

MIL NEWS

Electronics for Security and Defence



Remote-controlled semi-mobile radiomonitoring and radiolocation systems



Digital VXI-based VHF/UHF receiver for COMINT/ESM systems



Powerful encryption for military communication

7

2003



ROHDE & SCHWARZ

A new modular system combines the features of the R&S®RAMON radiomonitoring and radiolocation software with mainly standardized station types to provide a flexible system concept for remote-controlled semi-mobile radiomonitoring and radiolocation systems (page 4).



43740/4

TITLE STORY



Radiomonitoring System R&S®RAMON
Remote-controlled semi-mobile radiomonitoring and radiolocation systems 4

COMMUNICATION

VHF/UHF Airborne Transceivers R&S®M3AR
Secure and jam-resistant radio links for UAVs 10

News about the HF Transceiver Family R&S®XK2000 13

Data protection protocol RS.ARP
New data protocol gives wings to PostMan II 14

Deployable tactical command center 16

Military ATC system for Slovak air force 18

Military data links (part 2)
Standards ensure efficient military communication 20

ELECTRONIC WARFARE

Automatic Modular Monitoring System R&S AMMOS®
 Seeing clearly through the thicket of signals 24



VHF/UHF Receiver R&S®EM 050
 Digital VXI-based receiver for 20 MHz to 3.6 GHz 29

IT SECURITY



Multimode Multirole Crypto System R&S®MMC 3000
 Powerful encryption for military communication 32

REPORT

2003 trade fair of AFCEA Bonn e.V. 35

R&S AMMOS® is a universal family of systems from Rohde & Schwarz for monitoring analog and digital signals in the HF, VHF and UHF frequency ranges. The base system presented on page 24 is designed for narrowband signal processing in the HF range from 10 kHz to 30 MHz.



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Rohde & Schwarz offers a wide range of products specially tailored to the needs of radiomonitoring. The R&S®RAMON software family provides all the control components for setting up systems of various sizes. This article presents a scalable system that comprises standardized units and system software based on R&S®RAMON.

Radiomonitoring System R&S®RAMON

Remote-controlled semi-mobile radiomonitoring and radiolocation systems

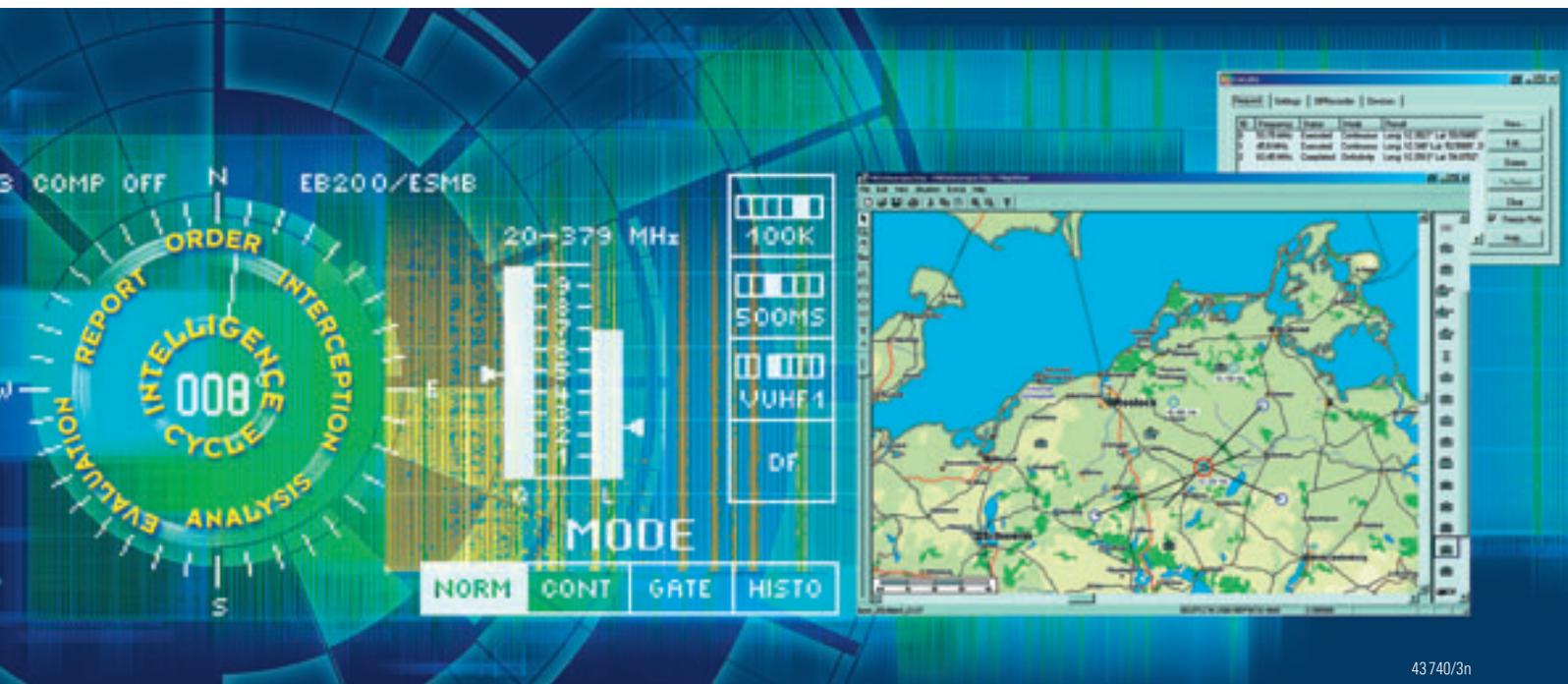
Remote control of radiomonitoring systems

A typical radiomonitoring task is to monitor remote target areas without setting up an infrastructure or deploying highly qualified personnel on site (FIG 1). In this case, unattended radiomonitoring and direction finding stations are set up for each of the target areas and controlled from a central monitoring and evaluation station. The latter can cover a number of these target areas, either in time-sharing mode or, provided there are sufficient resources, in parallel.

In the new modular system, the features of the R&S®RAMON [*] software family are united into a flexible system using mainly standardized units. In the design phase of the R&S®RAMON-based system software, special emphasis was placed on the remote control capability of all functions. The remote-controlled semi-mobile radiomonitoring and radiolocation systems have already been tried and tested by customers in practice and are available at short notice.

The advantages of this new concept are:

- ◆ Evaluation and analysis personnel can work centrally and under optimum conditions. Operation of the individual stations on site (setup, power supply, security) requires no trained personnel.



43740/3n

- ◆ The individual units can be grouped into subsystems as needed, to allow monitoring in a target area of particular interest.
- ◆ The entire system can be regrouped quickly if the priorities of the task at hand change.

For remote control of the unattended stations, different possibilities for data communication have already been implemented.

Standardized units

The following standardized units are currently available as system components:

- ◆ **Semi-mobile radiomonitoring and direction finding station (SMSR)**
- ◆ **Semi-mobile communication hub (SMCH)**
- ◆ **Semi-mobile central station (SMCS)**
- ◆ **Stationary central station (FCS)**

The **semi-mobile radiomonitoring and direction finding station (SMSR)** is remote-controlled and usually unattended (FIG 2). The entire station together with all the necessary accessories is housed in a shelter on a vehicle. A generator set mounted on a single-axle trailer provides the power supply.

Each SMSR is equipped with two receivers (R&S®ESMB, R&S®EB 200 or R&S®ESMC) for the frequency range 20 MHz to 1300 MHz (3000 MHz) and a digital radio direction finder (consisting of a DF Unit R&S®EBD 195, the DF antenna and a receiver of the same type) for this frequency range (FIG 3). Up to four semi-mobile radiomonitoring and direction finding stations (SMSR) form a regional subsystem for monitoring in one target area.

FIG 1
Central monitoring of remote target areas with remote-controlled semi-mobile radiomonitoring and radiolocation systems.

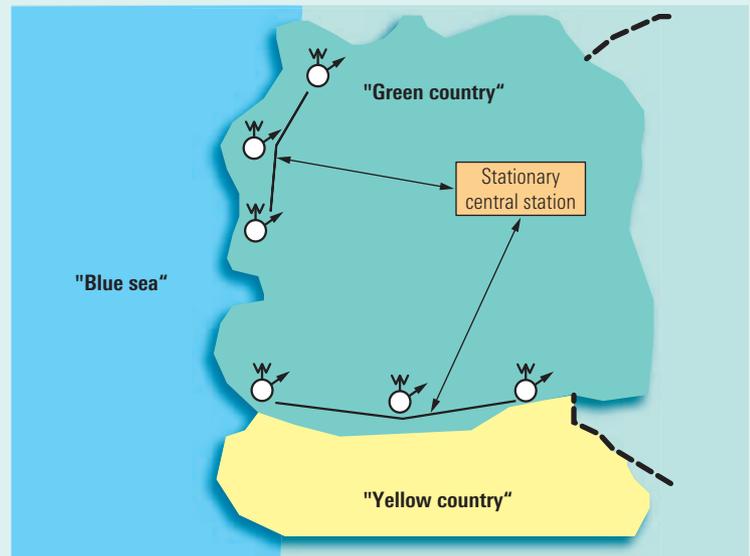


FIG 2
Semi-mobile radiomonitoring and direction finding station (SMSR), set up in the field.

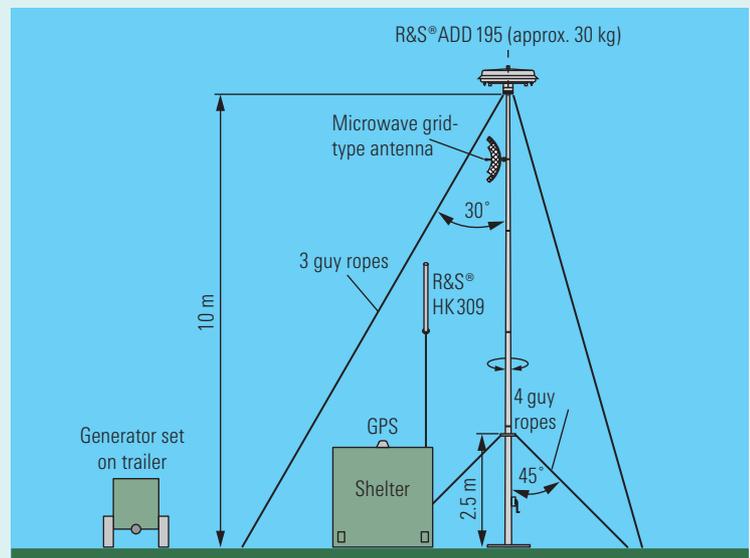
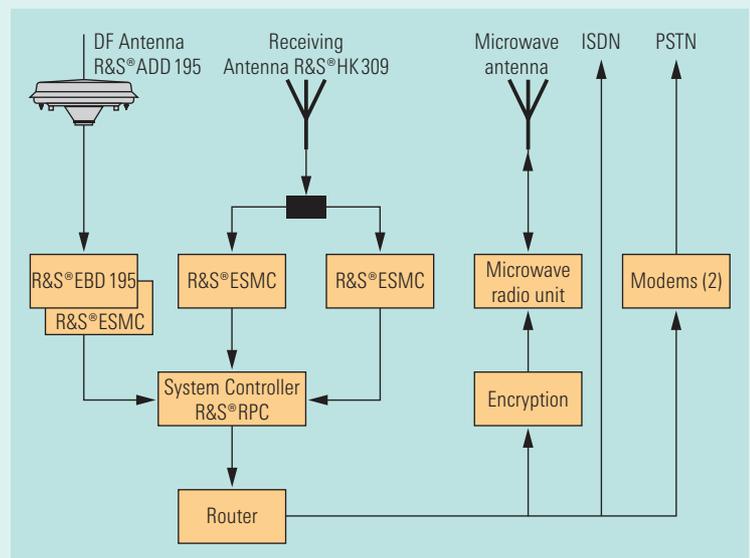


FIG 3
Structure of a semi-mobile radiomonitoring and direction finding station (SMSR) (version with Compact Receiver R&S®ESMC).



► The **semi-mobile communication hub (SMCH)** enables the quick setup of microwave links to as many as four semi-mobile radiomonitoring and direction finding stations (SMSR). Like the SMSR, the SMCH is integrated in a shelter and mounted on a vehicle with a single-axle trailer complete with all its accessories (FIG 4).

The microwave links operate in the 2.5 GHz band using DSSS (direct sequence spread spectrum) technology and are encrypted.

The **stationary central station (FCS)** controls one or more subsystems and can be set up for temporary or continuous operation. It comprises a communication section for making the remote-control connections, a server and a number of workstations for the operators. The individual components are interconnected via a local area network (LAN), allowing the central station to be set up and put into operation

quickly. Each operator workstation can be assigned radiomonitoring tasks as well as any desired resources of the connected SMSRs (receivers, direction finders, recording equipment).

The FCS is delivered as a complete unit and can be set up in a suitable room by the customer or by Rohde & Schwarz.

The **semi-mobile central station (SMCS)** unites the possibilities of the three station types already mentioned:

- ◆ The monitoring resources of a semi-mobile radiomonitoring and directing finding station (SMSR)
- ◆ The microwave link system of a communication hub (SMCH)
- ◆ Two operator workstations to control a small autonomous system with up to three SMSRs; additional operator workstations can be connected externally

The station is housed in a shelter and transported on a vehicle with single-axle trailer.

Operational concept

The semi-mobile radiomonitoring and direction finding stations (SMSRs) in the described system are supposed to be operated in unattended mode. The resources (direction finders, receivers, recording equipment) of all remote-controlled units are fully operable from the central station (stationary central station FCS or semi-mobile central station SMCS). The audio signals of the receivers are also available there.

Each operator workstation in the central station is assigned one or more search or monitoring tasks and the required resources from the pool of available resources. The assignments can be changed at any time by an authorized operator (supervisor) and adapted to the situation.

The resources of the radiolocation subsystem are available to all operator workstations. The radiolocation system can be used either exclusively by one workstation or quasi-simultaneously by several workstations (time-sharing mode).

The system software of the solution described here is based on R&S®RAMON and can be adapted to the user's tasks and requirements at any time. R&S®RAMON is equipped with modules for all the core tasks of a radiomonitoring system, including:

- ◆ **Drivers and user interfaces for all Rohde & Schwarz products** used in radiomonitoring systems.
- ◆ **Tools for collecting the DF results for radiolocation.** The results are graphically displayed on an electronic map and can be inserted in reports. The DF system can be individually configured for each operator from the available semi-mobile radiomonitoring and direction finding stations (SMSR).
- ◆ **Software for manual or automatic recording of the audio signals** of all



FIG 4
The semi-mobile communication hub (SMCH) in shelter, ready for transport.

system receivers. The recordings can be centrally administered and evaluated.

- ◆ **Modules for defining complex search, scan and monitoring tasks (JobEdit).** These can be prepared, optimized and saved in advance. They are subsequently available at the

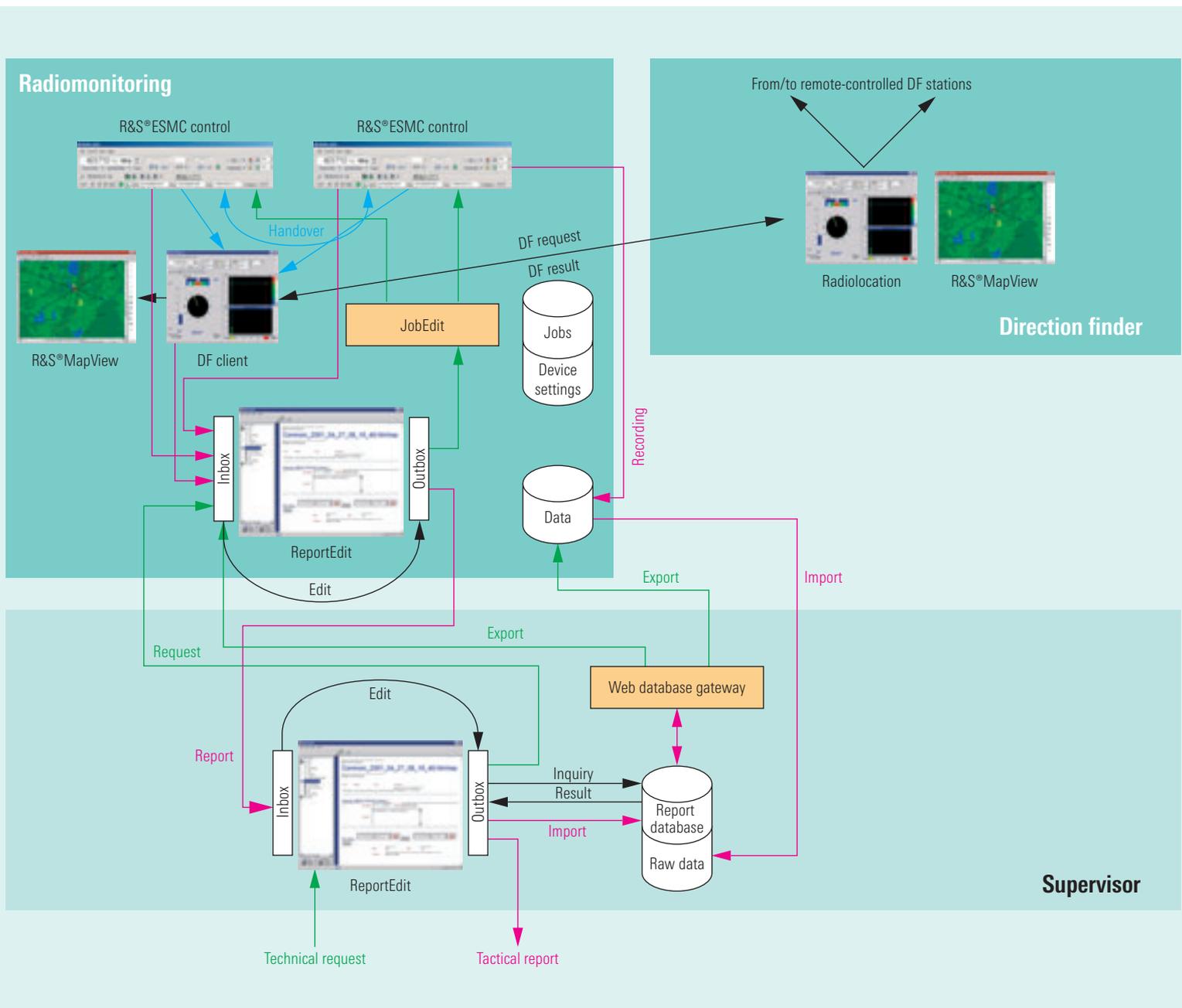
press of a button to take over complete device control.

- ◆ **Modules for compiling, compressing and administering reports (messages).** The reports contain technical information (device settings and readings), which is saved via mouse click, and information written by the opera-

tor (e.g. comments). Multimedia components (audio recordings, map displays, etc) can also be saved.

- ◆ **A database for saving reports.** Research tools make the database a pool of knowledge for monitoring staff and evaluators.
- ◆ **Tools for system configuration.** The supervisor can assign the interception ▶

FIG 5 The R&S®RAMON system model.



► processing channels of the spatially spread system to the central station's individual workstations virtually in any way desired. In addition to the user interface, the corresponding audio channels for audiomonitoring in realtime and recording are available.

FIG 5 shows how typical operating steps in a radiomonitoring system are mapped with the R&S®RAMON software family. For further information on R&S®RAMON, a Technical Information is available.

Summary

The component solution for semi-mobile radiomonitoring and radiolocation systems presented here has decisive advantages over specially developed equipment:

Applications and implemented systems

Control of remote regional subsystems from a central monitoring and evaluation station

Up to four radiomonitoring and direction finding stations (SMSRs) are deployed as a regional subsystem for radiomonitoring in a target area (FIG 6).

Depending on the existing possibilities, these stations are connected to the stationary central station (FCS) via dedicated lines, switched analog or ISDN lines, or using microwave link via the SMCH communication hub.

If analog or digital channels of the fixed network are used, dynamic load distribution and channel banding techniques are used.

If available, transmission channels with higher bandwidth can also be used between the central station and the regional subsystem, e.g. ISDN PRI with 2 Mbit/s (PRI: primary rate interface). Alternatively, the semi-mobile radiomonitoring and direction finding stations (SMSR) can also be connected directly to the central station via analog or digital fixed-network

lines. A stationary central station (FCS) can control one or more regional subsystems (FIG 7).

Creation of small autonomous regional systems

If it is desirable to deploy the monitoring and evaluation personnel directly on site, i.e. within a regional subsystem's coverage area, it may be wise to combine the semi-mobile central station (SMCS) with up to three semi-mobile radiomonitoring and direction finding stations (SMSR). These then form together a more or less autonomous radiomonitoring and radiolocation system (FIG 8).

Operation of the SMSRs is unattended. Up to two operators can work in the shelter of the semi-mobile central station (SMCS). If necessary, a LAN / fiber-optic (FO) link is used for additional operator workstations which can be accommodated in a suitable place in the vicinity of the SMCS (tent, building, container, etc).

The semi-mobile central station (SMCS) is equipped with all the necessary technical requirements for setting up the microwave links to the SMSRs. This cre-

ates a small system with relatively high mobility for fulfilling tasks that are limited with respect to time and space.

Integration of portable mobile stations

In addition to the shelter-based SMSRs, the Tactical Interception and Direction Finding Systems R&S®TMSR [*] can be integrated in a radiomonitoring and radiolocation system. An R&S®TMSR can be easily installed in an off-road vehicle or also indoors (FIG 9).

- ◆ The individual station types are completely documented, tried and tested in practice and equipped with all required hardware and software components. The delivery period is therefore considerably shorter.
- ◆ The components (station types) are harmonized to each other, allowing

users to configure custom-made solutions in a short time.

- ◆ The flexible data communication is prepared for a wide range of different infrastructure conditions.

Holger Megow

More information and data sheet at www.rohde-schwarz.com

REFERENCES

[*] Technical Information available on request.

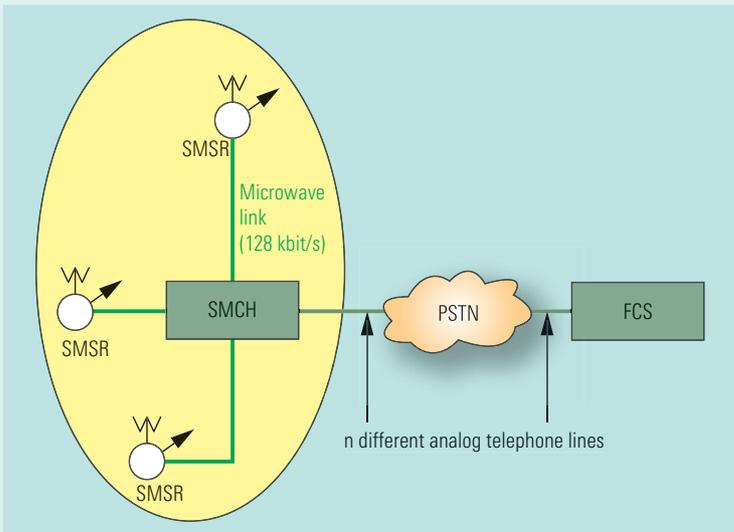


FIG 6 Control of remote regional subsystems via a central station (FCS).

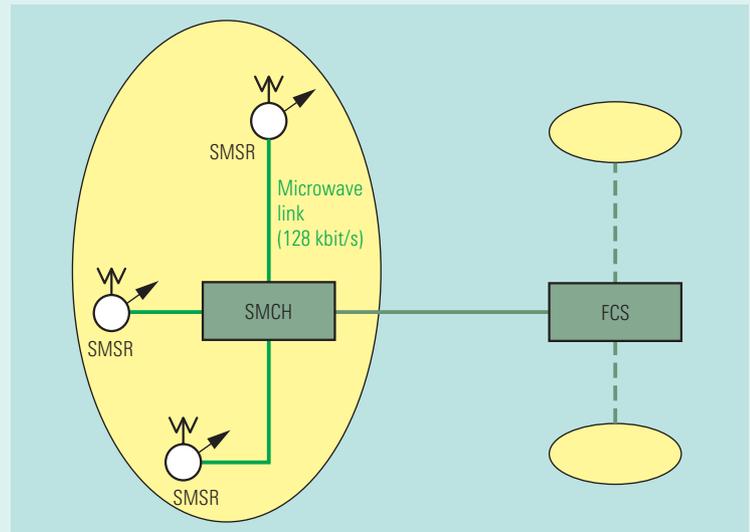


FIG 7 Stationary central station (FCS) for controlling a number of regional subsystems.

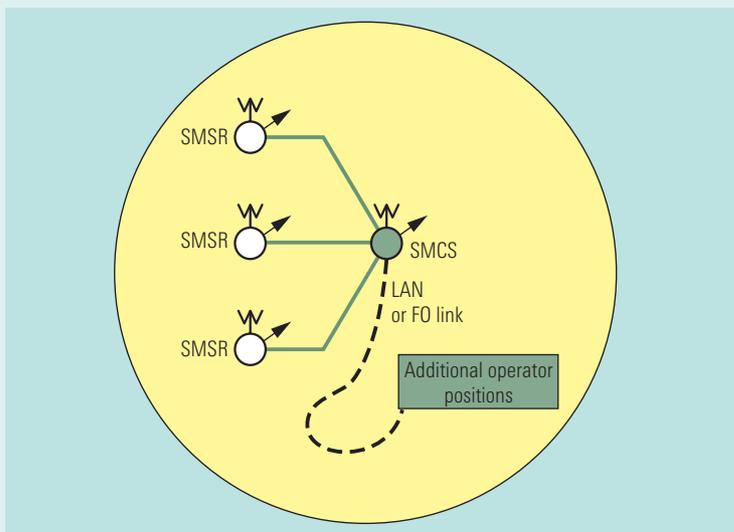


FIG 8 Small semi-mobile system.



FIG 9 Tactical Interception and Direction Finding System R&S®TMSR.

Due to the availability of powerful onboard computers and reliable radio links, unmanned aerial vehicles (UAVs) are gaining in importance with armed forces. Rohde & Schwarz is contributing to this very promising development with its R&S®M3AR airborne transceivers in various pilot projects.

VHF/UHF Airborne Transceivers R&S®M3AR

Secure and jam-resistant radio links for UAVs

UAVs: unmanned, versatile and efficient

The scope of currently deployed UAVs ranges from mini-UAVs with a wing span of just a few centimeters all the way up to unmanned fighter aircraft and research UAVs with a span width of 80 meters. The military missions they are used in are diverse. UAVs are very effectively deployed primarily in intelligence, reconnaissance, surveillance, fire control, combat missions, information transmission, electronic warfare or support with target acquisition. FIG 1 on the next page shows the German Army's future TAIFUN combat UAV (CUAV) from STN ATLAS Elektronik.

Aircraft size and missions vary just as much as duration and altitude of the flight or payload of the individual types. Common to them all, however, is the need for secure, jam-resistant radio links for communication.

Telemetry data in realtime

Depending on their mission, UAVs are equipped with a wide variety of different sensors, e.g. radar, target acquisition lasers, video or electronic thermal imaging cameras. The data obtained should already be directly available to the operational forces during the flight, preferably in realtime and via jam-resistant data links.



43722/3



Photo: STIN ATLAS Elektronik

FIG 1 TAIFUN – the German Army’s future CUAV.

In addition to the standardized NATO methods HAVE QUICK or SATURN, the R&S®M3AR transceivers also offer the proprietary frequency hopping method SECOS, which ensures a high data transmission rate even with numerous frequency changes per second. Compressed images and image sequences can thus be transmitted with a delay of only a few seconds – a level of performance far superior to data transmission via shortwave.

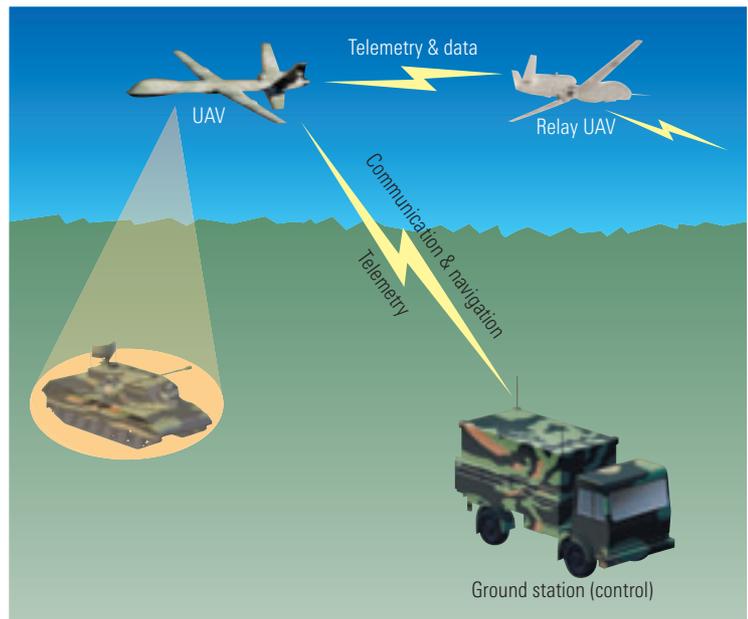
Although satellite links offer broader radio coverage and possibly even higher data transmission rates compared to the VHF/UHF range, they are relatively unprotected from jammers and therefore not always able to ensure interruption-free radio links. Moreover, satellite links are not always available everywhere at all times.

Satellite or radio links act as transmission media in the HF range or, with line of sight, the VHF/UHF range (FIG 2). Depending on the number of sensors and the data volume to be transmitted, it may be necessary to use several parallel radio lines.

Up to now, the software-defined airborne transceivers of the R&S®M3AR family were mainly deployed in manned platforms; however, owing to their flexible architecture, they are also ideal for use in UAVs. Particularly outstanding are the R&S®M3AR units of the R&S®MR6000R series. Compared to international competitor products and shortwave transceivers, the extremely compact design and low weight of these units ideally comply with the tight restrictions imposed on UAV payload and stowage recess (FIG 3).

Efficient encryption plus frequency hopping are necessary to ensure reliable and jam-resistant data transmission.

FIG 2
Block diagram of data exchange with UAVs.



► **Extremely reliable and secure radiocommunication**

In unmanned aircraft, sensors, onboard computers, control surface actuators and throttle control systems replace the human pilot. Depending on the programmed flight itinerary, an autopilot controls aircraft attitude and aircraft performance. For example, if a mission is changed during flight, the ground station can intervene in the defined mission plan. The necessary control information is transmitted via radio to the onboard computer which then initiates the appropriate flight manoeuvre. This change in mission must be extremely reliable and safe from unauthorized commands, which is ensured if frequency hopping and encryption are used, as offered by SECOS in the R&S®M3AR.

Use as a relay station

In military communication, UAVs are also used as substitutes for satellites or to increase coverage in the VHF / UHF range. Such communication relay stations are equipped with two radios: one to receive the signal, the other to retransmit it amplified at another frequency. Radio messages can thus be forwarded beyond the horizon. Such a relay



FIG 3 The software-defined VHF/UHF Transceiver R&S®MR6000R from the R&S®M3AR family.

station can also be implemented with just one R&S®M3AR transceiver by first recording the data and then sending it (Store & Forward).

Communication with civil aviation

Since UAVs can, under certain conditions, enter the air space assigned to civil aviation, communication with civil air traffic control must be guaranteed so that the UAV operator can log on to the responsible air traffic controller via radio. For this purpose, military ground personnel sets up voice contact with air traffic control via a satellite or shortwave receiving system in the UAV and a connected R&S®M3AR airborne transceiver.

as fast frequency hopping methods and efficient encryption ensure that they can reliably accomplish their tasks. It comes as no surprise that armed forces are increasingly using this high-tech communications equipment in UAVs.

Thomas Kneidel

More information and data sheets at www.rohde-schwarz.com
(search term: M3AR)



R&S®M3AR overview



Data sheet
R&S®MR6000R

Summary

The Rohde & Schwarz R&S®MR6000R transceivers from the R&S®M3AR product family are exceptionally suitable for use in UAVs. Their flexible, software-defined architecture, low weight as well

News about the HF Transceiver Family R&S®XK2000

Another JITC certificate for the HF Transceiver Family R&S®XK2000

MIL NEWS 5 (2001) contained a report about the JITC certification of the Transceiver R&S®XK2100 for ALE MIL-STD-188-141B. In the meantime, the 1000 W Transceiver R&S®XK2900 has also been certified by the JITC, having undergone numerous tests to verify its interoperability according to MIL-STD-188-141B, App. A and B. In addition, its conformity to Link 11 in accordance with STANAG 5511 and the general HF parameters (STANAG 4205) has been verified.

The Link 11 mode in particular places high demands on the HF transceiver: phase jitter, signal propagation times and the quality of AGC/ALC must especially be taken into account as critical parameters for this operating mode. By far not all the products on the market meet these high stability and signal-quality requirements.

HF transceivers from different manufacturers that operate in radio networks with standardized protocols and waveforms must adhere to the specifications (HF parameters, timing, etc) with tight tolerances. Because MIL standards also define optional functions (referred to as user unique functions, or UUFs), which can differ from manufacturer to manufacturer, national security organizations test radio equipment for compliance with the standards. Official certification can be granted only by the JITC (Joint Interoperability Test Command), a US government agency under the Depart-

ment of Defense which conducts independent tests of communications equipment. One of the agency's main areas is testing the interoperability between military radio equipment from different manufacturers. The tests verify whether the equipment meets the basic specifications of the internationally recognized military standards. Certification gives users the assurance that their newly purchased radio equipment is compatible with already existing equipment and that no communication problems will arise during joint missions with friendly forces.

New option: digital voice transmission with encryption

The R&S®GN2120 is a plug-in module that unites voice digitization (vocoder), modem and encryption functions. It can be used in all transceivers and receivers of the R&S®XK2000 family.

Even the basic models of the R&S®XK2000 transceiver family feature digital signal processing at the IF. Up to now, however, voice signals have been transmitted via the air interface in analog mode. The SSB method used here offers generally satisfactory voice communication but utilizes only some of the possibilities of the R&S®XK2000, which is designed for data transmission.

With the new R&S®GN2120 option, the quality of voice communication can be further increased, and above all makes digital encryption possible. For this purpose, the option contains a high-quality vocoder based on the voice-lock-pre-

dict (VLP) algorithm with a data rate of 2400 bit/s and an integrated error correction facility. The VLP coder offers an excellent compromise between voice quality and required data rate, and is considerably superior to conventional algorithms, which operate according to the LPC (linear prediction coder) principle, for example.

In addition, the vocoder is well-armed against background noise, which is advantageous primarily when the option is used in vehicles, for it can distinguish between the useful and noise component in the signal and remove the noise components.

The module also contains the modem required for transmission – a multi-tone modem that operates in SSB mode and provides the necessary bit rate of 2400 bit/s at a bandwidth of 2.7 kHz. The R&S®GN2120 has an integrated crypto module with a 256-bit key.

The new option supports the "plain override" function, which makes it possible to receive analog (SSB) transmissions on the set channel, although the transceiver is operating in the digital mode. If operators decide to accept the open call, they switch to SSB mode only for the duration of the call.

Ulrich Otto

Data protection protocols play a key role in radiocommunications, for they alone ensure error-free data transmission. The new Adaptive Radio Protocol RS.ARP from Rohde & Schwarz can be used in both point-to-point and point-to-multipoint systems, with maximum data throughput.

Data protection protocol RS.ARP

New data protocol gives wings to PostMan II

Radiocommunications: fast or secure?

Ensuring error-free data transmission at the highest possible transmission speed is the job of data protection protocols. They must perform this task single-handedly – for although the bit error rate during transmission can be significantly decreased by self-correcting error codes (FEC – forward error correction) and appropriate channel coding, this does not ensure an error- and loss-free transmission of a file, for example. The desired security is achieved only when the receiver acknowledges to the transmitter the error-free reception of each transmitted data packet, as is the case with ARQ (automatic repeat request). With this method, data packets without a positive acknowledgement are automatically resent.

Multiple ARQ requests automatically result in a lower data transmission rate, which is usually caused by channel conditions (signal-to-noise ratio) becoming worse and the corresponding increase in the bit error rate. An adaptive data protection protocol can counteract such a situation by the following measures:

- ◆ **Increasing redundancy** to improve the self-correction of bit errors
- ◆ **Decreasing the data packets** to increase the probability of error-free transmission
- ◆ **Changing the modulation** (for example, from 8PSK to 4PSK) to increase the S/N ratio
- ◆ **Switching to a better channel with as little noise as possible**

How and when the above measures are implemented depends heavily on the requirements.

With RS.ARP: fast and secure!

A number of technical hurdles had to be overcome in the development of the new radio network data protection protocol RS.ARP. In the integration of radio networks in wireline communication networks, usually TCP/IP data streams have to be transmitted over half-duplex links without a long delay, if possible. Managing such a task requires the capacity to change directions quickly and tolerates no large protocol overheads.

Another challenge in designing this new protocol was taking into account the network topology. Radiocommunication networks often have a star-shaped structure with a central node and a number of remote stations. In point-to-multipoint systems of this type, the information gained in the remote stations is reported to the central station, where it is collected, evaluated and made available to the entire network if necessary. RS.ARP achieves this by using a dynamic TDMA (time division multiple access) method, in which the remote stations can cyclically exchange information in both directions with the central station in defined time windows (FIG 1). If the specified time window is not large enough for the transmission of an e-mail, for example, the transmission is interrupted after the maximum permissible period of time has elapsed and is continued in the next cycle. If the data volume between a remote station and the central station

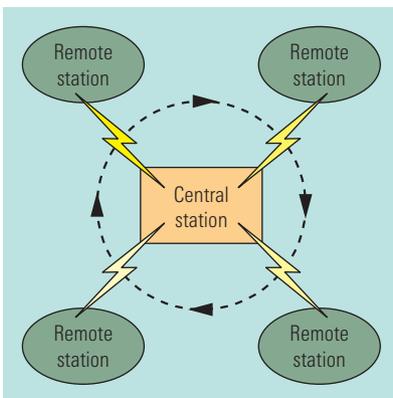


FIG 1 Dynamic TDMA method of new data protection protocol RS.ARP.

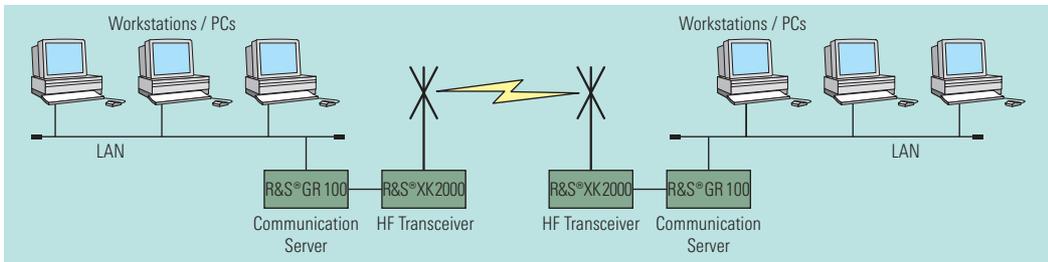


FIG 2
The data protection protocol runs on the Communication Server R&S®GR 100.

is low, the system switches to the next remote station before the time window expires.

The use of RS.ARP is not restricted to a specific frequency range. Besides being used with the HF Transceiver Family R&S®XK 2000, excellent results have also been achieved in the VHF/UHF frequency range with the Software Radios R&S®M3SR – together with an external modem.

RS.ARP is implemented as software that can be ordered as an optional extension to PostManII. Like all PostManII software, it runs on an external controller, the Communication Server R&S®GR 100, which is connected to all workstation PCs in the network and controls all radio components such as modem or transceiver (FIG 2). In the basic configuration, the data packets to be transmitted are placed directly at the radio modem input via the asynchronous serial interface of the R&S®GR 100. However, this data can

also be forwarded in synchronous mode if the Radio Router R&S®GR 300 is used. In this operating mode, no start and stop bits are needed for control, which increases the net data rate by 25% vis-à-vis asynchronous mode (FIG 3).

As a result of the computer-based concept, many of the transceivers used by the customer – including those of other manufacturers – can be integrated into R&S®PostMan II communication networks.

If necessary, RS.ARP can also be used in broadcast mode, i.e. unacknowledged transmitting mode. To increase the error tolerance, the individual data blocks are transmitted more than once.

Of course, individually tailored encryption methods can be used to protect the information to be transmitted against unauthorized access. A large number of encryption options are available, ranging from pure software solu-

tions and combined software and hardware engineering at the computer end to the integration of customized encryption units into the information flow. The Rohde & Schwarz subsidiary SIT has developed various system solutions for this purpose.

Summary

With the aid of RS.ARP, the PostMan II features such as fax service or voice mail can now be used with virtually any conceivable system requirements and scenarios – while maintaining maximum data throughput. RS.ARP is thus a reliable “doping agent” for the use of PostMan II in international radiocommunications competition.

Thomas Kneidel

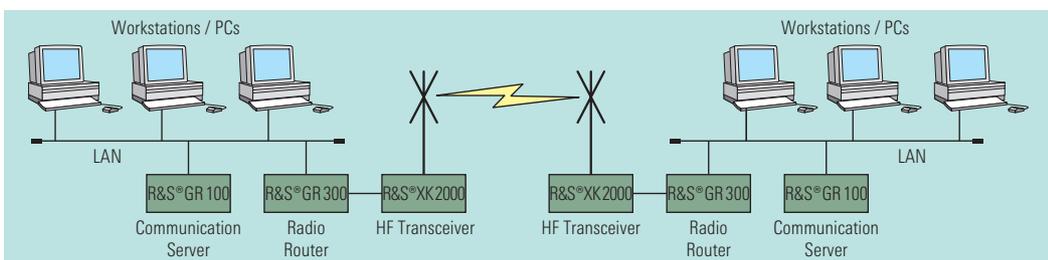


FIG 3
The Radio Router R&S®GR 300 allows faster transmission in synchronous mode.

The Australian defence and aerospace company ATI owns and operates a deployable tactical command center (DTCC) housed in a semi-trailer over 13 meters long. In the DTCC, which is used to display and edit realtime data, radio equipment from Rohde & Schwarz ensures secure voice and data communication.

Deployable tactical command center



Photo: ATI

FIG 1 The deployable command center in the semi-trailer.

Mobile and communicative

The deployable command center (FIG 1) makes it possible to receive and display satellite images and intelligence data. It uses the TADIL* Multi-Link System Test

and Training Tool approved by the Australian armed forces, which allows real-time simulation, recording and analysis of training exercises as well as hardware and software verification. In addition, it provides facilities for pre- and post-exercise meetings.



Photo: ATI

FIG 2 The operators' room of the command center (in background: R&S®XK2100 L and R&S®XD432 U8, connected to a DTS (data terminal set) with Link 11 modem and encryption units).

The DTCC is equipped with high-grade units (FIG 2), including the field-proven Rohde & Schwarz Transceivers R&S®XK2100 L (HF) and R&S®XD432 U8 (UHF), which ensure secure voice and data communication during the performance and simulation of armed-forces exercises. According to ATI, this command center will create new training possibilities for the Australian armed forces, because it makes it possible to

* TADIL: tactical digital information link.

instruct the crews before the exercises and to analyze the events in detail after the exercises.

The DTCC is specially designed for long-term operation at remote locations. It is also available to other companies, enabling them – above and beyond the aforementioned possibilities – to check their equipment during a platform upgrade or modification in a progressive project schedule, instead of performing a single test at the end of a project.

The deployable command center offers a variety of functions, including the following:

- ◆ Data transmission / reception via Link 11 (HF and UHF)
- ◆ Transmission / reception via Link 16
- ◆ TADIL hardware validation and verification
- ◆ Intelligence links
- ◆ Display of satellite images
- ◆ Recording and analysis of training exercises in realtime
- ◆ A number of workstations with 2D and 3D displays
- ◆ LOS (line of sight) operations in HF and UHF transceivers
- ◆ Commercial phone and fax functions

Comprehensive system solutions “from the microphone to the antenna” for implementing complex, interference-free radio transmission systems is one of the areas Rohde & Schwarz specializes in. The transceivers used in the DTCC are from the radio equipment families R&S®400U and R&S®XK2000 (box on right). They are part of the complete product line for HF, VHF and UHF from Rohde & Schwarz covering a wide range of different applications and requirements.

Brian Warner; Michael Fraebel

R&S® 400 U / R&S® XK 2000: versatile military communication

Radios of the **Series R&S®400/400 U** are in use in over 70 countries. They offer operational flexibility and high operating convenience:

- ◆ 100 preset channels and prepared for up to 100 networks in EPM (ECCM)* mode
- ◆ Half-duplex operation for 50 transmit and receive channels
- ◆ 8.33 kHz channel spacing (optional, only for VHF)
- ◆ Fast, robust TX/RX PIN diode antenna switch for special applications such as frequency hopping, data link or 100 W high-power UHF (FM) transmission
- ◆ Integrated guard receiver (option)

Furthermore, the Series R&S®400 U offers virtually interference-free operation even under difficult collocation conditions:

- ◆ Receivers with excellent large-signal behaviour and RFI suppression
- ◆ UHF circulator (option)
- ◆ Wide range of antenna interfaces (option)
- ◆ Preselectors for fixed-channel applications (option)
- ◆ Transmit/receive filters for fixed-channel and EPM (ECCM) applications (option)

A large number of local and remote-control possibilities are available, depending on the selected interface options (V.24 / RS-232-C / RS-485 or DTMF [dual tone multiple frequency] code).

The **Series R&S®XK2000** offers not only full functionality for standard HF radio-communication but also a wide range of customer-specific applications:

- ◆ Telephone, fax and e-mail
- ◆ Transmission of images and data at up to 9600 bit/s
- ◆ GMDSS (global maritime distress and safety system) for maritime applications
- ◆ Military data links and wireless transmission via TCP/IP

Further advantages are:

- ◆ Failsafe 24-hour operation
- ◆ EMC protection according to international standards (MIL and EN)
- ◆ Robust design
- ◆ Plug-in options
- ◆ Optimized operating concept

Communication processors compliant with international standards, fast and secure data transmission and message handling (e.g. with R&S®PostMan2000) allow the integration of the HF Transceiver Family R&S®XK2000 in modern multimedia systems, creating the basis for reliable, worldwide communication independent of existing infrastructure. In addition, it is possible to configure R&S®XK2000 component-based high-power broadband communication systems of 150 W, 500 W and 1000 W for multichannel transmissions with low frequency spacing and different modulation modes.

* EPM: electronic protective measures
ECCM: electronic counter countermeasures

In 2000, the Slovak partner of Rohde & Schwarz, the company 3S (Specialne Systemy a software, a.s.), was selected as the system supplier for the air traffic control (ATC) system of the air force of the Slovak Republic. 3S delivered a turnkey system, from the design phase to the complete installation.

Military ATC system for Slovak air force

Top quality from a single source

The first system, located in West Slovakia, was put into operation at the end of 2001; the second has been operating in Central Slovakia since December 2002. Each site is equipped with remote-controlled radios. The Rohde & Schwarz VHF/UHF Transceivers R&S®XT 452 U8, the automatically tunable Filters R&S®FD/FU 221 and VHF/UHF antennas form the core of the radio site, supported by uninterruptible power supplies, multiplexers, microwave links as well as monitoring and control systems (FIG 2). The control center includes a digital voice communication system with operator consoles.

For the customer, two factors tipped the scale in favour of this solution: the high quality and operational reliability of the Rohde & Schwarz equipment and the competence of 3S as a local system supplier for turnkey solutions.

One of the key components is the remote monitoring and control (RMC) system developed and implemented by 3S. It provides status information about the entire radiocommunication system and detailed information about each peripheral. A network of RMC stations allows the parameters of all the important system components to be displayed and set locally or by remote control. The redundancy of important system components and the use of parallel communication lines make the RMC system very reliable.

The first ATC system to leave the factory (FIG 1) has in the meantime passed all official tests. In operation for over a year and a half, it has not had a single breakdown. As a result, the operating personnel and the logistic support organization have rated the system very highly.

Additional systems in planning

Once the Slovak Republic becomes a full member of NATO, further systems of this type will be implemented in the years to come. Plans include radiocommunications



FIG 1
The first ATC system for the Slovak air force to leave the factory.

Photo: 3S

R&S®M3SR: easy to adapt to NATO standards

tion systems based on the Digital Re-programmable Software Radios R&S®M3SR (Series 4400) from Rohde & Schwarz, because these can be easily upgraded to meet NATO standards. In addition, they have numerous outstanding features (box on right).

Stefan Lozek; Michael Fraebel



FIG 3 Digital Reprogrammable Software Radio R&S®M3SR.

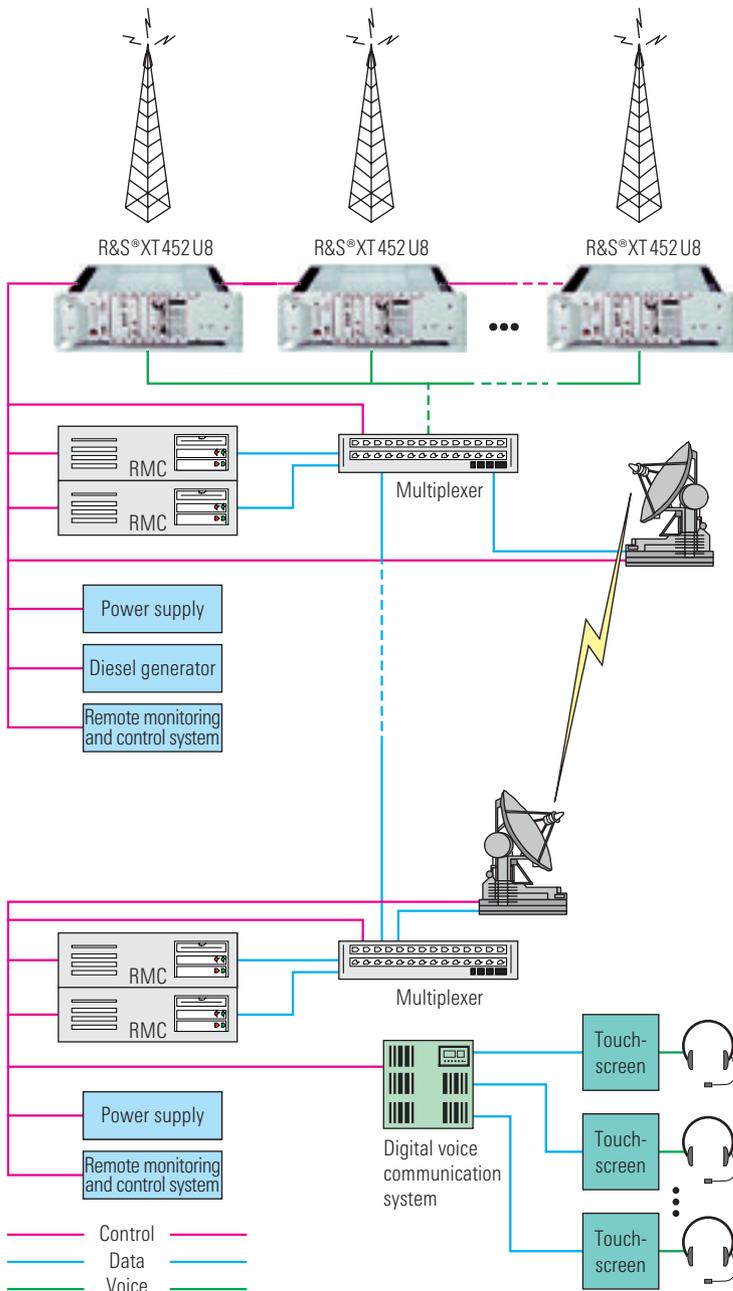


FIG 2 Diagram of the military ATC systems for the Slovak air force.

Multiband capability

The radios of the R&S®M3SR series (FIG 3) fully cover the VHF/UHF range 100 MHz to 512 MHz. Both AM and FM modulation is possible. Optional guard receivers for parallel monitoring of VHF and UHF distress frequencies can be integrated. Channel spacing of 8.33 kHz and 25 kHz complying with international standards (ICAO) is available in the VHF/AM mode.

Multimode capability

Voice transmission is in simplex or half-duplex mode. Interoperability in NATO operations (HAVE QUICKI/II according to STANAG 4246, SATURN / HQII according to STANAG 4372, Link 11 according to STANAG 5511) is of high priority and can be achieved in the radios by downloading software and installing optional hardware modules. Government-furnished external encryption units such as the KY-57 / -58 / -100 or ELCRODAT 4-2 ensure secure voice and data transmission. Alternatively, Rohde & Schwarz provides SECOS as a secure EPM / ECCM waveform with integrated COMSEC and TRANSEC.

Multirole capability

Multirole capability makes it possible to implement different equipment types on a single platform. The platform can be designed as a transmitter, receiver/multireceiver or transceiver, for example. Furthermore, as part of the pre-planned product improvement (P3I), a number of additional functions are to be implemented in the future, such as automatic link establishment or setup (ALE/ALIS) or an integrated HF data modem.

This article is the continuation from MIL NEWS 6, in which the most important wireless military data links were described. This second and final part discusses Link 22, Link 4A and Link 16*.

Military data links (part 2)

Standards ensure efficient military communication

Link 22

Link 22 is an EPM-capable data transmission method that was designed as the successor of Link 11. Originally introduced as NILE (NATO Improved Link Eleven), Link 22 is to acquire additional features such as resistance to jamming and inherent encryption. Link 22 is primarily intended for naval applications, in which it is used for transmitting position data, radar tracks and other tactical data.

Link 22 can transmit fixed data formats, or messages. A message is a coded piece of information from a catalog of information items defined in a standard. Link 22 uses messages already defined for Link 16 (STANAG 5516) as well as additional messages specified in STANAG 5522 which consist of several (up to eight) 72-bit words.

Four transmission modes

Link 22 messages can be transmitted in four different ways: using fixed frequency or EPM (frequency hopping), each in the shortwave or UHF range (FIG 1).

With fixed frequency in the shortwave range (HF), Link 22 offers different operating modes (waveforms) which differ with respect to modulation method (QPSK and 8PSK), coding and user data rate. The choice of waveform makes it possible to adapt the transmission system to different channel qualities and optimize the data throughput. The user data rate ranges from 1493 bit/s to 4053 bit/s.

The same applies to shortwave frequency hopping. Here too, the transmission system can be adapted to channel quality by using different coding; the user data rate is between 500 bit/s and 2200 bit/s.

To achieve jamming-resistant operation in the UHF band, the SATURN method (second generation of anti-jam tactical UHF radio for NATO), which is defined in STANAG 4372, is used as the carrier. With Link 22, this NATO method with a very high frequency-hopping rate becomes a data link having excellent anti-jam features.

FIG 1 The four transmission modes in Link 22 and their user data rates.

	Fixed frequency	Frequency hopping
HF 2 MHz to 30 MHz	1493 bit/s to 4053 bit/s STANAG 4539	500 bit/s to 2200 bit/s STANAG 4444
UHF 225 MHz to 400 MHz	12 667 bit/s STANAG 4205	n.a. STANAG 4372

* Many details of military data links are classified and can only be viewed in the respective documentation.

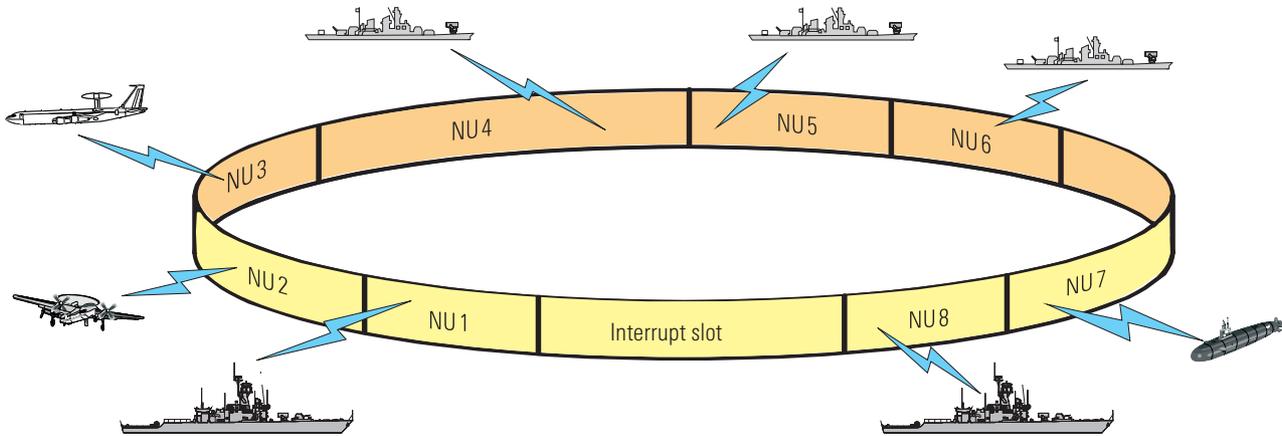


FIG 2 Multiple access with Link 22.

Multiple access

The users grouped together in a Link 22 access the radio medium via a TDMA (time division multiple access) method. Users (e.g. a ship or aircraft – referred to as NILE units, or NUs) are assigned timeslots during which they can transmit information and send messages (FIG 2). High-priority messages can be transmitted in a special interrupt slot. The TDMA method used has a dynamic character (dynamic time division multiple access, DTDMA): If necessary, a user can request additional transmission capacity, i.e. more timeslots. Other NILE units receive this request and provide timeslots that they were assigned but currently do not need. This method ensures an adaptive response to changing requirements and environments.

Setup of Link 22 systems

FIG 3 shows a schematic diagram of a Link 22 system. The tactical data system (TDS) and the data link processor (DLP) contain user functions such as generating and processing tactical messages, higher-level priority management and address management.

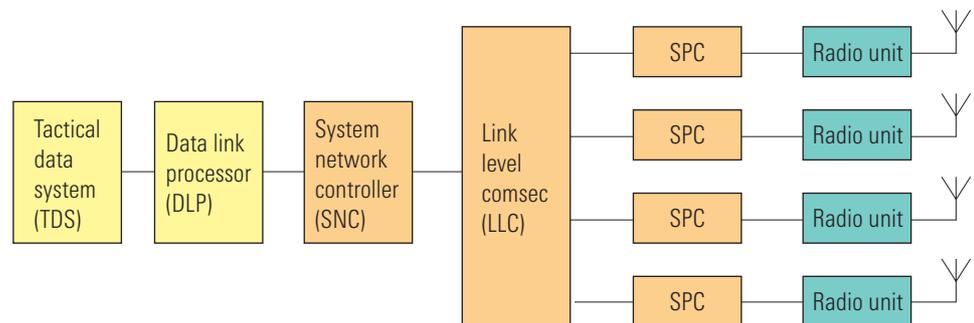
The system network controller (SNC) processes the transport and network protocols, including network management, DTDMA, fragmenting messages as well as relay and routing functions. The interface between the SNC and link level comsec (LLC) is a conventional local area network (LAN).

The LLC is a special Link 22 module that is used for encryption, decryption and integrity mechanisms. An LLC can operate a set of up to four SPCs (signal processing controllers) with associated radio unit via one serial interface for each. Each set can be made up of units for different Link 22 transmission modes

(HF, UHF, with / without EPM). In practice, the SPC is usually integrated in the radio unit. A separate SPC is required for each of the four Link 22 modes.

Compared with Link 16, Link 22 offers a transmission range that extends beyond line of sight (BLOS) with shortwave plus greater flexibility, because it allows the choice between a combination of UHF and HF with or without EPM. Further advantages over Link 16 are the dynamic TDMA, the interrupt slot and additional features for LPI (low probability of intercept) such as Tx power control and radio silence.

FIG 3 Basic setup of Link 22 systems.



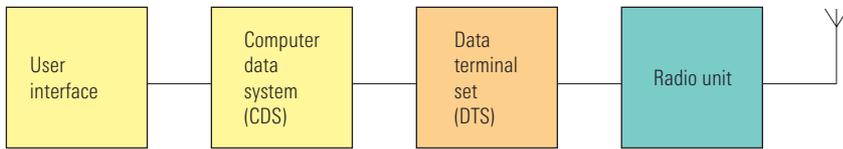


FIG 4 Typical Link 4A system.

▶ **Link 4A**

Like many other data links currently in use, Link 4A is relatively old. It was designed in the late 1950s as one of the first digital data links. Primarily it serves the following purposes:

- ◆ Transmission of target data or operational data from a ground station to aircraft
- ◆ Transmission of messages from aircraft to the ground station
- ◆ Help for aircraft landing on aircraft carriers
- ◆ Military air traffic control

Link 4A allows data transmission at 5 kbit/s with FSK modulation in TDM access. It has no inherent encryption and no special facilities for jamming-resistant transmission. This is one of the essential differences vis-à-vis Link 22 and Link 16, which provide these possibilities. The frequencies it uses are in the UHF band between 225 MHz and 400 MHz.

A Link 4A system consists of the user interface, the computer data system (CDS), the data terminal set (DTS) and the radio unit (FIG 4). The data to be transmitted is handed over in parallel format from the CDS to the DTS, where it is converted to serial format and arranged in the correct chronological sequence for the actual transmission via the radio unit. The radio unit must have certain defined properties in order to be suitable for this purpose. For instance, it must ensure a transmission rate of 10 000 bit/s during the synchronization phase.

Link 4A provides two main modes:

- ◆ **CAINS mode** (carrier aircraft inertial navigation system)
This mode is used for transmitting data to fighter aircraft on aircraft carriers. This can be navigational data of the carrier itself or geographic navigation points for the aircraft's mission.

- ◆ **CDS mode** (computer data system):
This mode supports the transmission of data for the following purposes:
 - ◆ Intercept vectoring (guiding the aircraft to a target detected by the vessel)
 - ◆ Air traffic control (guiding the aircraft for air traffic control purposes)
 - ◆ Automatic carrier landing system, or ACLS (automatic guidance of the aircraft in its final approach to the aircraft carrier)
 - ◆ Precision course direction (precision control of the aircraft to a destination)

Besides Link 4A, Link 4C, which is used for tactical communication between fighter aircraft, is also still in occasional use. The two links are not interoperable.

Link 16

Link 16 is a communication, navigation and identification system primarily for airborne applications and functions in the upper UHF range (969 MHz to 1215 MHz). It is used to selectively distribute tactical data – such as the exact position of friendly and enemy aircraft, vessels and ground troops – to one's own fighter and reconnaissance aircraft, vessels and command centers.

Although Link 16 is among the technically most sophisticated transmission methods in use today, it is relatively old: it was first introduced in the early 1970s. Back then, however, a class-1 terminal was the size of a cupboard. Today a modern MIDS terminal is only as big as a shoebox.

Features of Link 16

The most important features of Link 16 are the following:

- ◆ Transmission of voice and data
- ◆ Immunity to jamming
- ◆ Integrated encryption

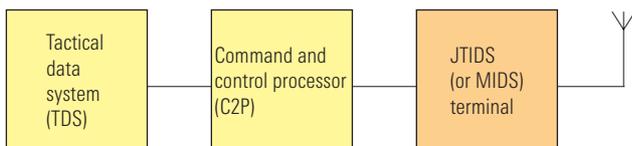


FIG 5 Setup of Link 16 systems.

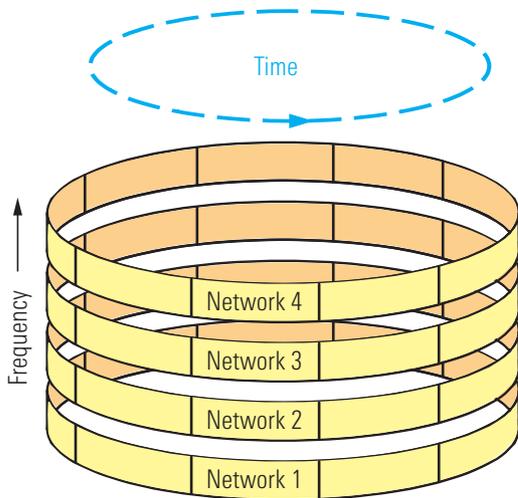


FIG 6 TDMA and network structure with Link 16.

- ◆ Relative navigation
- ◆ Identification
- ◆ Increased data rate (vis-à-vis already existing methods)
- ◆ Line-of-sight transmission via relay function
- ◆ Transmission without central facility

Link 16 is a hybrid method, combining a number of principles to achieve resistance to jamming – namely, direct sequence spread spectrum, extremely fast frequency hopping and pseudo-random time jitter.

Setup of Link 16 systems

In the case of transmission, the tactical data system generates the tactical data to be transmitted and transfers it to the command and control processor, which prepares the data for Link 16 transmission (FIG 5). Unlike Link 22 or Link 4A, Link 16 unites all further functions such as encryption, modulation, coding and other transmission functions in the JTIDS (or MIDS) terminal (see terminology box). The different users share the network by way of a TDMA method

in which the length of a timeslot is 1/128 second.

Link 16 uses a TDMA method in a stacked net configuration (FIG 6). With this method, a number of networks exist simultaneously, each with its own TDMA access. These networks are separated by different frequency hop sequences defined from a pool of 51 available frequencies. A user can be a member of more than one network.

The relative navigation in a Link 16 system functions continuously, as soon as one Link 16 terminal is in operation. The basic principle is that the relative positions of the terminals to each other can be determined by measur-

ing the propagation times of the signals between the different terminals. If the absolute position of one of the terminals in the system is known, the position of all the other ones can be calculated from this.

Link 16 can be configured in many different ways. For example, it is possible to switch error correction (Reed-Solomon) on or off or to select double transmission (double pulses). These possibilities also change the usable data rate. It is highest – 238 kbit/s (with only one transmitting user) – when the double pulses and the error correction are switched off. With double pulses and FEC, a data rate of 29 kbit/s can be reached (again with one transmitting user).

Dr Rüdiger Leschhorn

Link 16 terminology

The different terms used in connection with Link 16 often cause confusion.

Link 16 designates the NATO message standard (STANAG 5516), i.e. the structure of the individual messages.

TADIL J is the matching counterpart in the USA defined in a MIL standard.

JTIDS (joint tactical information distribution system) designates the communication component, i. e. the radio unit (also referred to as terminal). The NATO term for JTIDS is **MIDS** (multifunctional information distribution system). The technical properties are defined in STANAG 4175. With modern versions of JTIDS or MIDS, the term **LVT** (low volume terminal) is also used.

IJMS (interim JTIDS message specification) is one of the three message families used in Link 16.

The term Link 16 is also used differently in the USA and in NATO. In the USA, it often denotes the entire transmission system including the communication components. At the NATO level, Link 16 usually refers only to the messages and protocols defined in STANAG 5516.

R&S AMMOS® (automatic modular monitoring of signals) is a universal family of systems from Rohde & Schwarz for monitoring analog and digital signals in the HF, VHF and UHF frequency ranges. The base system presented here (FIG 1) is designed for narrowband signal processing in the HF range from 10 kHz to 30 MHz.

A new VHF / UHF receiver for R&S AMMOS® is described on pages 29 to 31.

Automatic Modular Monitoring System R&S AMMOS®

Seeing clearly through the thicket of signals

R&S AMMOS® – meets any challenge

A primary task in communications intelligence is to monitor analog and digital HF, VHF and UHF radiocommunications. In the military area, strategic and tactical applications are differentiated; the requirements placed on a system concept for an R&S AMMOS® radiomonitoring system are thus completely different (FIG 2).

Strategic application is comprehensive and covers long ranges and large

areas. Due to wave propagation conditions and operational concepts, radio-communications to be monitored is limited to satellite connections and short-wave (HF) radio. The enormous technical expenditure, for example with antenna systems (that may easily take on the size of several soccer fields), permits worldwide radiomonitoring in the HF range. For this field of operation, stationary radiomonitoring systems are deployed, with the focus on unrestricted scalability and expandability. They are usually equipped with a large number of receivers and workstations with parallel

FIG 1 Example of an R&S AMMOS® base system for the HF range with two sensor groups for processing up to 16 digital data transfers simultaneously.



43934/2

use of the available sensors. They are designed to carry out the "production" – to log decoded, digital radio signals as readable text – and the analysis of signals and transmission methods, in most cases automatically. "Technical analysis" analyzes signals and transmission methods. With such requirements, the systems predominantly feature highly automated processes that are monitored by operating personnel.

Tactical communication links are usually operated in the VHF / UHF range, less frequently in the HF range (ground wave). **Tactical application**, i.e. the quick recording and processing of radio-communications and identification of the corresponding radio stations on the basis of the collected data, calls for small, compact systems. These systems should be designed for mobile use, be modular in structure, provide all system functions using just a few workstations, and allow fast response to detected changes in the situation picture. The focus is on the detection and re-detection of signals, transmitters and methods to obtain tactical information.

The tasks could hardly be more challenging, yet R&S AMMOS®, with its fully modular design with regard to sensor devices and software, is ideal for such purposes and delivers outstanding performance for virtually all possible applications.

The architecture of R&S AMMOS®

A 19" VXI mainframe (FIG 1) serves as the carrier for the sensor devices. It accommodates the VXI modules such as the VXI Monitoring Receiver R&S®EM 010 [*] or the DSP Board R&S®GX 400 DP (FIG 3). Depending on the requirement, the modules can be flexibly combined according to their

FIG 2
R&S AMMOS® is ideal for COMINT.

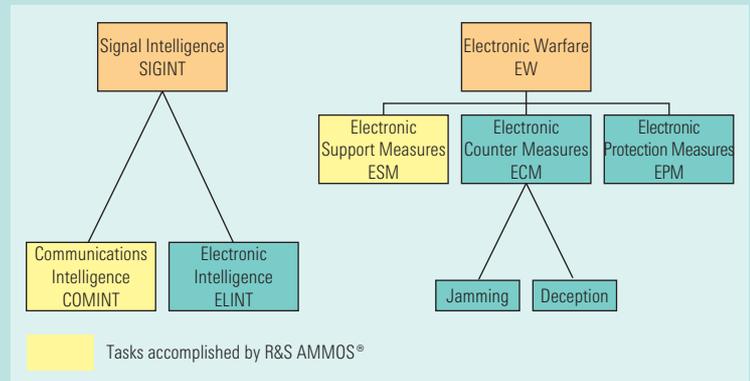
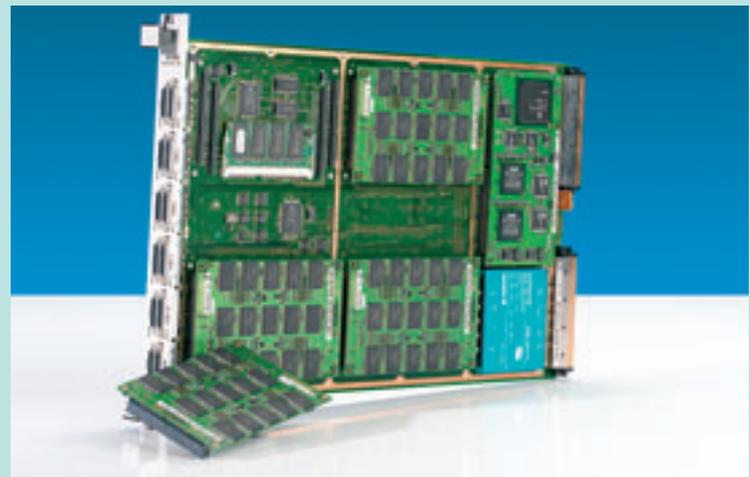


FIG 3
The DSP Board R&S®GX 400 DP is equipped with powerful digital signal processors.



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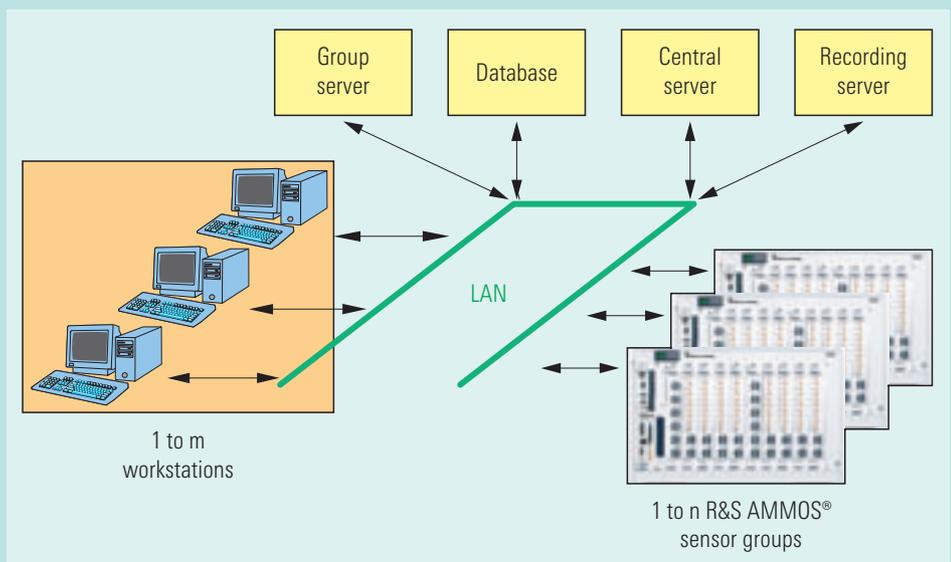


FIG 4 An Ethernet LAN serves as the central means of communication in R&S AMMOS®.

▶ function and quantity. A compact main-frame populated with eight VXI Monitoring Receivers R&S®EM 010 and two DSP Boards R&S®GX 400 DP – a sensor group – can process up to eight digital data transfers simultaneously.

The sensor group is equipped with a CORBA interface (common object request broker architecture), via which it is addressable using a modern interface definition derived from object-oriented software development. The interface transmits not only control and digital data signals but also digital audio signals, so that only one Ethernet connection between sensor groups at one end and the workstations, servers, signal recording machines, etc. at the other end is used for data exchange (FIG 4). Thus, R&S AMMOS® is prepared for operation via a wide area network (WAN), e.g. via a satellite link.

The IPC concept of R&S AMMOS®

An interception processing channel (IPC) in R&S AMMOS® combines a number of devices (e.g. receivers, demodulators, decoders) that were previously controlled separately, thereby forming a unit. It is able to function automatically in accordance with the preparameterization by the operator.

Each sensor group provides a number of IPCs that can be controlled both automatically by the system and manually by an operator. An IPC is configured dynamically on request using the available resources in the sensor pool and is then "specialized" for efficiently performing the task at hand (FIGS 5 to 7).

Each IPC is presented to the operator on a graphical user interface ideally adapted to the data/information to be displayed (FIGS 8 and 9).

Automation of productive operation

In productive operation, the IPCs can respond to a change in the signal or in the mode used by parameterization with known characteristics of the signals to be monitored (e.g. when the modulation mode or the coding changes) and can automatically adjust themselves (FIG 10).

Recording and replaying signals

All IPCs have a signal buffer in which the last 60 seconds of the signal being recorded are digitally stored (digital IF with 20 kHz bandwidth). The operator can start recording the digitized IF data stream at any time for later processing or analysis. The data is taken from the signal buffer and recorded with a lead time of up to 60 seconds.

To replay the digital IF data, it is fed directly to the VXI Monitoring Receiver R&S®EM 010 via the VXI bus. Feeding the data to the IPC input ensures that the same functions and processing capacities are available to the operator both online (with signals from the antenna) and offline (with signals from the recording).

FIG 11 shows a table indicating which data types can be recorded with the R&S AMMOS® base system and stored on the workstation hard disk.

Multichannel operation

Multiple IPCs can be used simultaneously at a workstation. The control processes, which are usually automated, can be deactivated at any time, allowing the operator to manually control the IPC whenever desired. ▶

IPC type	Application
Tuner	Detection of speech transmission (acoustic). Application of the R&S®EM 010 scan functions for monitoring a frequency range.
Data (digital communication)	Detection of digital radiocommunications. Demodulation and decoding of the signal.
Morse	Similar to data-type IPC but specially for Morse signals (Morse radio).
Classification	Classification of signal parameters of "unknown" signals (modulation mode, coding method).
Decoder development	A decoder-development environment from Rohde & Schwarz enables users to add new decoders to the library in the sensor group by themselves. This IPC type is designed for testing decoders during the development phase; it can be used in the same way as a data-type IPC.

FIG 5 The IPC types for R&S AMMOS®.

ASK2
FSK2 / 4 / 8
MSK
PSK2 / 4 / 8
Multitone (2 to 64 tones)
Multichannel (MPSK2 / 4 / 8, MFSK2; up to 24 channels)

FIG 6 The modulation modes in R&S AMMOS®.

7-bit ASCII 1 or 2 stop even / odd parity
8-bit ASCII 1 or 2 stop even / odd parity
ARQ-E3 4Ch / 8Ch
ARQ-E 4Ch / 5Ch / 8Ch
ARQ-N
ARQ-S 4Ch / 5Ch / 6Ch
AUTOSPEC
BAUDOT 1.0 / 1.5 / 2.0 stop bit
COQUELET-8 / -13 / -80
FEC-A, FEC-S
G-TOR
PACTOR 1 version 1-7 (HAM, ICRC, UNHCR, IFRC)
PICCOLO MK6 / MK12
POL-ARQ
SITOR-A / -B
SPREAD 11 / 21 / 51
SWED-ARQ (short, middle, long)

FIG 7 The standard decoding methods in R&S AMMOS®.

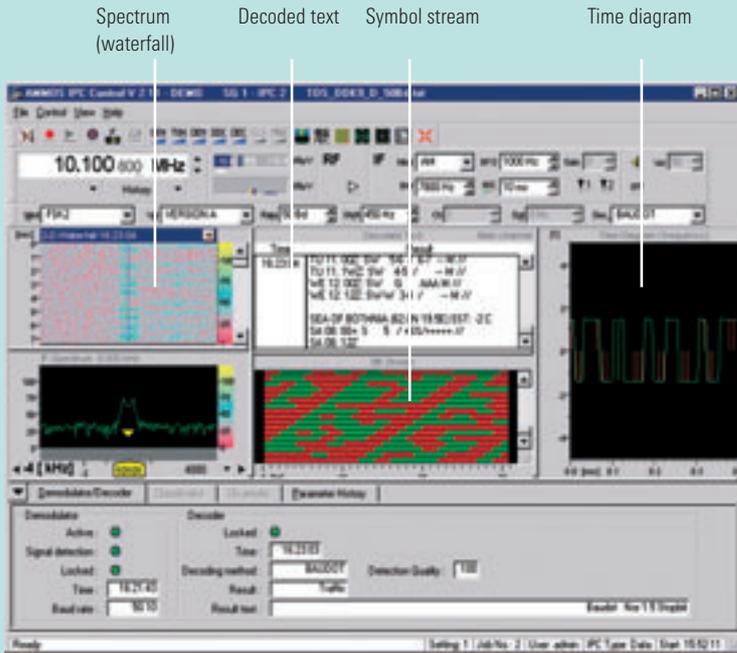


FIG 8 A data-type IPC demodulates and decodes a Baudot meteorological radio signal (productive operation).

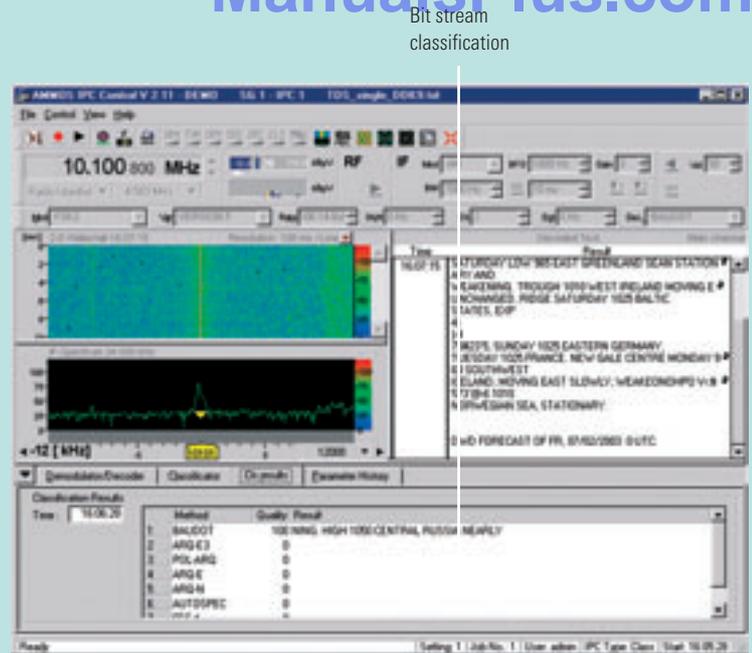


FIG 9 A classification-type IPC classifies the parameters of the demodulator and the coding method (Baudot in this example). The IPC subsequently switches to productive operation.

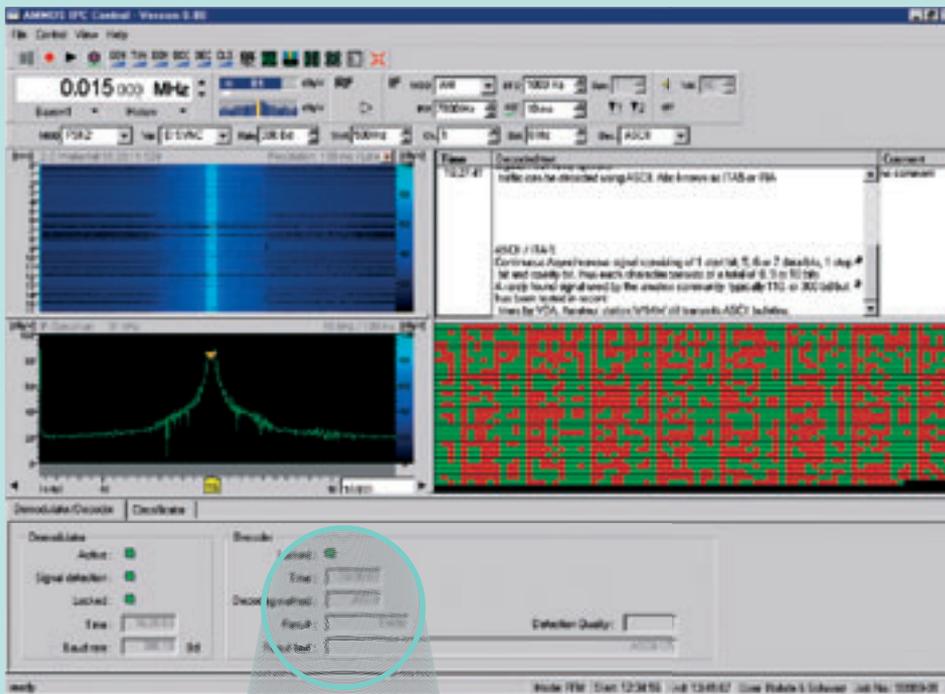
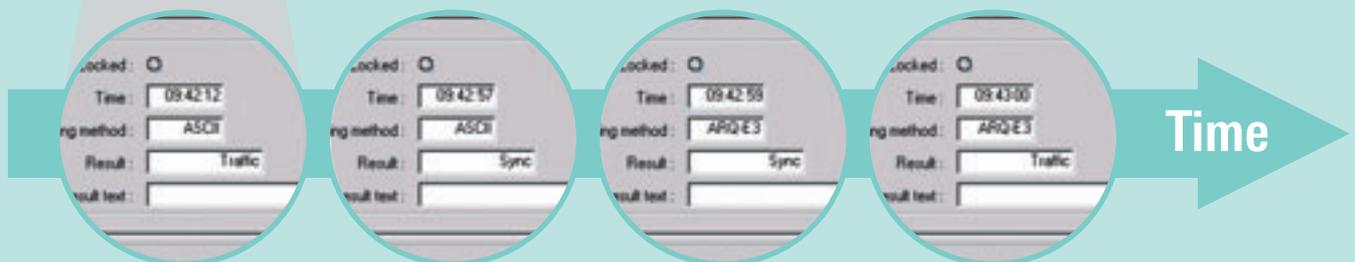


FIG 10

In accordance with its preparameterization, a data-type IPC independently follows the switchover of the coding method in the signal from ASCII to ARQ-E3. First the ASCII decoder recognizes that it can no longer process the signal (switch from "Traffic" to "Sync"). Then the IPC switches back and forth between the decoders until one of them (in this example, the ARQ-E3 decoder) can decode the signal again (switch from "Sync" to "Traffic").



► **The future development of R&S AMMOS®**

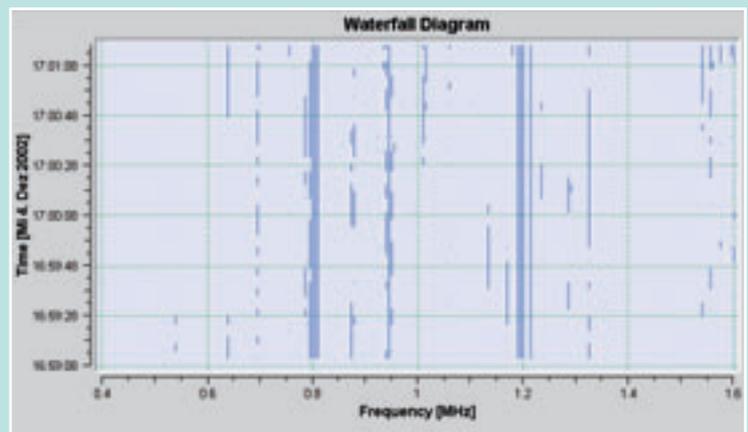
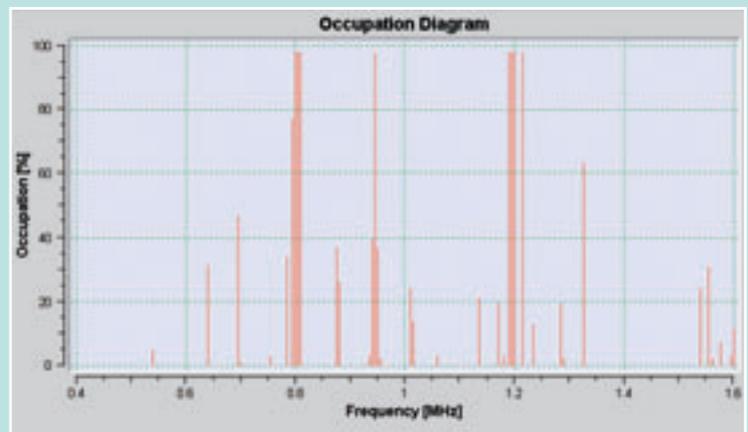
The system presented here is part of the flexible R&S AMMOS® overall solution for multichannel search, monitoring and production systems. In the future, R&S AMMOS® will also incorporate wideband and narrowband signal processing in the frequency range 300 Hz to 3.6 GHz, including direction/location-finding information. This will also make it possible to detect modern signals such as burst or frequency-hopping signals.

Jürgen Modlich

Data type	Task
Digitized intermediate frequency with 20 kHz bandwidth (branched off at the digital IF output of the VXI Monitoring Receiver R&S®EM010)	Replay of a recorded signal for offline processing with an IPC.
Symbol stream (branched off at the demodulator output)	Analysis of the bit stream with special programs developed for this in order to obtain more information about the mode used (demodulation, decoding) in the case of unknown signals.
Decoded text	Readable message content. Can also be encrypted (decryption outside of R&S AMMOS®).
Technical parameters Measurement results of the classification (modulation mode recognition, bit stream classification)	Evaluation of the measured signal parameters, e.g. to allow correct parameterization of an IPC for monitoring the signal.
Recording of frequency occupancy information using the scan functions of the tuner-type IPC	Compiling of frequency occupancy statistics (display, which frequencies and how often and/or how long they were used; see FIG 12).
Reports	Summary of different data for later evaluation (e.g. current instrument settings and results obtained with it) in HTML format, including a screenshot of the IPC visualization.

FIG 11 Data types that can be detected with an R&S AMMOS® base system and stored on the hard disk of a workstation.

FIG 12
Display of the statistical frequency occupancy (top) and the time occupancy (waterfall diagram, bottom) within a monitored time period. It can be clearly seen that two transmitters are continuously active at 0.8 MHz and 1.2 MHz (radio stations Bayern1 at 801 kHz and Voice of America at 1197 kHz).



More information and data sheet at www.rohde-schwarz.com (search term: R&S AMMOS)

REFERENCES

[*] HF Receiver R&S®EM010 – Digital, VXI-based HF receiver with broadband IF output. News from Rohde & Schwarz (2000) No. 168, pp 25–26

VHF/UHF Receiver R&S®EM050

Digital VXI-based receiver for 20 MHz to 3.6 GHz

The new VHF/UHF Receiver R&S®EM050 (FIGs 1 and 2) is another vital component in the state-of-the-art VXI receiver and analyzer family from Rohde & Schwarz, opening up the 20 MHz to 3600 MHz frequency range. It combines outstanding RF characteristics with the powerful signal processing of state-of-the-art technology.

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FIG 1 The digital R&S®EM050 monitoring receiver in VXI technology meets the most stringent requirements of the relevant MIL standards.

New addition to tried-and-tested technology

For well over two years now, the VXI HF Receiver R&S®EM010 [*] has proven a success in numerous COMINT/ESM systems in the 300 Hz to 30 MHz frequency range. Its attractive characteristics coupled with easy system integration quickly sparked user interest in receivers designed for higher frequency ranges. Building on this success, the VHF/UHF Receiver R&S®EM050 was developed to VXI standard (VXI: VME bus extension for instrumentation; VME: versa modular eurocard IEEE 1014); it is based on years of Rohde & Schwarz production expertise in the area of professional radiomonitoring receivers.

Wide dynamic range – high sensitivity

With the R&S®EM050, great importance was placed on excellent large-signal characteristics and high sensitivity – two features that are crucial if numerous powerful transmitters “challenge” the receiver, or if weak signals in critical radiomonitoring scenarios require unambiguous identification. The operator quickly finds the correct settings for successful radiomonitoring even in a signal environment prone to interference. Furthermore, optimum receive conditions are ensured by matching preselection ranges with tracking or fixed bandpass filters.

► Powerful digital signal processing

All intermediate frequencies are processed in powerful signal processors and field programmable gate arrays (FPGA). This technology allows the implementation of functions that are indispensable in modern COMINT/ESM systems. The new receiver includes numerous filters, different evaluation methods for level measurements, matching time constants and a multitude of standard demodulators, to name just the most important features. Another advantage of this technology is the availability of signals or signal contents in digital form on different interfaces, which is a crucial prerequisite for the implementation of powerful interception and analysis systems. One of the receiver's special features is its front panel data port (FPDP) interface which has been designed for maximum data rates. Moreover, signal processing provides sufficient leeway for future expansions.

Narrowband – wideband

Up to now, different applications required different receivers. The R&S®EM050, however, is capable of processing both narrowband and wideband transmissions without any performance loss. Its digital IF filters with bandwidths between 150 Hz and 10 MHz plus numerous internal demodulators allow the receiver to handle a multitude of signals; if it is connected to external DSP boards via the appropriate interfaces, it can also process complex signals. This combination opens up the full scope of analysis and demodulation of digital signals as are used increasingly in military radio services.

Yet this is by no means all that the R&S®EM050 can do. Transmission methods such as used with spread signals (DSSS: direct sequence spread spectrum), frequency-varying emissions (FH: frequency hopping) or pulsed signals require even wider bandwidths.

Together with a wideband DSP board that is connected to the wideband IF output of the receiver, the latter can reliably detect such signals and make them accessible for further processing. But optimum signal analysis is not much use if the signals are not detected. Such tasks require high scan rates that ensure high probability of intercept. This is no problem with the wideband combination of receiver and DSP board since scan rates in the two-digit GHz range can be easily achieved, depending on the settings made.

Large systems – small systems

The R&S®EM050 is designed for multi-channel interception and signal processing in state-of-the-art COMINT /ESM systems, for example in the powerful R&S AMMOS® monitoring system from Rohde & Schwarz (page 24). Its automatic, parameterized processes allow operators to handle the enormous data flow and to detect and analyze signals of interest without incurring any loss of information. R&S AMMOS® of course fully controls the R&S®EM050. The modular design of the system enables the user to start on a small scale and expand the system step by step; there are no limits to performance.

The new receiver offers decisive advantages in both larger systems and smaller-sized units, because the diverse hardware and software combinations that are feasible allow optimum adaptation to the tasks at hand. Simply combining a receiver with different DSP boards from Rohde & Schwarz and the associated software opens up an unprecedented variety of functions in military radiomonitoring. This flexibility yields even more advantages because the user gets everything from a single source.

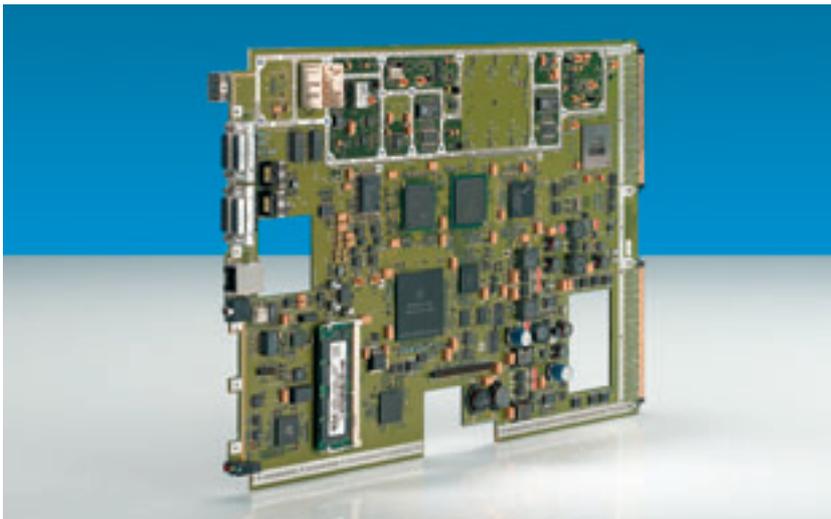


FIG 2 State-of-the-art DSPs and FPGAs on a multilayer with 10 layers ensure extremely powerful signal processing in the R&S®EM050. The rear is for the VXI bus only; everything else can be accessed from the front panel.

43 971/3

The user can, of course, personally integrate the R&S®EM050 into a monitoring system. The necessary interfaces and commands are detailed in the manual.

Versatile applications

Whether the R&S®EM050 is integrated into large or small systems, it can handle a multitude of further applications in addition to the ones already mentioned, for example:

- ◆ Buffer memory for wideband signals
- ◆ Signal-specific detection
- ◆ Visualization of wideband spectra
- ◆ Monitoring of wideband frequency occupancy
- ◆ Statistics on frequency / level / time
- ◆ Replaying and reprocessing of recorded wideband signals

Summary

The R&S®EM050 is a powerful receiver that will superbly accomplish the tasks at hand for many years to come. Since internal signal processing can be adjusted via software, the R&S®EM050 is also ideal for handling future signal scenarios.

Christian Gottlob

Main characteristics of the R&S®EM050

Operating modes

- ◆ Fixed frequency
- ◆ Memory scan
- ◆ Frequency scan
- ◆ Fast RF spectrum
- ◆ Replay (IF)
- ◆ Wideband
- ◆ Test

Data output

- ◆ Baseband signals (I and Q) in digital form; 10 MHz maximum bandwidth
- ◆ IF analog
f = 405.4 MHz, B ≥ 50 MHz
f = 21.4 MHz, B = 10 MHz
- ◆ Video digital
- ◆ Video analog, B = DC to ½ IF bandwidth
- ◆ DAT recorder, AES3 format
- ◆ Audio digital
- ◆ Audio analog (600 Ω and headphones)

Demodulation modes in fixed frequency operating mode

AM, FM, CW, LSB, USB, ISB, PULSE, IQ

IF bandwidth is settable between 150 Hz and 10 MHz in 23 steps.

Squelch is settable from –30 dBμV to +130 dBμV in 1 dB steps.

Gain control is selectable: either automatic (AGC) or manual (MGC) gain control.

In **memory scan** mode, all relevant parameters can be set for each channel:

- ◆ Memory
- ◆ Frequency
- ◆ Demodulation mode
- ◆ Bandwidth
- ◆ Preamplifier / attenuator
- ◆ Squelch

In **replay mode**, recorded IF data can be fed via the data interface for post-processing.

In **test mode**, a comprehensive selftest is performed, either as a short or as a long test.

Condensed data of the R&S®EM050

Frequency range	20 MHz to 3600 MHz
Second-order intercept point	typ. 55 dBm
Third-order intercept point	≥17 dBm (20 MHz to 300 MHz) ≥20 dBm (300 MHz to 3600 MHz)
Noise figure	≤12 dB (f < 2000 MHz) ≤15 dB (2000 MHz to 3000 MHz)
Digital IF filters	21 filters, 150 Hz to 2 MHz

More information at

www.rohde-schwarz.com (search term: AMMOS)

REFERENCES

[*] HF Receiver R&S®EM010: Digital VXI-based HF receiver with broadband IF output. MIL News from Rohde & Schwarz (2000) No. 4, pp 27–28

Multimode Multirole Crypto System R&S®MMC3000

Powerful encryption for military communication

The compact R&S®MMC3000 crypto device can be used in military scenarios for versatile applications: for voice and data encryption via wired networks and radio networks both for tactical and strategic use.

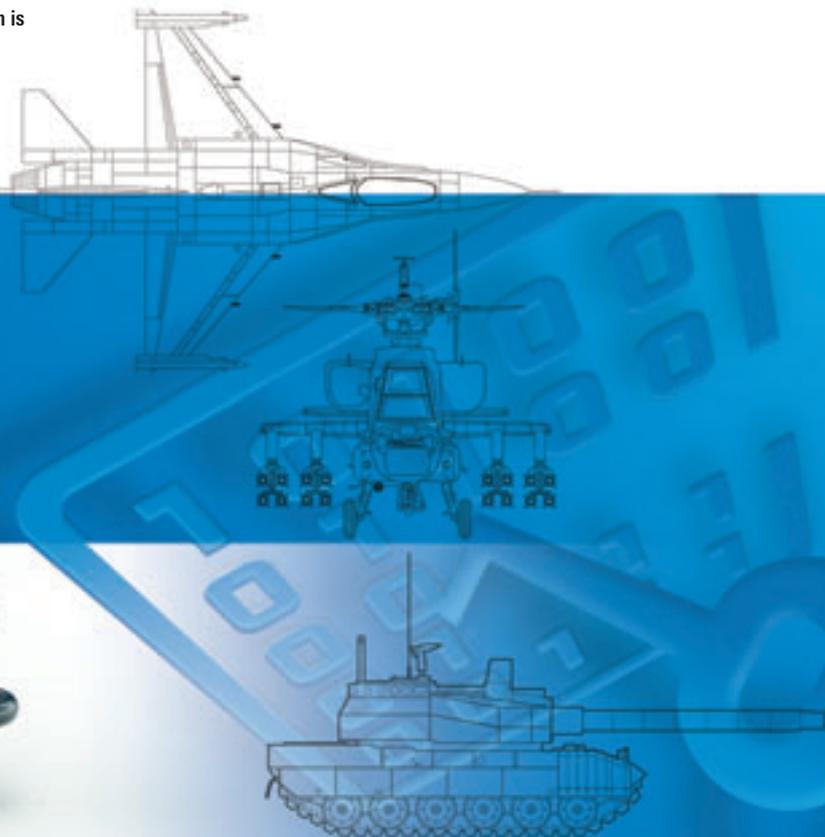
All-in-one solution for secure communication

The R&S®MMC3000 crypto device (FIG 1) encrypts speech and data in wired networks and in radio networks via HF, VHF and UHF radios. Alternatively, a bypass function allows unencrypted transmission. An optional security management system (SMS) complements the crypto device to form an all-in-one solution for versatile applications (see box right).

An LPC 10E vocoder in accordance with STANAG 4198 or a continuously variable slope delta (CVSD) codec in accordance with STANAG 4209 with 16 kbit/s is available for speech digitization.

There are different choices available for transmitting the digitized speech signals: an LOS modem with 2400 bit/s based on V.26, an HF modem in accordance with STANAG 4199, a wideband interface with 16 kbit/s or a V.24 interface.

FIG 1 The R&S®MMC3000 crypto device is equipped with a powerful crypto algorithm from Rohde & Schwarz. A security management system is optionally available.



With the exception of the wideband interface, the same facilities are available for data and speech transmission, i.e. a V.24 interface (optionally X.21) both at the terminal end and at the transmission end. The terminal controls data transmission via handshake lines and Hayes commands without any need to manually operate the R&S®MMC 3000 crypto device. In the V.24 Hayes mode, the dial-in data coming from the terminal is looped through the crypto device to the external modem that is connected to the V.24 interface at the transmission end. After the modem has set up the connection, the crypto device automatically assumes encryption mode.

Input and output levels are adjustable within a wide range by means of the electronic level control.

Operational versatility

The R&S®MMC 3000 can be operated via a control unit or, alternatively, via a MIL-bus module in accordance with MIL-STD-1553B. This ensures maximum flexibility for diverse installation scenarios. The control unit can be operated locally when attached to the control unit, or remotely. Operation includes primarily the loading of keys, security settings and the configuration and setting of the required operating modes. An optional crypto ignition key (CIK) and password protection prevent unauthorized use of the R&S®MMC 3000.

Consistent architecture in the interest of security

The architecture of the crypto device has been consistently designed with a view to logical and physical separation of plain and crypto data (red/black separation). To comply with the high demands placed on red/black separation, the

power supply provides separate voltages for the plain and crypto data modules.

Data is processed on separate modules, each with its own digital signal processor (DSP) (FIG 3). The crypto board is another separate module that is equipped with a powerful crypto variable algorithm from Rohde & Schwarz and a hardware noise source for the

generation of true random data. A slot for additional modules has been provided to permit future expansions.

The two signal processors control the crypto device. The module processing the crypto data has the master function and ensures communication with the control unit or, alternatively, with the MIL-bus module that can be connected via an RS-485 interface.

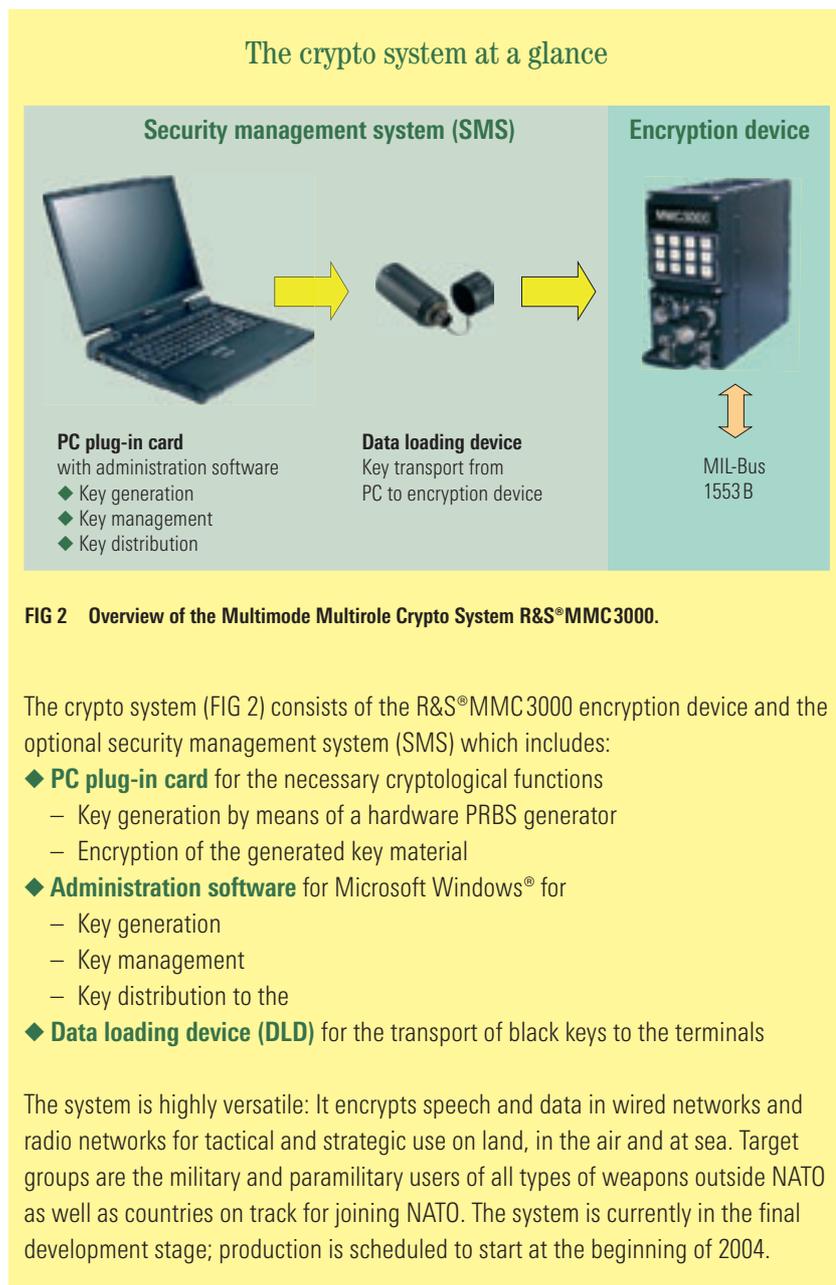


FIG 2 Overview of the Multimode Multirole Crypto System R&S®MMC 3000.

The crypto system (FIG 2) consists of the R&S®MMC 3000 encryption device and the optional security management system (SMS) which includes:

- ◆ **PC plug-in card** for the necessary cryptological functions
 - Key generation by means of a hardware PRBS generator
 - Encryption of the generated key material
- ◆ **Administration software** for Microsoft Windows® for
 - Key generation
 - Key management
 - Key distribution to the
- ◆ **Data loading device (DLD)** for the transport of black keys to the terminals

The system is highly versatile: It encrypts speech and data in wired networks and radio networks for tactical and strategic use on land, in the air and at sea. Target groups are the military and paramilitary users of all types of weapons outside NATO as well as countries on track for joining NATO. The system is currently in the final development stage; production is scheduled to start at the beginning of 2004.

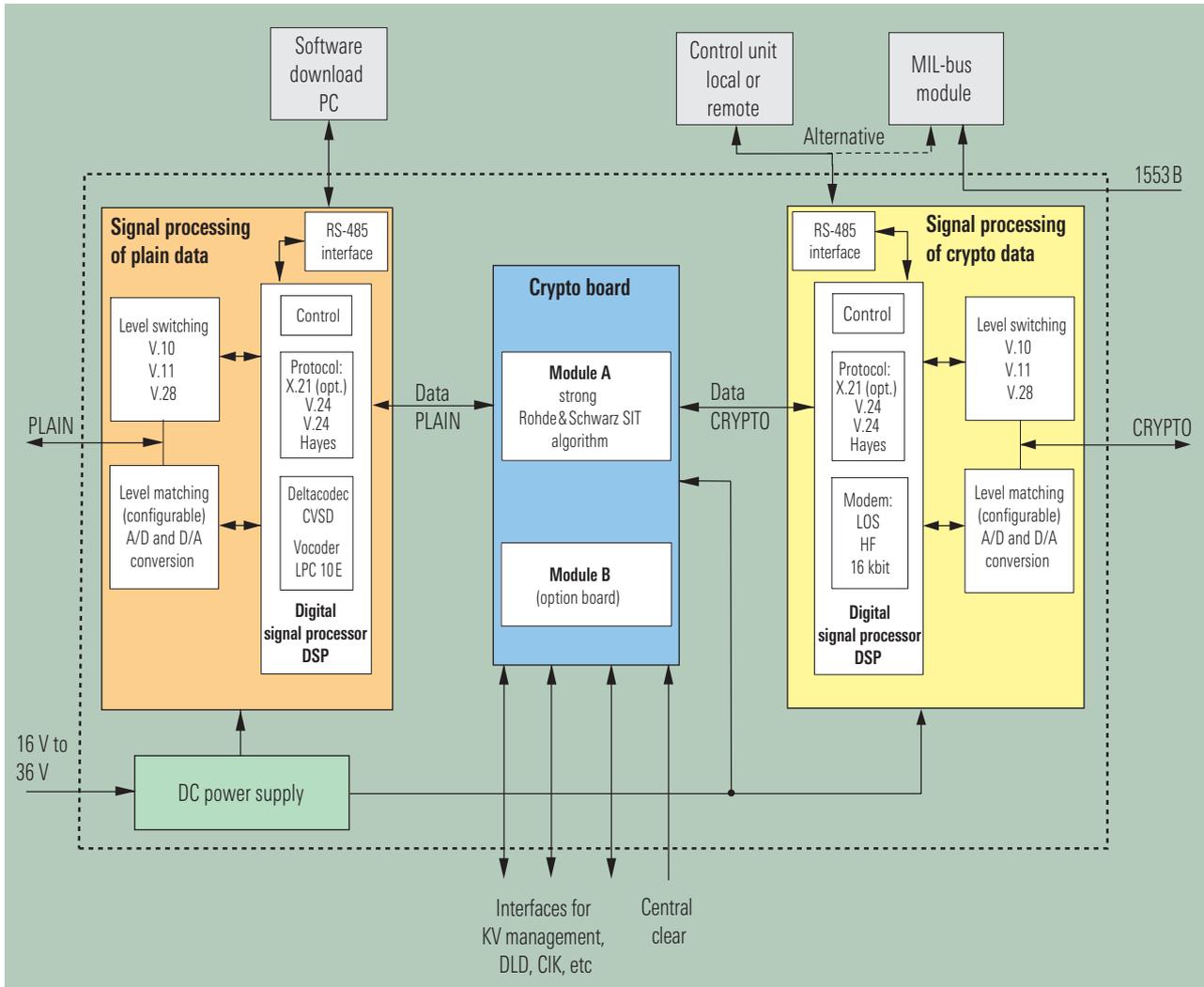


FIG 3 Basic architecture of the R&S®MMC3000 crypto device.

► For maximum flexibility and upward compatibility, the complete device software – with the exception of the software for the crypto module (DSP and control software) – can be downloaded securely and encrypted via an externally accessible RS-485 interface.

are able to replace defective modules themselves, provided they have received appropriate training. In addition to the selftest with test connectors, the R&S®MMC3000 also features various built-in tests (BIT): a power-on BIT (PBIT), an initialized BIT (IBIT) and a continuous BIT (CBIT).

Ulli Fetzer

Service and maintenance concept

A comprehensive selftest integrated in the R&S®MMC3000 crypto device allows the localization of defective cards and, with the aid of supplied test connectors, also of interfaces so that users

More information and data sheet at www.rohde-schwarz.com (search term: MMC3000)

Data sheet R&S®MMC3000

2003 trade fair of AFCEA Bonn e.V.

“The future of information and communication technology”



Photos: Author

The 17th trade fair of the Bonn chapter of AFCEA (Armed Forces Communications and Electronics Association) was held in the municipal hall in Bad Godesberg near Bonn on 7 and 8 May 2003. More than 60 exhibitors presented their ICT products and systems to the nearly 1800 visitors attending the fair. The Rohde & Schwarz products commanded a high degree of interest from the visitors.

The company showcased the Software Radios R&S®M3TR, with one as a fixed station establishing a radio link with a mobile man-pack version of the R&S®M3TR.

The Rohde & Schwarz subsidiary R&SBICK Mobilfunk GmbH – which has a wide range of products and many years of experience in setting up professional mobile radio systems



IT-AmtBw president, Ministerial Director Stolp (left), and vice president, Brigade General Scherz (center), learn about current product developments and future activities of Rohde & Schwarz.

– demonstrated the advantages of the digital trunked radio system TETRA with the compact and robust outdoor Mini-Base Station R&S®TOB 500.

The encryption systems ELCRODAT 4-2 and ELCRODAT 6-2 from the Rohde & Schwarz subsidiary SIT, which fulfill the highest demands regarding tap-proof telephone and data communication, also attracted a lot of attention.

The finishing touch to the overall positive impression was added by a presentation of the Rohde & Schwarz Service Center in Cologne about interactive electronic technical documentation.

Besides the many high-ranking visitors, primarily from the Ministry of Defence, the Ministry of the Interior and the Foreign Office, a special highlight was the visit of the delegation of the new Federal Office for Information Management and Information Technology of the German Armed Forces (IT-AmtBw), which is based in Koblenz and was established last year.

Led by their president, Ministerial Director Wolfgang Stolp, and vice president, Brigade General Reimar Scherz, the IT-AmtBw delegation learned about current product developments and future activities of Rohde & Schwarz.

Klaus Otting



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