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Electronics for security and defense

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ROHDE & SCHWARZ

Information superiority

with the latest generation of
software defined radios



Military radiocommunications in the 21st century

Today's military missions are typically based on combined missions in a multinational environment. A key factor for mission success is the ability to gain information superiority through fully network centric operations. The technological basis for this is now available with the first member of a completely new family of software defined radios opening up entirely new possibilities for military operations.



Ground forces on the way to network centric operations (NCO)

Efficient communications are crucial to today's military missions. Combined missions in multinational environments in particular call for solutions that satisfy the growing demand for information relating to situational awareness and at the same time ensure command and control effectiveness in threat scenarios. These requirements apply especially to ground forces, where migration to network centric operations is of vital importance.

State-of-the-art radio equipment such as the new R&S®SDTR software defined tactical radio supports this approach by providing entirely new functionality. Rohde&Schwarz presented the R&S®SDTR in December 2012 as the first member of an innovative software defined radio family. The new radio is based on the standardized software communications architecture (SCA) and uses the new R&S®HDR waveforms, which deliver high data rates for narrowband and wideband applications. As a result, the radio opens up entirely new possibilities for military operations. This article discusses these novel applications from a user perspective.

The R&S®SDTR (shown opposite) is the first member of a new family of software defined tactical radios. It is intended for use in vehicles and in semi-mobile or stationary platforms.

Key facts

- Compact tactical radio with integrated power amplifier and cosite filters
- Optimized for use in vehicles; meets stringent requirements on vibration, size, weight and power consumption
- Weight approx. 15 kg
- No shockmounts required
- Multiband capability in VHF/UHF range from 30 MHz to 512 MHz, very high frequency-hopping rates
- 50 W output power (PEP and CW)
- Rugged design in line with MIL-STD-810G
- SCA 2.2.2 based, expandable tactical radio platform and waveforms
- In conjunction with R&S®HDR waveforms:
 - Support of external, IP-based applications
 - Jam-resistant (TRANSEC) and tap-proof (COMSEC) communications
 - Simultaneous voice and data transmission

Combined international missions – a core challenge to communications

Somalia, Kosovo, Afghanistan, Congo, Lebanon, Timor-Leste, Mali – these countries have been a topic in the international media countless times. In the face of local and supranational conflicts, the United Nations is compelled to send multinational troops to the regions concerned in order to carry out peacekeeping or peacemaking missions. The forces deployed in these missions are exposed to diverse threats. Numerous discussions with experienced end users have helped Rohde&Schwarz to focus attention on two mission scenarios. By creating these realistic scenarios, it becomes easier to plan the deployment of state-of-the-art communications equipment such as the R&S®SDTR. The R&S®SDTR operational concepts were verified based on the mission scenarios described below.

Mountainland – A fictitious area for an international peacekeeping mission. Based on a United Nations resolution, multinational forces have been stationed in the various regions of that country, where they are in charge of police and military tasks. The country is run by a democratically elected interim government that is supported and protected by the international forces. The country's security forces are currently being established and trained by international experts. The security situation is basically stable; however, the country is struck again and again by the activities of militant rebel forces. Random attacks launched against the international peacekeeping forces require these forces to remain on high alert. This scenario serves as a blueprint for operations in response to asymmetric threats.

Homeland – A fictitious, economically stable country with appropriate defense resources, firmly integrated in multinational alliances with reliable partners. A country bordering on Homeland with modern military forces has been shaken by civil unrest for several months. The country's government is fighting the domestic rebel forces. During this conflict, the neighboring country's regular forces repeatedly violate the borders of Homeland. Homeland has responded with military presence and is now requesting assistance from its international partners in order to protect its borders and accommodate refugees. Under a UN mandate, international support forces under joint control are sent to the country. The primary threat comes from the neighboring country's regular forces. This scenario serves as a blueprint for operations in response to symmetric threats.

The above scenarios reveal the upcoming challenges for military missions. While both scenarios place equally high demands on mission forces, they involve radically different operational requirements.

In the Mountainland scenario, the opponent's strength and organization are often unclear. Because operational conditions

can change rapidly, the defending forces must dynamically adapt to mission requirements. For example, the operational objective of gaining the local population's trust can – in the light of new intelligence – quickly change to arresting a high-ranking leader. As a result, staffing and materials requirements will also change. The dynamic nature of such missions calls for a high degree of flexibility, which in turn requires appropriate equipment.

In the Homeland scenario, by contrast, the opponents are well-equipped regular forces. This scenario places completely different requirements on communications equipment. While this scenario is less frequently encountered than a hundred years ago, the risk of such conflicts remains and is therefore given major consideration in the planning of military forces around the world. Often, opponents can be assumed to have comparable technological capabilities, which means that resources will be stretched to their limits both in terms of staffing and equipment.

Common to both scenarios is a growing demand for the exchange of information. Especially when forces from different nations participate in a mission, it is crucial to coordinate actions and exchange situational and position data in order to ensure mission success.

An obvious example is the International Security Assistance Force¹⁾ (ISAF), which has been deployed in Afghanistan since 2002. With over 50 nations participating in the mission, ISAF has demonstrated the need for a joint, networked information base. Within the framework of the mission, the information transfer principle was changed from “need to know” to “need to share”, with the objective of significantly improving command and control effectiveness as well as information superiority in the context of network centric operations²⁾. The Afghan Mission Network (AMN) was established to handle the storage and distribution of data. The information sharing principle has proven its value in multinational missions and serves as a blueprint for the communications networks of future international missions.

The greatest potential challenge to collaboration during missions is the secure, reliable extension of IP-based communications networks down to the company and platoon command levels. The forces involved must be highly mobile. They mainly communicate via tactical radio or satellite links. These communications means, however, do not usually offer high bandwidths or high availability, and operating costs are high.



The R&S®SDTR was subjected to extreme environmental and stress tests to ensure its operability and reliability under any operating conditions.

New solutions resolve the bottleneck in tactical radiocommunications

Tactical radiocommunications have always been the bottleneck in the hierarchical networking of armed forces. A new generation of software defined tactical radios based on the standardized software communication architecture (SCA) now provides a solution to this problem. These radios, in conjunction with new high data rate (HDR) waveforms, provide even highly mobile units with secure, reliable high data rate communications links based on the Internet protocol (IP).

A major benefit afforded by SCA is that it makes it easy to port the radios' application software, i.e. the waveforms. Until a few years ago, it was almost impossible to port software between tactical radios from different manufacturers. The standardized SCA now makes software porting relatively easy, providing substantially higher flexibility in the procurement of equipment. A market that was previously closed is now open to technological competition, offering users shorter innovation cycles and lower costs. The new generation of radios is interoperable with legacy radios and therefore protects existing investments.

Common communications platform for joint operations

The threats in today's missions are often multidimensional and involve more than one branch of the armed forces. Joint operations of the army, air force and navy are therefore an integral component of modern military command and control. The complexity of such scenarios can grow quickly, as can be

1) www.isaf.nato.int

2) Fleischmann, A.: Afghan Mission Network. Erfahrungen und Ausblick. Europäische Sicherheit und Technik (European Security and Defense) (09/2012), pp 73–77.

Practice rather than theory: "Vigilant Observer" demonstration presents real-world scenarios

To allow customers to discover for themselves the benefits of the new R&S®SDTR tactical radio, Rohde&Schwarz provides a practical demonstration of network centric operations (NCO) of the future. Real-world communications scenarios are used to demonstrate how the radio systems interact and perform in a military tactical environment.

Rohde&Schwarz will of course provide detailed information in the form of product brochures and data sheets on request. But a practical demonstration is doubtless more convincing, which is why Rohde&Schwarz has established a special demo room at its Munich headquarters. This room includes a simulated headquarters and command post. The scenario is completed with a Mercedes-Benz G class offroad vehicle used as a patrol car. Information is presented using a 9Land BMS battle management system supplied by SAAB. The simulated network centric operations demonstration includes the following:

- Simultaneous voice and data transmission
- Tap-proof, jam-resistant, near-realtime information transmission (chat messages, e-mails, situational pictures)
- Support of external, IP-based applications (e.g. sensors, blue force tracking, battle management systems)

The vehicle is equipped with an R&S®SDTR radio with 50 W transmit power, using an R&S®HDR-AJ waveform for tap-proof, wideband VHF/UHF radiocommunications. An R&S®M3TR software defined radio with integrated 150 W amplifier is also installed for IP-based HF radiocommunications in line with STANAG 4538.

Two R&S®HK061 wideband VHF/UHF antennas are mounted to the vehicle front, spaced approximately one meter from each other; an R&S®HV3011 whip antenna is mounted to the rear. An NVIS loop antenna is available for communications in the close HF range. The vehicle also contains two R&S®MR3000P handheld VHF radios to simulate missions involving dismounted soldiers.

The demonstration starts with headquarters requesting a situation report from the command post. Headquarters and command post communicate via a video conference implemented by the R&S®HDR-WB wideband waveform (air data rate 2 Mbit/s). The vehicle then starts patrolling and sends voice messages, pictures and position information simultaneously over an R&S®SDTR radio link using an R&S®HDR-AJ anti-jam waveform. A potential enemy observer is reconnoitered and a corresponding message is sent immediately via the command post to headquarters. As the distance from the command post increases, the patrol vehicle switches to an HF link and continues sending voice messages and position data simultaneously.

The above demonstration shows that the equipment described provides military forces with the ability to compile a situation picture as a basis for decision-making as required for NCO missions.

Uwe Gröner; Michael Fraebel

Demo room with command post.



Offroad vehicle with integrated radio system.



demonstrated by an example scenario for the fictitious Mountainland. In this scenario, the international peacekeeping force has decided to send surveillance patrols to the country's rural areas, which it suspects to be areas of retreat for rebel forces. Helicopters provide air support. The convoy leader can call on the support of joint fire support teams (JFST) in order to counteract attacks by rebel forces. These teams, in turn, can call on support from ships offshore or request air support. All teams and forces involved must be coordinated and controlled, translating into a rapidly increasing demand for secure and reliable communications equipment.

It was precisely this environment – characterized by rapidly changing communications requirements by multiple branches of the armed forces – that Rohde&Schwarz had in mind when developing the new, SCA-based generation of software defined radios. The R&S®SDTR vehicular tactical radio with the R&S®HDR-AJ-NB narrowband waveform is the first member of this family. In 2015, the R&S®SDAR for airborne platforms will follow, and then the R&S®SDSR for stationary/shipborne platforms. The members of the new radio family have a common digital platform, ensuring that waveforms can be used by all branches of the armed forces without any extra porting effort and that they can be easily integrated into other platforms.

Network centric operations – secure and reliable

Military scenarios generate a tremendous amount of digital data: position data of enemy and defending forces operating on land, in the air and at sea, information delivered by a multitude of sensors, terrain data, still and video images supplied by mobile units, as well as biometric and health data. This enormous amount of information needs to be exchanged

between allied forces in order to ensure effective network centric operations. The primary objective of a network centric operational concept is to gain and maintain information superiority so that military commanders can respond flexibly to unexpected and changing situations and act faster than their opponents.

Future military communications networks will be fully IP-based. The next-generation high data rate waveforms – such as the R&S®HDR waveform family – can be seamlessly integrated into existing IP networks, ensuring that data packets are securely and reliably forwarded even to highly mobile units.

The R&S®HDR waveform family from Rohde&Schwarz includes the following variants:

- R&S®HDR-AJ-NB (high data rate anti-jam narrowband), available now

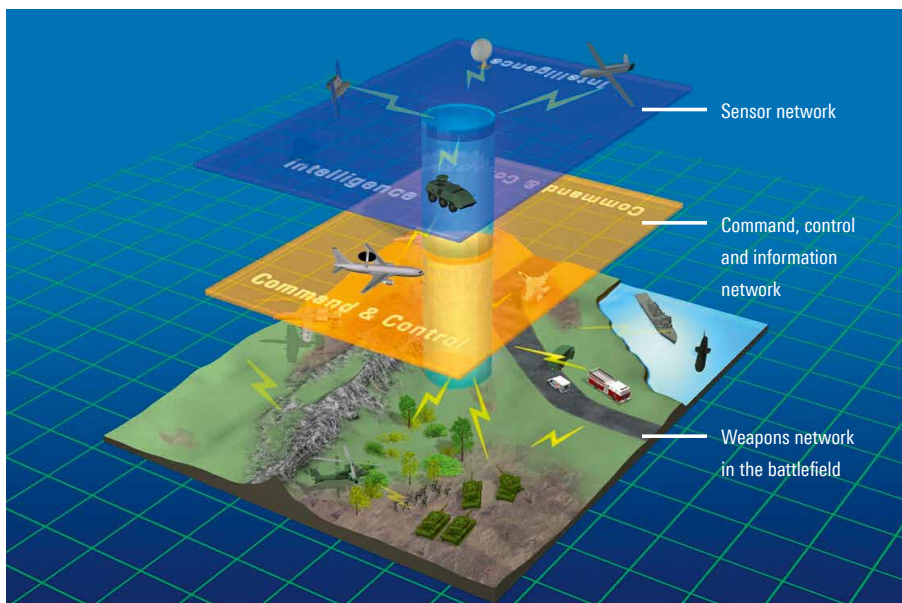
Best possible data rate in tactical VHF range, widest possible range, high jamming resistance, low bandwidth requirements – for uncompromising reliability and wide range in the classic 25 kHz VHF band. The network enabled high-performance narrowband waveform for scenarios involving acute threats.

- R&S®HDR-WB (high data rate wideband), available in late 2013

Mobile networked, high data rate, medium range, adequate jamming resistance – for best radio system performance in terms of networkability and data rate in a controlled environment.

- R&S®HDR-AJ-WB (high data rate anti-jam wideband), available in mid-2014

Mobile networked, medium data rate, wide range, high jamming resistance – a good compromise between reliability and performance. The all-purpose wideband waveform.



Networking across all operational levels is the first and foremost condition for mission success.

Despite extensive command and control capabilities, forces still rely on voice communications for operations control in critical situations. Tactical radios of the new generation must be optimized for this application. If two parallel voice channels are available, a soldier can simultaneously use two radio lines, for example to communicate with neighboring or subordinate units over one line and with the command and control center over the other. The R&S®HDR waveforms and the R&S®SDTR set new standards, using modern voice codecs such as the MELPe vocoder (MELPe – enhanced mixed-excitation linear predictive) and featuring an integrated quality of service (QoS) function for reliable digitized voice transmission.

Secure networking of classified information

Multinational missions require the exchange of information among allies. But what information should be exchanged, and with whom? Some information concerns a country's national interests and should not be made generally accessible. However, there is also a rapidly growing demand for open source information from the Internet, and this information needs to be made available down to the tactical level. These requirements illustrate how important it is to classify data and to separate the communications networks for the various communities of interest. Because vehicles typically offer only a few communications lines, data separation places high demands on the radios' architecture.

The R&S®SDTR perfectly satisfies these demands with a security architecture that features strict separation of plain and encrypted data (red/black separation). This prevents plain data from being transmitted unintentionally via the radio channel.

Transmitted information needs to be protected against eavesdropping by using state-of-the-art encryption methods based, for example, on the advanced encryption standard (AES). Payload data encryption is referred to as communications security (COMSEC) and is an integral function of the R&S®HDR waveforms. In an asymmetric threat scenario, the strict separation of plain and encrypted data and the encryption of payload data often provide adequate protection.

Symmetric threats pose significantly greater challenges. An opponent with a comparable level of technology can be perfectly able to gain access to third-party communications networks, simulate network structures, persistently disturb communications or restrict the availability of services (denial of service). Modern radios, therefore, must be able to protect networks and services against unauthorized manipulation, disruption and reconnaissance. The R&S®SDTR provides this ability, which is referred to as network security (NETSEC), by

encrypting relevant information on the air interface and by using complex protection mechanisms in the waveforms.

Additional protection is provided by complex frequency-hopping methods implemented in the anti-jam (AJ) variants of the R&S®HDR waveform family. Frequency hopping is a transmission security (TRANSEC) technique. It enhances the jamming resistance in networks and therefore raises the sustainability of the defending forces.

The combination of all these features in the R&S®SDTR and the R&S®HDR anti-jam waveforms makes it possible to securely perform even technically challenging missions as described in the Homeland scenario.

Efficient use of resources

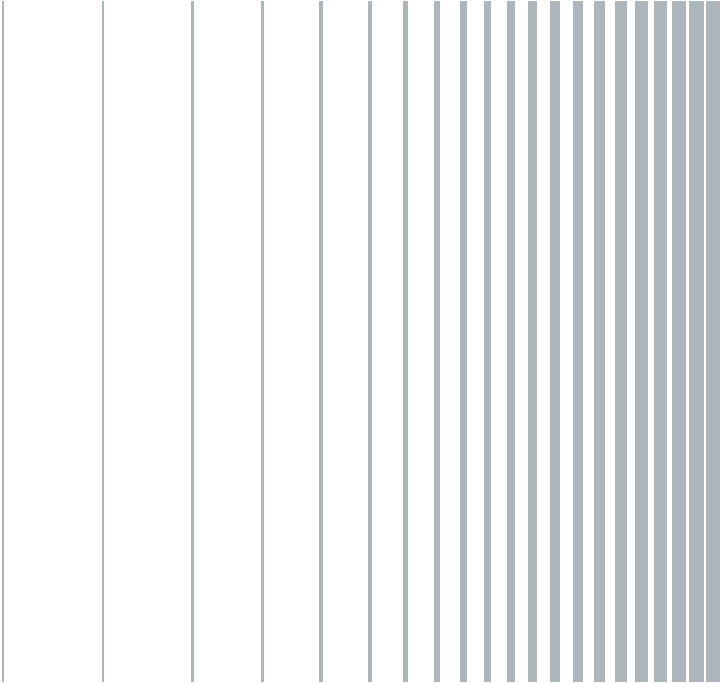
Time, money and personnel – striking the balance between available resources is a key factor in ensuring freedom of action in military missions. During network planning and integration or when adapting to changes in operational requirements, the configuration of today's IP-based radio networks must be adapted to the structure of mobile units and automated to the greatest possible extent. Errors can be avoided through the use of suitable planning software that ensures system consistency. It is crucial that errors be identified during the planning stage and not during operation. To fully support joint operations involving the army, air force and navy, planning tools must encompass all branches of the armed forces. Rohde&Schwarz addresses this need with a suite of tools that supports all members of the new R&S®SDxR family of radios over their entire lifecycle.

Paving the way for 21st century network centric operations

The launch of the new R&S®SDTR tactical radio in conjunction with high data rate waveforms makes it possible for ground forces to move toward 21st century network centric operations. Full integration into existing IP networks, excellent RF characteristics for cosite radio operation, state-of-the-art security architecture – these are just a few of the outstanding features of the new generation of software defined radios, making them ideal for deployment in military operations.

Brochures and more information about the various applications of the new radios can be obtained from Rohde&Schwarz local sales offices or partners. Or register for the "Vigilant Observer" demonstration and discover for yourself the benefits and performance of the new generation of radios (see page 5).

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