wide range of modules for the following tasks: mission planning, control of all sensors and of information flow within a distributed system, analysis, processing and storage of all intercepted and reference data in database systems, reporting.

The R&S®RAMON software modules are designed as commercial off-the-shelf (COTS) products and are available at short notice.

Customized radiomonitoring systems based on Rohde&Schwarz components

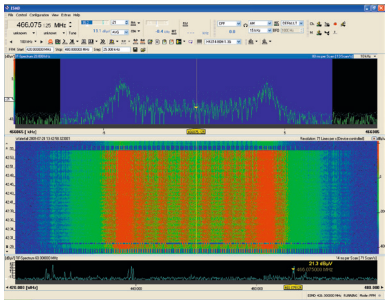
Sensor equipment
- Direction finders
- Receivers
- Analyzers
- Recording devices
- System devices

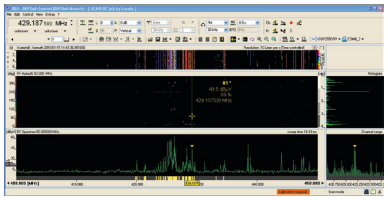


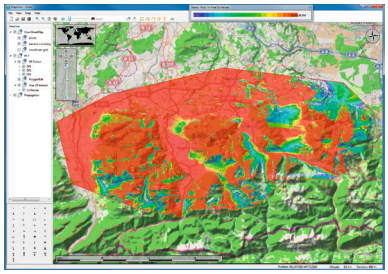


Services provided
- Turnkey system solutions
- Technical and operational training

System software
- Device control (local/remote)
- Mission planning
- Tasking/reporting
- Analysis/evaluation







High probability of intercept

State-of-the-art communications systems use various low probability of intercept (LPI) transmission methods to make interception as difficult as possible.

R&S®RAMON systems are tailored to handle precisely such signal environments. Their high probability of intercept makes it possible to reliably detect LPI emissions, and to locate and store them for further processing in order to identify them.

This is achieved through the use of wideband sensors (receivers and direction finders) and detection algorithms that allow the user to see even the briefest of emissions. The system software permits such emissions to be re-identified on repeated interception. For this purpose, the software automatically compares the measured parameter values with signal profiles stored in the R&S®RAMON database.

The remote operation of systems for LPI signal detection is possible thanks to intelligent compression methods for data transmission.

Flexibility and scalability

Scalability is a key feature in modern radiomonitoring systems and is increasingly gaining in importance especially from an operational point of view. The scalability and modularity of the R&S®RAMON systems offer the following advantages:

- The systems can be adapted and reconfigured by the customer as required for the task at hand (in line with the current mission)
- Easy expansion and upgrading to meet changing requirements
- Interfaces allowing easy integration into existing customer architectures
- Remote control capability using any type of wired or wireless communications links and variable data rates

Remote control

Remote control capability via wired or wireless communications links

Remote control capability is a vital characteristic in radiomonitoring systems. It is crucial in systems in which multiple sensor subsystems need to communicate with one another via wired or wireless links, e.g. in a radiolocation network including multiple remote direction finders.

Use of simplex or full-duplex communications links

Radios – whether for military or civil applications – often allow simplex communications only. Data transmission via a wide area network (WAN), however, calls for full-duplex communications capability. This capability is offered by modem links using dialed or leased lines of the public, wired networks, as well as by mobile radio links (e.g. GSM), directional radio links and satellite communications links.

Communications between modules of the R&S®RAMON software family is based on the TCP/IP protocol. Where only a simplex communications link is available, the R&S®RAMON software modules at both ends of the link convert the TCP/IP-based data telegrams to a protocol suitable for radio transmission.

Adaptation to available bandwidth

The available transmission bandwidth in remote control applications is often limited. Directional radio systems or leased lines usually offer wideband links that enable the transmission of realtime information (e.g. of an IF spectrum or RF spectrum of a scanning receiver/direction finder). Narrowband links are not adequate for this type of data transmission.

The operational requirements placed on a radiomonitoring system need to be adapted to the available means of communications. If necessary, however, an existing communications system has to be replaced by a more powerful one to comply with more stringent operational radiomonitoring requirements.

The R&S®RAMON system software allows even wideband sensors, which deliver high data volumes, to be remotely controlled using low data rate communications links. This will not jeopardize probability of intercept. The only compromise will be with respect to time resolution in the result display.

Interference hunting

Defective or incorrectly set electronic devices, or devices with poor EMI suppression, can emit unwanted electromagnetic waves that interfere with radio services. Sources of interference are frequently located in urban areas. That makes precise direction finding extremely difficult due to the phenomenon of multipath propagation, which results from radio waves being reflected by surrounding buildings. Unless the operator has many years of experience in finding radio interference sources, having capabilities that quickly and automatically lead to the target is highly desirable.

Mobile DF system for use on commercial vehicles

R&S®Mobile Locator enables users to take bearings on transmitters from a moving DF vehicle, plus it allows them to determine a transmitter's position automatically. Within minutes, a compact DF system based on the R&S®DDF007 portable direction finder turns a commercial vehicle into a DF vehicle operating in the frequency range from 20 MHz to 6 GHz. R&S®Mobile Locator can also be used with more powerful Rohde&Schwarz DF systems in dedicated DF vehicles and helicopters.

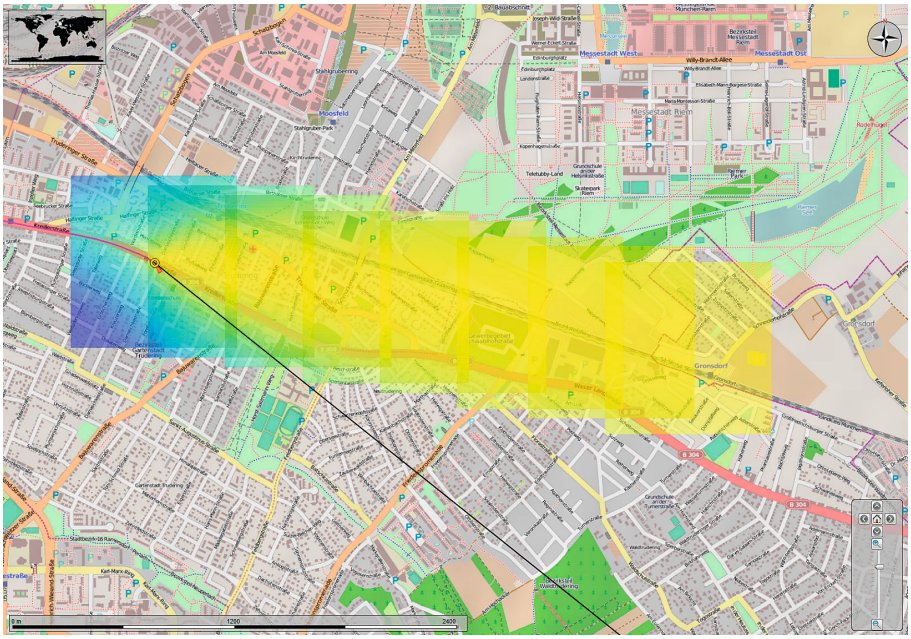
DF vehicle with the R&S®ADD107 compact DF antenna (20 MHz to 1.3 GHz) and the R&S®DDF007 digital direction finder (in vehicle, not visible).

Automatic target location in urban environments

While the vehicle is moving, R&S®Mobile Locator continuously records bearings and, using a special algorithm, computes from this data the most probable direction for the emission of interest. The system automatically eliminates reflections caused by multipath propagation, so that no experienced operator is needed to assess the bearings.

By overlaying a probability map on a digital map, R&S®Mobile Locator guides the driver toward the transmitter. When sufficient DF results of adequate quality have been collected, R&S®Mobile Locator indicates the transmitter's precise location on the map.

Probability map overlaid on the digital map. The direction of the radio transmitter is clearly recognizable although its precise location has not yet been calculated. Once a consistent and stable computation of the emitter location is possible, it is displayed on the map. The probability map is continually updated.



Propagation calculation with R&S®PCT

The R&S®PCT propagation calculation tool offers mission planners full support, allowing them to optimally deploy their radiomonitoring and radiolocation systems. In order to cover a defined area of interest, the tool relies on topographic data of the terrain (terrain profiling data) to calculate the best possible reception sites within a particular area. Results are displayed on a digital map in the R&S®MapView geographic information software. Mission planners can select the optimal reception sites for their radiomonitoring and radiolocation systems.

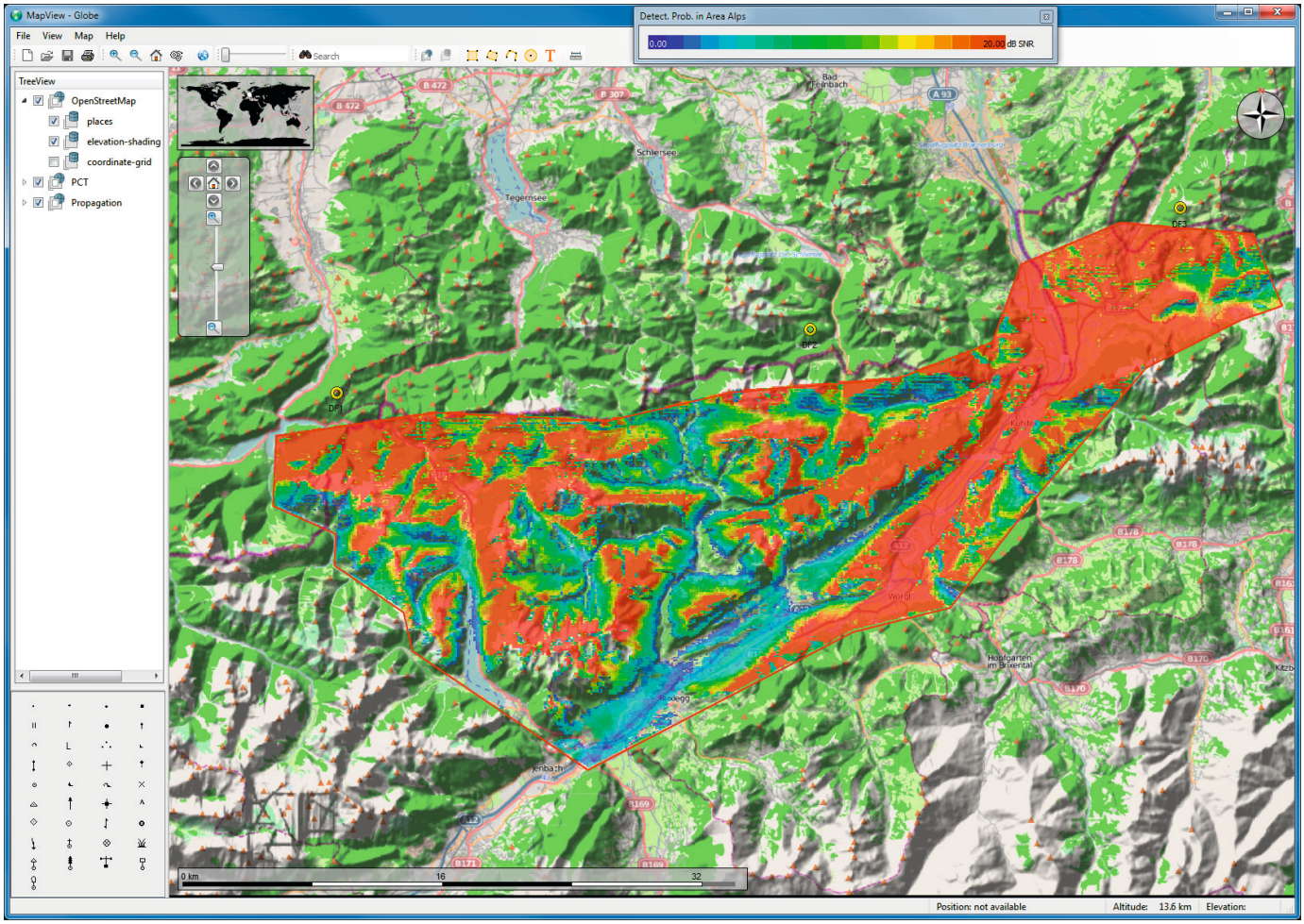
Determining the radio coverage for optimum site planning

A vital factor in the successful deployment of radiomonitoring and radiolocation systems is the selection of the optimum sites. This applies to stationary systems as well as to mobile and transportable systems. Mission planners require a reliable tool for calculating the coverage of the area of interest for their radiomonitoring and radiolocation systems and for planning the communications links required to network the individual monitoring subsystems.

Planning the communications links for subsystem networking

Radiomonitoring and radiolocation systems frequently require communications links for networking the monitoring subsystems in order to control remote sensors or for exchanging data between attended stations. The R&S®PCT propagation calculation tool can be used to plan the communications links between the monitoring subsystems in order to provide the desired functionality.

Mission planning: expected field strength in a geographic area.



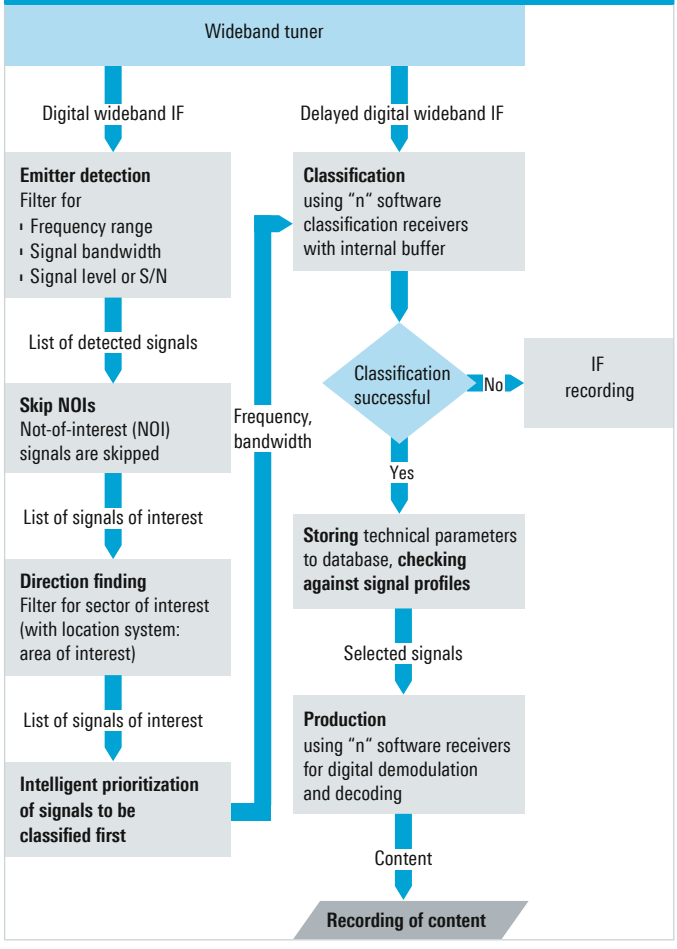
Automation of radiomonitoring sequences

Combining radiomonitoring functions into complex, fully automated sequences

The R&S®RAMON system searches a defined frequency range for radio emissions with predefined or known signal characteristics. This is done using a wideband receiver that employs an algorithm to automatically detect signals in its wideband IF spectrum. A list of the detected signals is created and automatically compared with a list of not-of-interest (NOI) frequencies; the NOI frequencies are filtered out. For all remaining signal frequencies, the system queries bearing values or location data from the direction finding/radiolocation subsystem, since only signals with bearings in a predefined sector or area of interest will be processed. The resulting signals are automatically assigned to a large number of narrowband classifiers that process the buffered IF. The operator is presented with a list of all detected, located and classified signals that is continuously updated. Based on the classification results, the system can automatically trigger a number of actions, e.g. comparing the signal characteristics with profiles stored in the emitter database (see figure). When classification of a signal is completed, the classifiers are immediately available to process the next signal.

Based on the classification results, the system can also automatically start content production for emissions with predefined signal characteristics.

Example of an automated radiomonitoring sequence



Time-controlled radiomonitoring tasks in unattended systems/subsystems

The R&S®RAMON task planner is used to define and execute tasks at defined times. A task is an automated sequence of radiomonitoring functions covering the detection, location and classification of radio signals. It is accomplished by means of an assigned number of resources including receivers, direction finders, decoders, etc. The R&S®RAMON resource management organizes the available hardware and software resources and supports operators in defining automated tasks.

These tasks are executed according to a defined time schedule. Definition of repetitive tasks at regular time intervals allows surveillance of radiocommunications signals with regular transmission patterns. Routine monitoring of radio networks, e.g. at defined times of day, can take place fully automatically, which reduces the personnel needed.

In this way, especially remote, unattended systems can automatically monitor radio activities.

Evaluation support and radio network detection

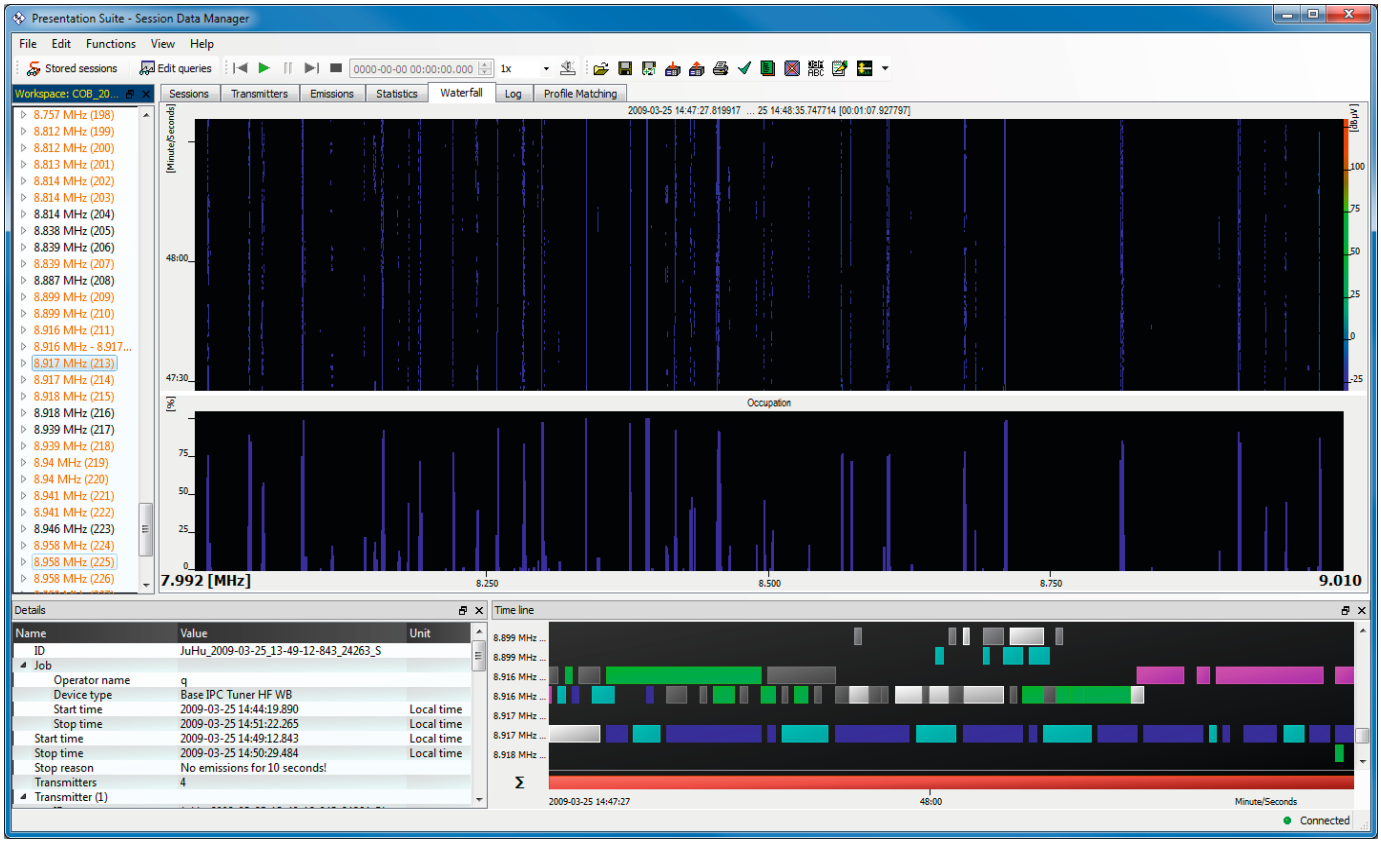
Radiomonitoring systems are used for various applications, depending on the mission. As a feature common to all such systems, signal interception and emitter location are followed by an evaluation process. R&S®RAMON ideally supports this process by means of two software options: R&S®Presentation Suite COM (communications data manager) and R&S®Presentation Suite REF (reference data manager).

Automatic detection of radio traffic and radio networks

All radio activities are saved automatically by means of software processes running on PCs that are linked to the system sensors (radio receivers, direction finders and analysis equipment). This ensures that all radio traffic taking place on the monitored frequencies is seamlessly captured and the communications patterns of all monitored radio stations are fully recorded. The data obtained is visualized, analyzed and evaluated by means of the R&S®Presentation Suite COM software option.

The R&S®Presentation Suite software was developed to efficiently handle the steadily growing amounts of data delivered by modern radiomonitoring systems. Using powerful algorithms, the software can automatically detect radio traffic and radio networks in the intercepted electromagnetic emissions, which significantly speeds up the evaluation process.

R&S®Presentation Suite COM: Overview of frequency band occupancy.



Display of electronic situation picture

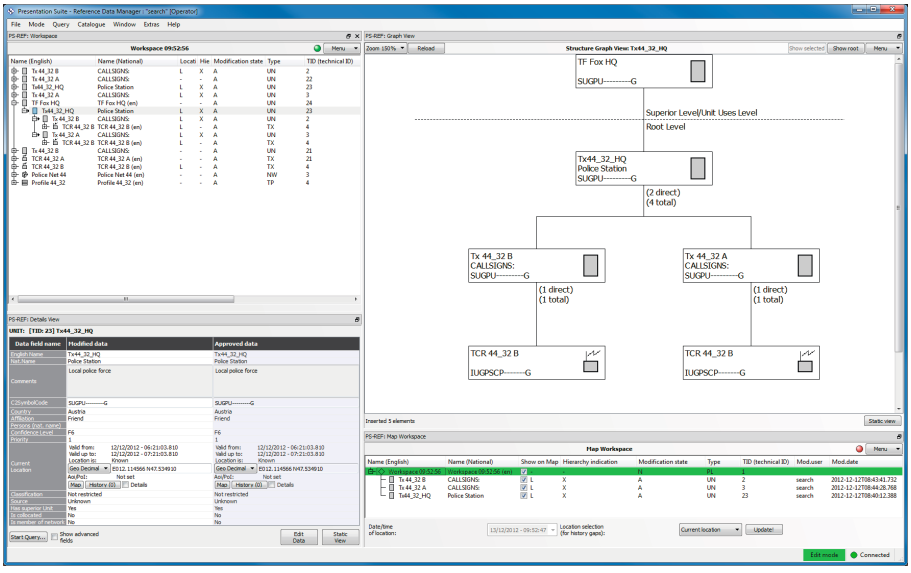
The automatically detected radio traffic and radio networks, together with their parameter values and metadata, are stored to the R&S®RAMON database, from which they can be retrieved for further analysis. The operator can load radio traffic and radio networks of interest by making specific database queries (time of emission, frequency, geographic area, specific signal parameters). The information can be displayed, edited, exported and stored. Different display formats, tables and display on a map are available for data visualization.

The R&S®Presentation Suite COM software option enables the automatic creation and display of an electronic situation picture from the data produced by the radiomonitoring system (see screenshot at bottom of this page).

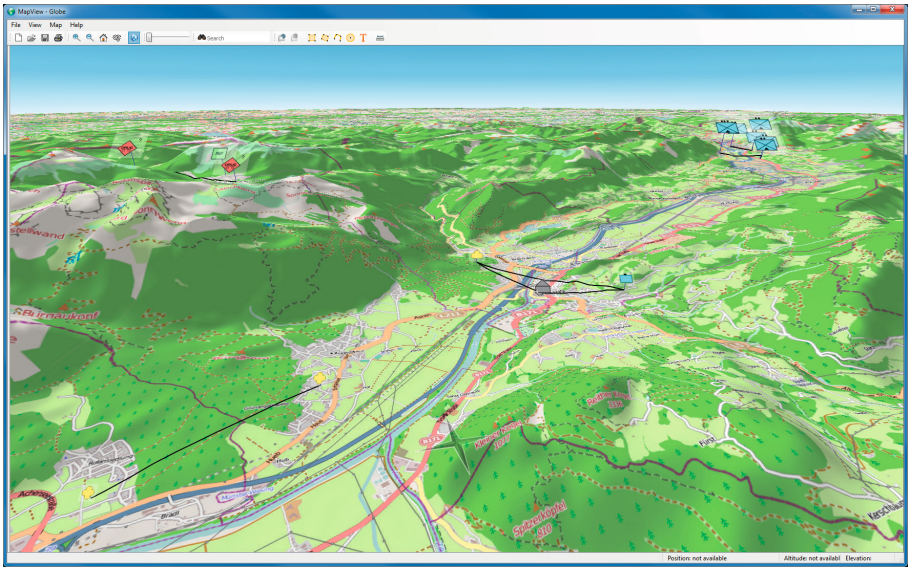
Re-identification of radio networks by means of emitter database

As a result of evaluation, reference data is produced and stored as profiles to the emitter database, which forms part of the R&S®RAMON database. A powerful symbol editor supports the operator in assigning symbols to emitters.

Based on the profiles stored in the emitter database, the system can re-identify previously detected radio networks during signal interception. For this purpose, the database of a mobile system, for example, is loaded with this reference data prior to a mission. Powerful matching algorithms are used to re-identify networks. This speeds up the detection of radio signals and networks of interest.



GUI of R&S®Presentation Suite REF – typical display.



Display of current situation picture using R&S®Presentation Suite.

Workflow control

Defining and tracking of orders and reports

The operation of a radiomonitoring and radiolocation system is based on a step-by-step process, covering the interception, location, classification, storage and analysis of radiocommunications signals. This process is controlled by tasking and reporting.

In larger systems with multiple workstations (see "Turnkey, customized system solutions", page 15), a supervisor usually organizes and plans the monitoring tasks based on an order from the user. The supervisor uses the R&S®ReportEdit software module to assign specific tasks (orders) to the individual operators.

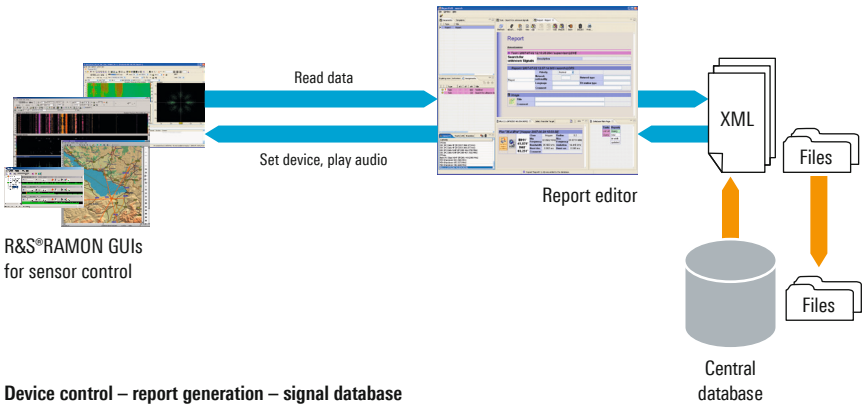
Each operator transfers the results obtained as a complete parameter set to a report simply by a mouse click and sends the report to an evaluation operator.

The following data can be stored in a report and forwarded to the subsequent operator:

- Setting parameters and measured data delivered by receivers, direction finders and analyzers
- Screenshots from device GUIs and situation picture on a map
- Hyperlinks to stored, demodulated audio signals and decoded texts
- Hyperlinks to stored IF signal samples
- Hyperlinks to stored signal activities in one or multiple frequency bands

The evaluator stores the results of the data evaluation to the R&S®RAMON database. The supervisor accesses this data and compiles reports for the user as well as new orders that incorporate the results just obtained.

Interaction between R&S®RAMON applications



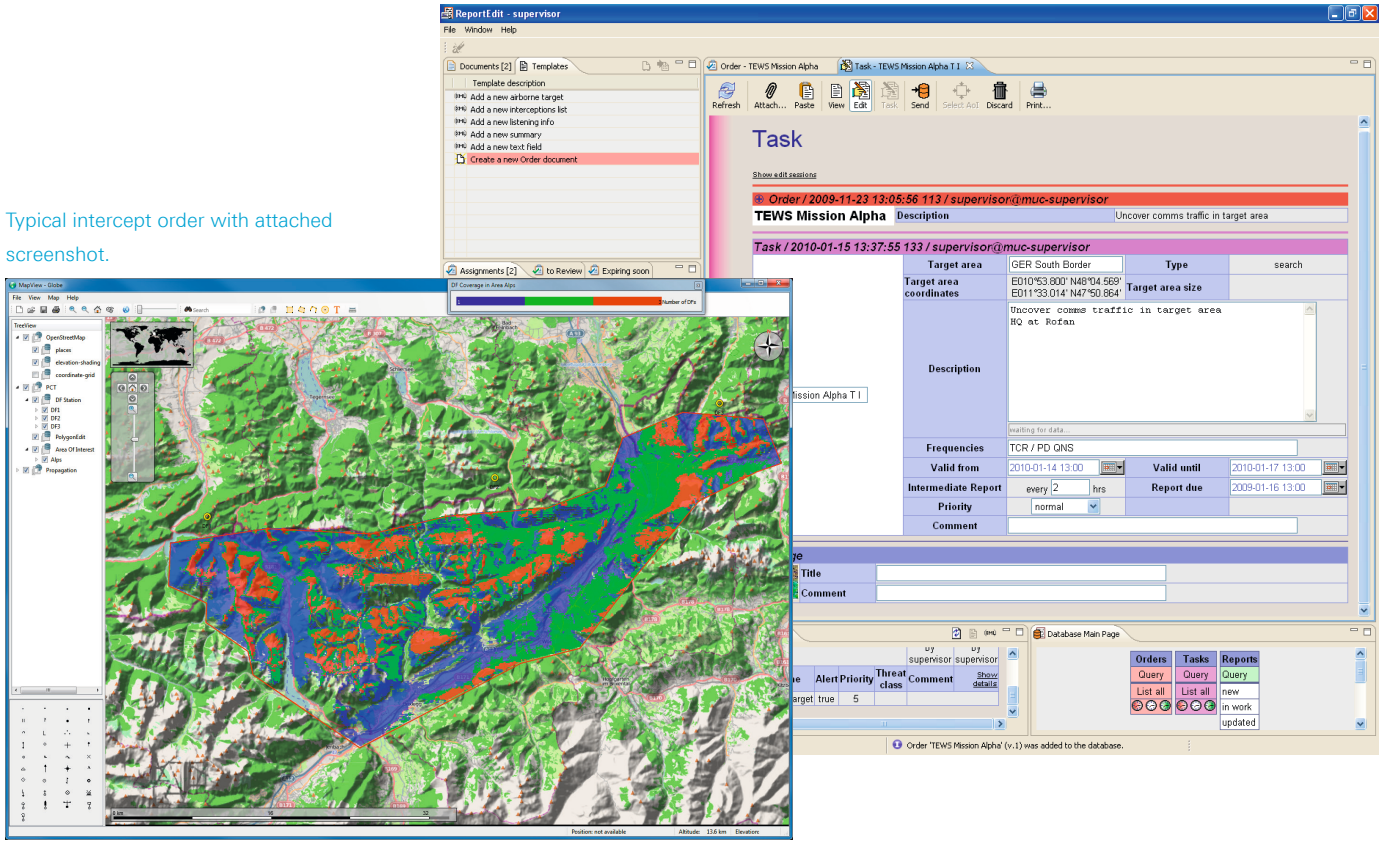
Device control – report generation – signal database

Clear-cut hierarchical structure

Depending on its size and structure, a radiomonitoring system may comprise several hierarchical levels that are clearly reflected in the database structure. Large systems usually include a master control level below which subsystems are arranged (grouped according to frequency range, for example).

Operators log on to the system with their name and password. From this information, the R&S®RAMON user management recognizes the role of an operator (e.g. supervisor or evaluator) and, based on this role, lets the operator access the appropriate functions and documents in the database.

The figure below shows a typical order. All documents are compiled from templates (included in the R&S®ReportEdit software module). The interlinking of and interactions between the individual workstations are specifically configured for each system. Like other settings, these configurations can be modified at any time.



Typical intercept order with attached screenshot.

Integration into existing systems

Expandable, future-oriented solutions thanks to open interfaces

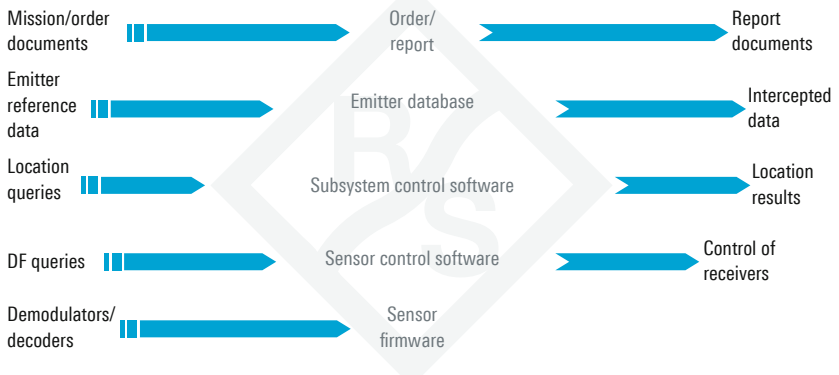
R&S®RAMON systems offer a wide range of open interfaces. They facilitate integration into existing customer systems and make the systems a safe investment.

Each R&S®RAMON radiomonitoring and radiolocation system can be integrated into the customer's order and reporting system. The supervisor of the radiomonitoring and radiolocation system is assigned missions and orders and returns the results obtained as reports to the user. The report files are transmitted in XML format. In this way, an R&S®RAMON radiomonitoring system could form part of a superordinate reconnaissance system.

R&S®RAMON systems can also be expanded by including customer software. The R&S®RAMON software communicates with customer software modules via data interfaces, e.g. TCP/IP or UDP interfaces, both to transmit commands and query results. The R&S®RAMON system in this case acts like a subsystem integrated into the customer's radiomonitoring system.

A typical example of an R&S®RAMON system integrated into a customer platform is a radiolocation system with multiple direction finding (DF) stations. The software controls the radio direction finders installed at each DF station and transmits the DF results to a central computer that runs the radiolocation software. At the IP interface, this software receives radiolocation queries from the parent radiomonitoring system of the customer. Radiolocation results are continuously returned to the customer's software application that is issuing the queries.

Interfaces to/from R&S®RAMON system



Turnkey, customized system solutions

System integration into almost any type of mobile platform

R&S®RAMON systems have for decades been successfully used in a variety of platforms. In the case of mobile systems, platforms include armored and non-armored land vehicles, shelters, aircraft, ships and submarines. Customers benefit from the many years of expertise and know-how Rohde&Schwarz has in system integration, as well as from the modular design and networking capability of the hardware and software components.

Example: integration into land vehicles

When integrating R&S®RAMON systems into land vehicles, a variety of requirements has to be met, since the vehicles were in most cases not specifically designed for use as a system platform. Challenges to be met include:

- Limited space conditions for the system and the operators
- Limited load capacity of the vehicle
- Heat dissipation and temperature control
- Stable power supply
- Integration of a semi- or fully automatic mast system
- Compliance with electromagnetic compatibility (EMC) requirements to prevent the high sensitivity of the radiomonitoring system from being degraded by interference caused by vehicle components (e.g. vehicle's air conditioning system, generator, DC/AC inverter, DC/DC converter, PCs and monitors, cables)
- Wireless data communications between multiple vehicles on a joint mission (forming a radiolocation system, for example) must not impair radiomonitoring and radiolocation performance
- Observance of national regulations (e.g. UN-ECE type approval) required in many European countries
- Correction of DF error of integrated direction finder based on DF accuracy measurements

R&S®RAMON radiomonitoring and radiolocation system integrated in a UNIMOG with DF antenna on 6 m mast. Communications via INMARSAT.

R&S®RAMON radiomonitoring and radiolocation system integrated in a shelter for transport on a truck with fully automatic mast system.

Example: integration into aircraft
R&S®RAMON systems have already been successfully integrated into aircraft.

Airborne platforms offer a major benefit: a high detection range not attainable with other types of systems. Airborne intelligence systems are able to detect radio traffic in areas not accessible to land- or sea-based systems.

Airborne systems always have a highly customized and sophisticated design as they need to be tailored for use in different types of aircraft. Integrating the full range of hardware components (antennas, receivers/direction finders and PCs) presents a major challenge. Plus, the high detection range places exacting demands on the system software, which must be able to cope with a large volume of radio signals that are intercepted simultaneously. The R&S®RAMON software is ideal for handling this task.

Since R&S®RAMON offers the capability to perform radiomonitoring tasks automatically (see "Automation of radiomonitoring sequences", page 9), the operators on board an aircraft can focus on the signals of interest. The remaining signals are detected by the R&S®Presentation Suite software (see "Evaluation support and radio network detection", page 10), and all radio traffic activities are stored to the R&S®RAMON database. The stored data is available for subsequent analysis in the intelligence system's ground segment.

Airborne systems also differ from land-based systems in that they use different radiolocation methods. Land-based systems employ two or more DF stations to calculate emitter locations by way of triangulation from the bearings delivered by the individual DF stations. Airborne systems, however, use a running fix to locate emitters. The R&S®RAMON radiolocation module includes special algorithms that automatically calculate the emitter location from multiple single bearings of a radio signal and display it on a map directly in the aircraft. This function is essential in network detection.

R&S®RAMON system integrated into a DA42 aircraft. The R&S®HE500 monitoring antenna (front) and R&S®ADD107 direction finding antenna (center) are mounted on the aircraft fuselage.

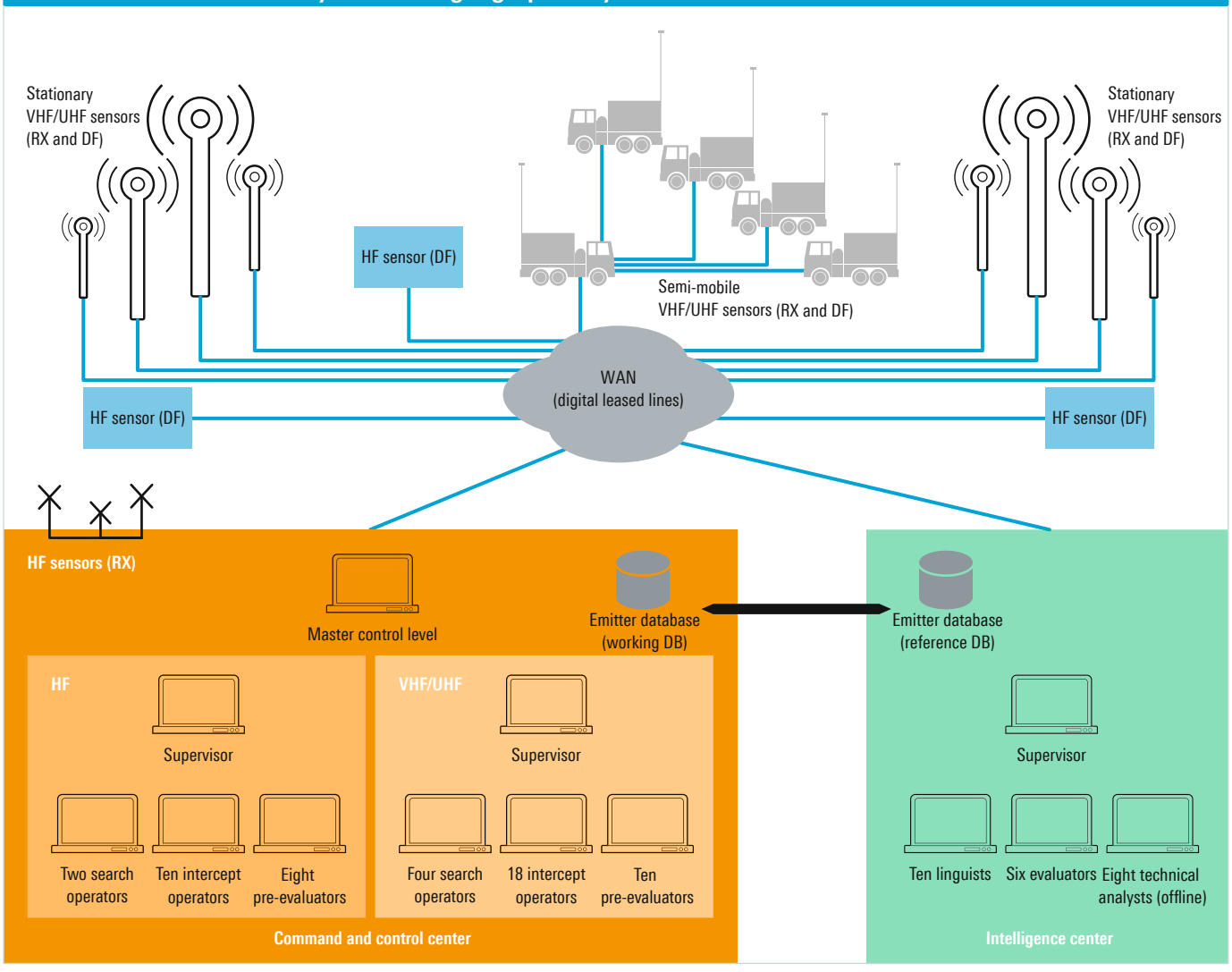
Planning, installation and putting into operation of stationary systems

The block diagram on this page shows a nationwide radiomonitoring and radiolocation system for border control operating in the HF/VHF/UHF range. Rohde&Schwarz has already implemented a number of systems of this type.

The task to be handled by the system is a typical application: monitoring a geographic area without deploying highly qualified staff on site.

Due to the shortwave propagation conditions, the HF sensor equipment (receivers, direction finders, analysis equipment) can be installed close to the central monitoring station. The VHF/UHF sensors, however, need to be installed close to the area of interest. This may be a coherent area or comprise multiple subareas, the focus on which may change dynamically in line with current developments.

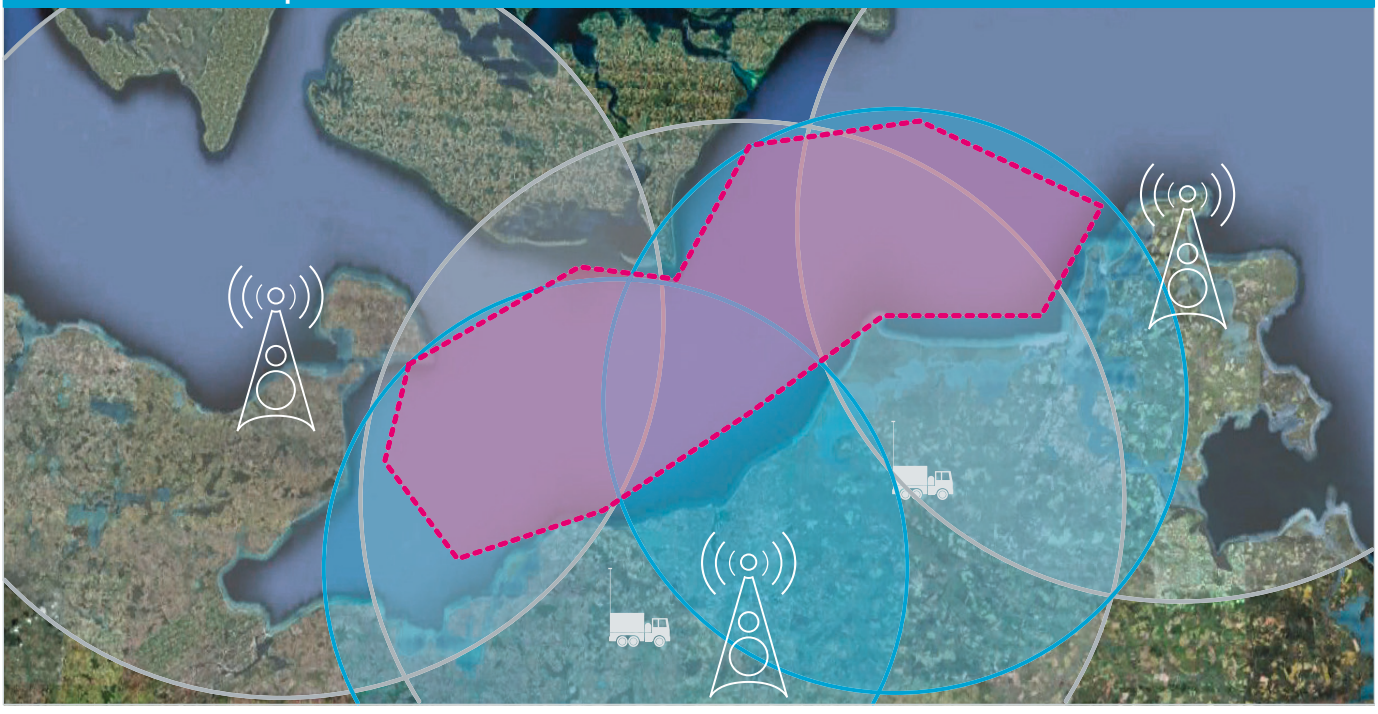
Nationwide R&S®RAMON system with geographically distributed sensor sites



Semi-mobile or mobile sensors can additionally be deployed to provide enhanced flexibility during intensified COMINT operations and to enable signal detection also in shadowed areas. For this purpose, shelters are used that accommodate the radiomonitoring and radiolocation equipment and carry the antenna masts. The sensor equipment is connected to the central WAN via a directional radio link (which may include one or more semi-mobile relay stations). The WAN is usually wire-based (using digital leased lines, for example) and offers a data rate that allows full remote control of all sensor functions. For the return of results gathered, data is compacted by means of the R&S®RAMON software algorithms.

Gray circles: intercept range of the stationary stations; blue circles: intercept range of the semi-mobile stations. The primary area of interest for the current intercept operations – the red area – is within range of at least three sensor stations.

Intensified COMINT operations with semi-mobile sensor stations



Ordering information

The R&S®RAMON radiomonitoring software comprises a wide range of different modules.

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PD 5214.3152.12 | Version 04.00 | March 2015 (sk)
R&S®RAMON Radiomonitoring Software

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5214.3152.12 04.00 PDP 1 en