



WIR VERSTEHEN DIE ZEICHEN DER ZEIT
KEEPING PACE WITH THE SIGNAL OF TIME

Publication

Automatic Signal Collection Classification and Processing

Communication and Intelligence Technology for a Better Security

Homeland



Sea



Air



Land



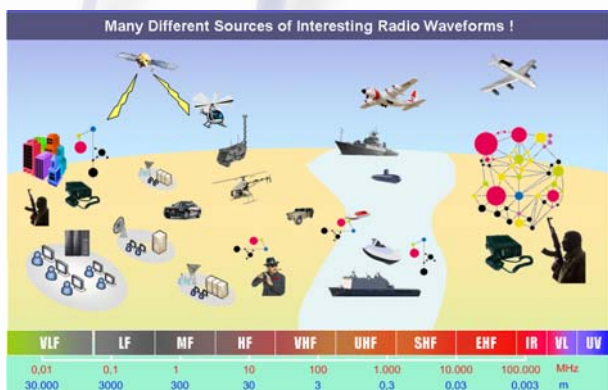
Introduction

COMINT and SIGINT solutions are essential parts of governmental systems to guarantee best support of agencies serving security aspects of different kind.



The signal scenario is determined by different aspects: sources, their operational behaviour, communication technology, and both the social and the communication networks they operate in define the challenges for security agencies. The electromagnetic spectrum of interest reaches from 0-30MHz (HF) up to 3 GHz (VUHF) and above (SHF).

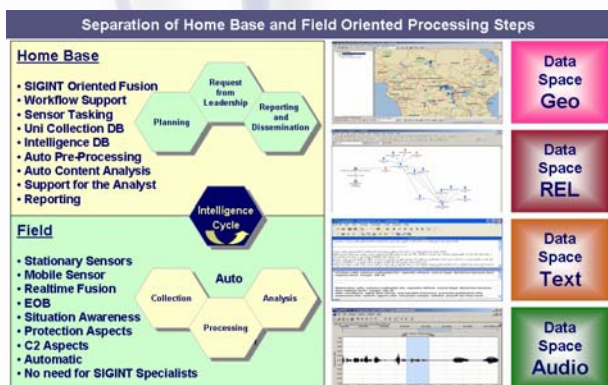
The applied technical solutions should be able to generate a complete overview of the relevant emitters, their deployment, their roles, and the networks they operate in. The map-based visualization of these results in the electronic order of battle (EOB), which can be easily analysed and interpreted by the leaders, is the



direct result in the tactical scenarios. The processes are running in real-time. However, today's operational scenarios do not allow the local involvement of SIGINT experts, so that all the steps of the information chain from the sensor to the EOB must in general be done automatically. Additionally, it is of interest to handle special situations and scenarios in the traditional way: by means of expert's analysis.

Besides the tactical scenarios, the need for strategically oriented information collection and the production of finished intelligence exists. Not only the analysis of meta data, but also content is of greatest value for the interpretation of scenarios. The analysis of content needs operators supporting the generation process of raw reports under simultaneous situational awareness. Intercepts (audio, text, images) must be processed, transcribed, translated, and analysed.

Relationship and event analysis are of highest importance for long-term oriented generation of intelligence reports.

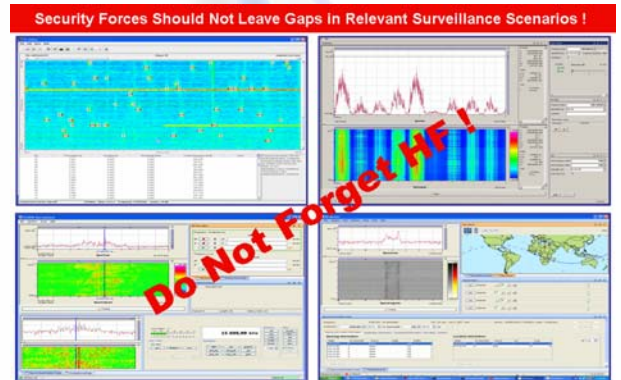


The analysis in the context of geographical information is a need.

The intelligence cycle describes the process from an intelligence request to the corresponding report and is split into two parts: (1) automatic collection, processing and analysis in the field and (2) the detailed strategically oriented analysis with the goal of generating signal and intelligence reports for long-term considerations at the home base.

It is important to realize that the sensors and the first processing steps can be used for both, tactical and strategic purposes, resulting in significant overall cost reductions.

The technological and technical world is determined not only by objective and logical considerations, but also by trends and intuitive decisions in the specification process. Cyber Scenarios are arresting the attention today and should not be put into question. For sure, cyber attacks and the various communication processes based on internet technology must determine general considerations in the design and realization of intelligence and situational awareness production systems. But ! – never leave a gap in the scenario of reconnaissance and surveillance – it would be used immediately by the enemy and terrorist for own benefit.



The traditional communication via HF and VUHF radios are of value for intelligence aspects today and in the future.

Processing Chain

The processing chain starts with the sensor and ends up with the intelligence back office for the strategic oriented end users and, in parallel, the preferably automated generation of the electronic order of battle (EOB) in tactical scenarios.

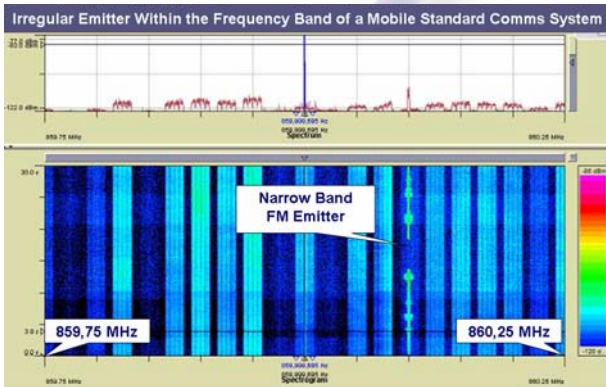
The information flow is organized in steps:

Without any doubt, the acquisition of signals in the electromagnetic scenario is determined by wideband technology. In the past, discussions have been made whether narrowband technology might result in positive technical parameters like dynamic range, sensitivity, probability of intercept etc. Today, all of the experts are convinced that only wideband technology can cover the needs and requirements in the surveillance and analysis of complex waveform scenarios.

Steps in the Information Flow – Tactical – Strategic		
Pre-Processing Steps:		Automatically
■ Wide Band Acquisition		→ IF Signal
■ Detection		→ f, B, TOA, T
■ Classification		→ Waveform
■ Direction Finding, TDOA		→ DF, Localization
■ Demodulation, Decoding		→ Content
Processing & Analysis Steps:		
■ Analysis of Meta Data	(online)	→ EOB
■ Analysis of Content	(offline)	→ Intelligence

The detection process is determined significantly by the a priori knowledge about the signals of interest and the disturbances to be considered. HF is still a challenge as a result of a complex, sometimes chaotic signal scenario. Also in the VUHF, irregular emitters can be found in real world scenarios as the following picture shows. It results from these experiences, that also VUHF scenarios being of interest for the intelligence community might be very similar to the complex and chaotic HF scenario.

The classification of the waveform is of high interest. The waveform is character-



ized not only by instantaneous parameters like carrier frequency, modulation type, shift, baud rate etc., but also by the entire used protocol to optimize the transmission system. Meta data support the identification processes and are basic parameters for demodulators and decoders in the content generation process.

Direction finding is part of the localization process. Interferometer and high resolution methods are applied today. The antenna design, especially for mobile platforms, is a challenge

by itself. TDOA based methods could help to reduce the complexity of the sensor (antenna, tuner, DF procedures) resulting in reduced weight, power consumption and costs.

Demodulators and decoders are essential elements in the content processing chain. An on-going development and upgrade process enables the reconnaissance system to follow current changes in the waveform scenarios.

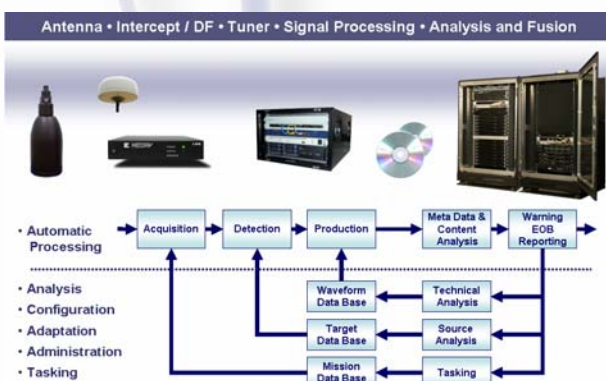
Results of the pre-processing are meta data and content, associated with each of the intercepts.

Meta data are subject of an analysis process based on statistical and rule based methods to automatically generate a map-based EOB, to visualize the emitters, the communication networks and the roles of the emitters in the battlefield or in the threat scenario.

The additional analysis of content, relations, and especially the analysis of events in the past and possibly in the future is a matter of investigation in the strategic oriented analysis.

Technical Solutions

We focus on off-the-shelf solutions covering the steps from the antenna to the automatically processed interception. The relevant keywords are: “off-the-shelf” and “automatically”.



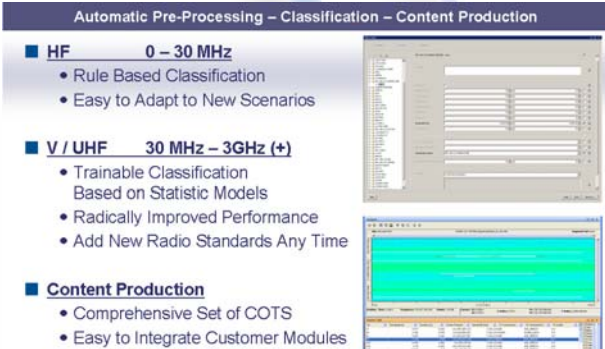
Solutions fulfilling these requirements are available today.

Antennas cover a wide range of applications and platform related specifications. Tuners, designed as universal applicable system components in the interception and the DF signal processing as well, are part of the system design. The detection, identification and classification processes are available for a wide range of waveforms. All processing modules are encapsulated software modules running on standard IT servers and computer systems.

Experiences from Operation

Successful operation of these systems needs a comprehensive understanding of the signal scenario. Signal recording systems of wideband and narrowband signals in combination with in-depth signal analysis capabilities are available. Results of the signal analysis are the basis for the development of processing modules used as plug-ins in the automatic working collection system. The development of the so called Virtual Devices is supported by tools, for example allowing easy integration of high level simulations in the SimuLink environment into the operational machines and systems.

The upgrade processes result in mission specific configurations and the adaptation of the surveillance systems to the current needs and requirements. The technical basis for the effective availability of such growth potential is the software defined intelligence architecture (SDIA), defining the principles and the APIs in the system design.



Automatic Pre-Processing – Classification – Content Production

- **HF 0 – 30 MHz**
 - Rule Based Classification
 - Easy to Adapt to New Scenarios
- **V / UHF 30 MHz – 3GHz (+)**
 - Trainable Classification Based on Statistic Models
 - Radically Improved Performance
 - Add New Radio Standards Any Time
- **Content Production**
 - Comprehensive Set of COTS
 - Easy to Integrate Customer Modules

The signal detection, identification and classification is a result of the application of sophisticated algorithms and methods. Different solutions are available and can be selected according to the signal scenario, the targets, and the missions.

In the HF domain, configurable rule based classifiers are used. The methodology for the combination of separate tools and modules can be defined according to the needs, experiences and the mission. Real-scale assessments, conducted jointly by representatives from end users and MEDAV in order to validate the operational concept, have been passed successfully and with best results in the years 2009 and 2010. It was proven that the performance of operators could be increased by a factor of about 100. Using automated systems, one operator can control more than 200 production channels today, resulting in increased efficiency and significant cost reduction.

Trainable classifiers in combination with a priori knowledge provide a solution not just able to identify waveforms, but also to identify communication services, their providers, and their users. One important resulting feature is the ability of using these capabilities also for the automatic process of identifying unknown and suspect emitters. Successfully passed field tests have proven the effectiveness of these approaches, opening a door in direction of the automation of the direct identification not only of signals, but also of communication services and their users.

Content processing of intercepts is partly performed automatically and also by human operators. The so called SIPAC (signal parameterization, analysis and classification) server supports all automatic processes. Modules for audio, text and image analysis are available. Demodulation, decoding, and also decryption, done by end-user's software, can be integrated into the information flow. The organization and the processing of data and information is controlled by a so called business process management system (BPMS).

Regional, country and mission specific aspects are additionally mapped into special configurations. Target and mission related data bases are updated and define the collection processes. Filter parameters in the domains of time, location, communication services, waveforms and targets are defined in the administration and the tasking of the acquisition systems.

The system structure is a result of the combination and integration of diverse hardware and software and many different technologies into a holistic solution. Aspects from the operational scenario are generating additional complexity. System suppliers as well as the end-users have to cope with the challenges of designing, operating and maintaining systems in an effective and successful way.

The spectrum of available products is: the automatic reconnaissance system

ARS-8000 and the compact reconnaissance system CRS-

8000 are covering today's needs in the area of signal collec-

tion, direction finding and localization. The connecting element

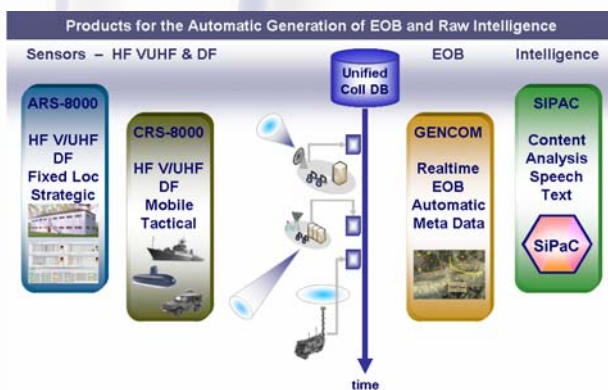
to the post-processing and analysis is the unified collection

data base (UCDB), which is also an important part of the intel-

ligence fusion system IFS-8000. GENCOM generates the

EOB in real-time based on statistical methods. SIPAC per-

forms all content oriented post-processing steps.



Reconnaissance and surveillance solutions, designed and configured on the basis of standard products, a modular and scalable design are today available within short time and at lowest risk.

Additional Aspects

Automation is an important component for the improvement of the efficiency and effectiveness of all SIGINT applications. However, more aspects are of interest in this context and are briefly addressed in the following.

Information and intelligence fusion on the basis of sensor specific results and reports in strategic scenarios is of great benefit. Information technology is available to support the organization and to control all elements in the work flow. The IFS-8000 system is a scalable and flexible framework, fitting into the SDIA concept, allowing the efficient realization and configuration of fusion centres of different kinds.

Additional important aspects are the costs and the handling of all upgrading processes of the system during the entire life cycle. An important element of the SDIA concept is the separation of different kinds of update and upgrade steps.

- Software administration and upgrades with extended functionality can be supported on a regular basis without changing hardware components.
- Computer, IT hardware and system components can be used over a longer period of time, depending on the technological progress and the resulting availability of higher performance. In combination with upgraded software, a higher overall system performance results at lower costs.
- Sensors, as antennas and also the acquisition and recording systems, can be used for the longest period of time.

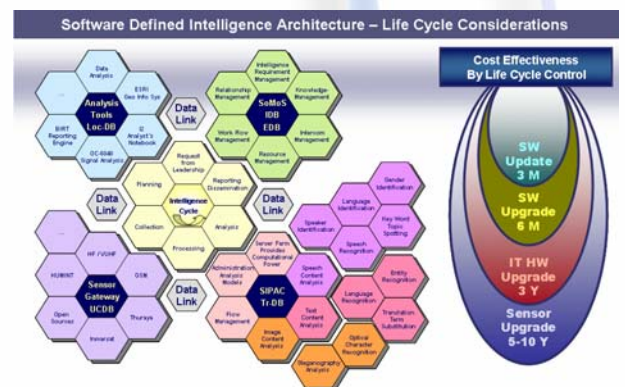
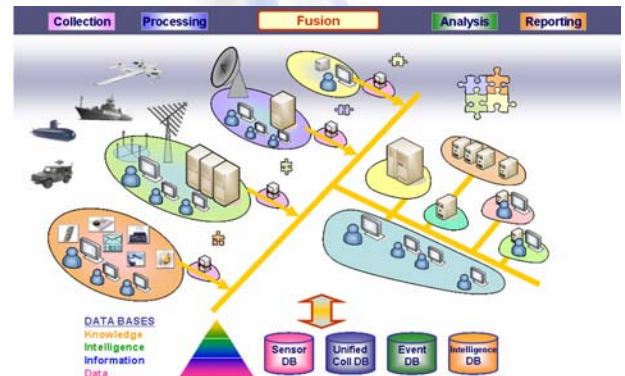
In total, the active control of the life cycle results in significant advantages concerning effectiveness, performance and cost reductions.

1 Conclusion

Technology has reached a level of perfection allowing the extensive automation of the collection, processing and classification processes even in complex or chaotic signal scenarios.

COMINT and SIGINT surveillance and reconnaissance systems are available as proven COTS products within short time of delivery and lowest risk for all involved parties.

Fusion Centres can positively benefit from a proven framework of IT modules in hardware and software. Life cycle considerations should always be part of the system design and include a large potential for cost minimization.



Sensors

Signals

Classification

Content

Information

Intelligence

Corporate Policy

Technology

... in the products, development and in the company management is state-of-the-art and represents a top level.

Quality

... in all divisions of our company is considered as the indispensable prerequisite for a risk-free and successful cooperation with our customers and business partners.

Position in the market

... is affected by extensive experience gained from signal and information processing. We are prepared best to face competition.

Product and engineering spectrum

... are comprehensive, complete and tailored to meet all requirements. As a single source supplier of solutions, we offer standard devices, systems and services.

Employees

... form the roots of the company and render the services necessary for maintaining and expanding the technical basis and a trustful and fair cooperation.

Growth

... on a stable technical and economical basis at home and abroad is our declared long-term goal.

Trust and fairness

... vis-à-vis our business partners and within the company are the basis of our business.

Compliance

... with excessive sensibility and compliance with German and international export regulations we act on a worldwide basis.