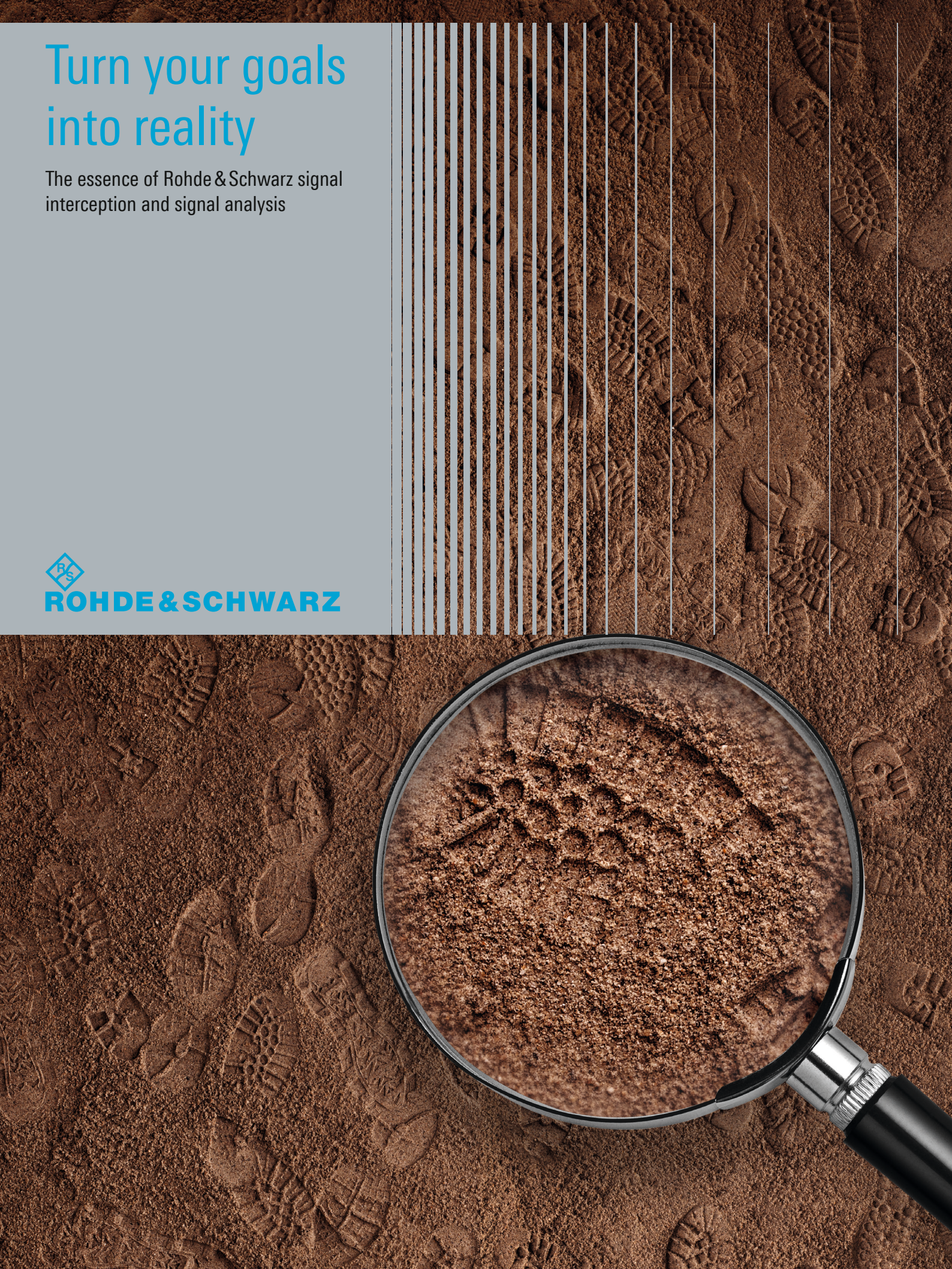
Turn your goals into reality

The essence of Rohde & Schwarz signal interception and signal analysis

ROHDE&SCHWARZ



Typical use cases

You want

- **Comprehensive COMINT** on the ground, at sea and in the air (i.e. intelligence systems in vehicles, surface vessels, submarines and aircraft)
- To achieve **effective radio reconnaissance** and **situational awareness**, through seamless monitoring of radio scenarios by capturing every emission within a large frequency band
- To **reduce the routine workloads** of your operators and **increase the efficiency of surveillance** (quick counteraction), by implementing automatic processes within your workflows
- To **gather strategic intelligence**, intercept emitters and enhance operational benefits, through automatic detection, classification and decoding of signals
- To **gain early warning** of security threats, by "listening in" on analog and digital voice communications using modern handheld radios
- To **exploit the communications pattern** and **obtain the content of the signals**, by recording diverse signal scenarios for post-processing or offline analysis
- To **extend your current system** with additional advanced monitoring features, by integrating the Rohde&Schwarz signal monitoring solution into your customized system via open interfaces

Our aim: to provide an all-in-one solution for coping with the increasing challenges and requirements in signal monitoring

First and foremost, we've succeeded!

Rohde&Schwarz stands for quality, precision and innovation in all fields of wireless communications. Our customers benefit from the extensive experience and expertise Rohde&Schwarz has in systems and equipment for the detection, location, and analysis of radio signals for use in public safety and external security applications as well as radiomonitoring and frequency management in the field of public administration. Our mission is technological leadership through continuous advancement.

The frequency spectrum is limited, but the diversity of applications in mobile, wireless and satellite communications is dramatically increasing. It poses ever-increasing challenges for civilian regulation authorities, intelligence services, security agencies, commercial communities, public and even private services. Undeniably, signal monitoring and interception across wide frequency ranges with different signal scenarios is very challenging. Furthermore, comprehensive signal analysis of unknown and complex emissions demands a great deal of effort. With thousands of signals occupying the frequency spectrum, our mission is to monitor all the target signals, detect signals of interest and identify the unknowns.

With the rapidly increasing demand for signal analysis in radiomonitoring and radiolocation, there is an urgent need for enhanced signal monitoring solutions. A proficient and advanced signal monitoring solution should enable the surveillance of a spectrum segment in order to detect emissions of interest which are then recognized, classified, and further processed. Its workflows might include signal interception, signal surveillance and signal analysis.

Signal surveillance: observing (i.e. targeted monitoring) the occurrence and behavior of specific signals in order to obtain situation awareness of a certain signal scenario. Surveillance systems must be capable of measuring unknown or "unfriendly" transmissions and extract the information content.

Signal interception: searching for, detecting, recording and reporting all signals of interest in a given scenario, often including content extraction by using demodulators and decoders.

Signal analysis: determining the technical signal parameters by performing automatic or manual measurements on live or recorded signals. This might also include using demodulators and decoders to resolve the content of an unknown signal.

Rohde&Schwarz signal analysis solutions are ideal for monitoring the complete signal scenarios – signal interception, signal surveillance and signal analysis.

We understand what you need

Nowadays, due to the explosive increase in activity within the radio spectrum and the ever-increasing density of the signal scenarios, searching for unknown signals is the equivalent of looking for a needle in a haystack. An ideal signal monitoring solution must comb through this "haystack" to find specific signals, effectively and reliably. The need to search for signals of interest in large, densely populated frequency ranges requires automated techniques for signal detection, classification, demodulation and processing, which are becoming the key elements in the design of signal monitoring solutions.

Missions range from the detection and processing of specific signals of interest to the discovery of unknown transmissions within a dense scenario – from classification of all emissions to automated recording and processing of both known and unknown signals according to user-specific criteria.

The challenges of radiomonitoring are on the rise as radio networking sweeps the globe and frequency bands are occupied with thousands of signals. The search for signals of interest in large, densely populated frequency ranges is the equivalent of looking for a needle in a haystack.

Technical requirements

A passion for working closely with our customers and understanding the needs of the market is the driving force behind our ongoing research and development programs. We are constantly expanding the horizons of our signal analysis solutions in order to meet your operational wants and needs. The list below summarizes the technical requirements and the necessary workflows for a complete signal monitoring solution. The listed requirements are comprehensively implemented within the Rohde&Schwarz signal analysis product family.

Your requirement
You need to monitor a large frequency range Covering the entire spectrum in HF/VHF/UHF/SHF as well as continuously detecting and monitoring communications scenarios
You need to intercept a densely populated signal scenario Surveillance of all signals in the frequency ranges of interest (automatic and manual). The solution must provide multichannel capabilities (> 100 processing channels) that allow monitoring of a large number of signals simultaneously
You need to detect known or unknown signals Intercepting of countless analog and digital signals, including fixed-frequency signals, bursts and even frequency agile, short-time emissions

We have what you want

Rohde&Schwarz signal analysis products provide all-in-one signal analysis solutions encompassing:

- Searching for, detection and classification of numerous signal types
- Analysis and characterization of unknown signal types
- Monitoring of signals that range from HF to SHF, covering a comprehensive array of modulation types and transmission systems
- Decoding of a wide range of transmission systems, including voice, text, fax, telemetry, signaling and data
- Analysis of analog and digital signals as well as LPI methods (e.g. frequency agile short-time emissions)
- Fully automatic interception and monitoring of specific signals
- Automatic profile recognition or separation of different frequency agile transmission systems and online recombination of frequency agile short-time signals to a continuous baseband signal
- Automatic classification, recording and content recovery
- Techniques for reducing the time required for detection, search and classification processes, e.g. frequency exclusion list, spectral shape detection and prioritizing
- Technical pulse analysis software offers an extensive set of detection, visualization and measurement tools for analyzing pulsed and FMCW radar signals

Our strategic signal monitoring solution

With our longstanding international experience in the field of radiomonitoring and radiolocation, Rohde&Schwarz is able to offer a wide range of suitable equipment and solutions. Modular concepts and customized solutions are tailored to meet the specific technical requirements of each and every user. The table correlates specific applications with the preceding list of described needs. The result is a clear, concise presentation of real-world issues that are comprehensively addressed by the innovative Rohde&Schwarz technology.

Our approach

Multichannel

- We have a multichannel signal analysis solution, realizing top-class signal processing with DDCs extraction up to HF: 128 / VHF/UHF: 32 channels simultaneously and a realtime bandwidth of up to HF: 20 MHz / VHF/UHF: 80 MHz per receiver. It is especially designed to support search and surveillance workflows for:
- A very large number of parallel signals per wideband receiver (essential for HF monitoring systems)
- Signal scenarios with large frequency ranges
- Detection of wideband signals (essential for VHF/UHF monitoring systems)

Scanning:
We have signal detection using a scanning receiver to cover any frequency range. This enables continuous searching for new emissions across a wide frequency range while processing detected signals in parallel. It is extremely useful to have a complete overview of the signal scenario and then to focus on specific frequency bands or emissions.

Automatic spectral energy detector

We have an advanced detector that automatically performs energy measurements within scan data or I/Q data in order to detect fixed frequency, burst and frequency agile, short-time emissions. Detections can subsequently be processed to automatically classify their modulation type and transmission system. Content recovery may also be achieved depending on the type of signal.

We understand what you need

Your requirement
You need to filter out the targeted or unwanted signals Enabling users to define a priority list with which the detections will subsequently be processed further or ignored
You need to search at high speed for signals of interest Accelerating the recognition of signals of interest in order to search for numerous signal types, fast and comprehensively
You need to classify the signals Reliably recognizing the transmission systems and modulation types. All technical signal parameters are to be automatically measured and updated.
You need to achieve fully automatic signal processing workflow Triggering specific actions (alarm, content extraction, recording, etc.) by detecting certain signals based on the user's predefined rules. A fully automatic signal processing workflow reduces the operator's workload by performing the routine tasks more efficiently and effectively.
You need to extract the signals' content Achieving content recovery (decoded text, graphic output, audio, etc.) by using an extensive library of transmission systems, demodulators and decoders
You need to record and replay multiple signals Enhancing the system capabilities by enabling the recording of entire wideband scenarios or of several individual narrowband scenarios during multichannel monitoring. Multiple I/Q data streams can be recorded in parallel with decoded data and audio content.
You need to create reports or send results to a database The final step in a typical COMINT workflow is the creation of a comprehensive report by consolidating the analysis result from different sensor subsystems.
You need to extend the solution by adding custom modules via open software architecture Extending the standard systems via an open interface that enables straightforward integration of customer-developed signal processing modules, such as demodulator, decoder, transmission system and receiver-driver
You need to measure the unknown signals (technical analysis) Going into detail to characterize unknown signals through measurement of emission parameters such as center frequency, bandwidth, frequency shift, symbol rate and channel spacing. Bitstream analysis is needed for analyzing the unknown channel coding. Performing measurements on live and recorded signals scenarios enables you to determine the technical parameters of unknown signals, effectively and efficiently.

We have what you want

Our approach

Priority list
We have enabled the user to assign priorities to the classification process. Priorities can be assigned based on any parameter provided in a detection result – e.g. frequency, bandwidth, level and status. Priorities can be assigned manually or automatically. Four priority levels are available: High, Medium, Low and Ignore. The principle is that detections with a higher priority are processed first. Use of "Ignore" lets you filter out unwanted detections, hence the overall process of classifying detections will be accelerated and the efficiency of signal analysis can be significantly improved.
You can assign priorities based on a set of conditions which meet your requirements, for example:
- Process the signals with a defined bandwidth first (e.g. 3 kHz)
- Ignore all signals already recognized by the spectral shape detector
- Ignore the particular frequency bands

Spectral shape detector
We have a high-performance spectral shape detector that excels in high speed-signal search, significantly (and consistently) accelerating the signal recognition process. Owing to its unique algorithm, this advanced detector can analyze over 1000 spectral shapes in 1 s, thus ensuring effective monitoring of radio bands of interest and reliable detection of signals even under harsh radio conditions.

Well-established classifier
We have a powerful classifier that automatically recognizes numerous modulation types and transmission systems. Classifications are based on precise measurement of technical signal parameters (bandwidth, level, duration, modulation type, number of channels, symbol rate, shift, etc.). These measurements are fed into a unique decision-tree-based classification algorithm that outputs the measured values along with the classification result. The result is flagged with a confidence value.

Fully automatic processing (rule-based decisions)
We have an impressive solution that combines the benefits of automatic detection and classification with fully automatic processing of signals. Classification results can be used as input for:
- Demodulation and decoding of the signal content, e.g. analog/digital audio, graphics and text
- User-defined rules that decide what further actions should be triggered, e.g. generating an alert message and recording the signal

For example: If a classification result contains a certain transmission type, then inform the operator and record the signal for 60 s. We also provide a script editing tool for writing, editing and testing the rules.

Extensive transmission system library
We have an extensive library of transmission systems, demodulators and decoders (currently over 150 in total). This library enables content extraction (i.e. listening to audio, obtaining decoded texts or image files) of numerous transmission methods, including TETRA, dPMR, PACTOR III, CODAN 3012, CLOVER signals, etc. We are continuously striving to expand this transmission system library.

Recording and replaying
We have enhanced the user's processing capabilities by providing different recording possibilities (up to 80 MHz wideband digital IF) and subsequent replaying of signals for detailed further technical analysis.

Report and database
We have integrated functionality for:
- Sending reporting messages to COMINT database servers
- Integrating signal processing solutions into R&S®RAMON (radiomonitoring) systems

In the case of R&S®RAMON, solutions can combine sensor equipment such as antennas, receivers, direction finders, IT components and reporting/databases. The system controls the workflow between operators at one or more stations and stores the intercepted signals along with the corresponding signal's calculated location in the COMINT database. Operators can evaluate this data as well as establish and update the emissions overview.

Extensibility via open interfaces (well-documented API)
We have an open interface to enable independent extension of signal processing capabilities by the user and integration into existing system solutions. Signal processing modules include the receiver-driver (for the third-party receiver), demodulator, decoder and transmission system. This flexibility enables users to extend and adapt their systems to suit their own specifications and requirements. Plus, if users have their own GUI, our solution can be integrated into their platform.

Technical signal analysis
We have a comprehensive signal processing and signal analysis solution for complex signal scenarios or the measurement of unknown signals. It covers the measurement methods specified in the ITU-R SM.1600 and other recommendations. For unknown signals, this solution offers a variety of representations and tools for analyzing and measuring technical parameters such as bandwidth, symbol rate, number of tones, tone spacing, shift, modulation index, length of guard interval, number of channels, signal duration, symbol valency and modulation type. Challenging tasks such as bitstream analysis and dehopping of frequency agile, short-time emissions can be addressed via additional Rohde&Schwarz products.

Product portfolio

R&S®GX460/465

is a recording/replaying device, ideal for use in signal interception systems and in combination with R&S®CA120/R&S®CA100 multichannel signal analysis and most Rohde&Schwarz receivers and direction finders:

- Sustained data transfer rate for recording baseband I/Q data with a maximum bandwidth of 80 MHz (R&S®GX465)
- Recording of various data formats (I/Q, symbol, image, audio, FFT, etc.)
- Various recording and replaying modes such as continuous recording
- One-page spectrogram summary of recording
- Multiple recordings of various data types in parallel

R&S®CA120

is a flexible and automatic multichannel solution for detecting, classifying and processing radiocommunications signals:

- Automatic interception and monitoring of complete signal scenarios
- High-speed signal search with the spectral shape detector
- Powerful classifier
- Extensive demodulators and decoders library
- Detection of fixed frequency, burst and frequency agile short-time signals
- Fully automatic processing of detected signals
- Modular scalability to over 100-channel signal processing solution
- Open interface

Recording/ replaying

Signal monitoring

Customized modules

Signal analysis applications

R&S®CA100

is a standalone software solution for analyzing, classifying, demodulating and decoding digital and analog IF signals (up to four channels with R&S®ESMD). The software provides powerful signal analysis and signal processing functions running on a Windows PC:

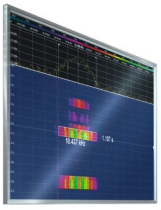
- Signal acquisition and receiver control
- Automatic search and classification of signals in a defined frequency range
- Detection, classification, demodulation and decoding
- Signal recording and replaying

The signal analysis workflow summarizes the necessary applications for a complete signal processing solution.
It represents the comprehensive algorithms and strategies needed to successfully search for, detect, classify, process and analyze signals.

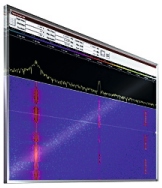
R&S®CA100IS

is an R&S®CA100 option enabling analysis of signal scenarios in line with ITU-R SM.1600:

- Measurement methods specified by the ITU-R SM.1600 recommendation
- Recognition of known or standardized methods
- Time/frequency segmentation for multisignal scenarios
- Advanced visualization
- Tools and functions for analyzing and measuring technical signal parameters such as bandwidth, symbol rate, number of tones, tone spacing, shift, modulation index, length of guard interval, number of channels, signal duration



Technical signal analysis

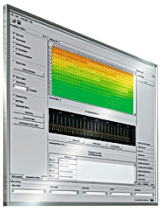


R&S®GX410

is an advanced solution for offline technical analysis of unknown or complex signal scenarios:

- Automatic and manual analysis solutions for fixed frequency, burst signals and frequency agile short-time emissions
- Hopper analysis and recombination
- Time and frequency domain signal analysis for determining technical parameters

Bitstream analysis



R&S®CA250

is powerful software for analyzing and manipulating signals at the bitstream/symbol stream level. It can be used to analyze the characteristics of demodulated signals with unknown coding:

- Bit manipulation functions: inversion, autocorrelation, descrambling, deinterleaving, etc.
- Bitstream analysis functions: structure analysis, entropy analysis, scrambler analysis, convolutional code analysis, etc.
- Extendable alphabet decoder and support for decoder development

Knowledge transfer/training

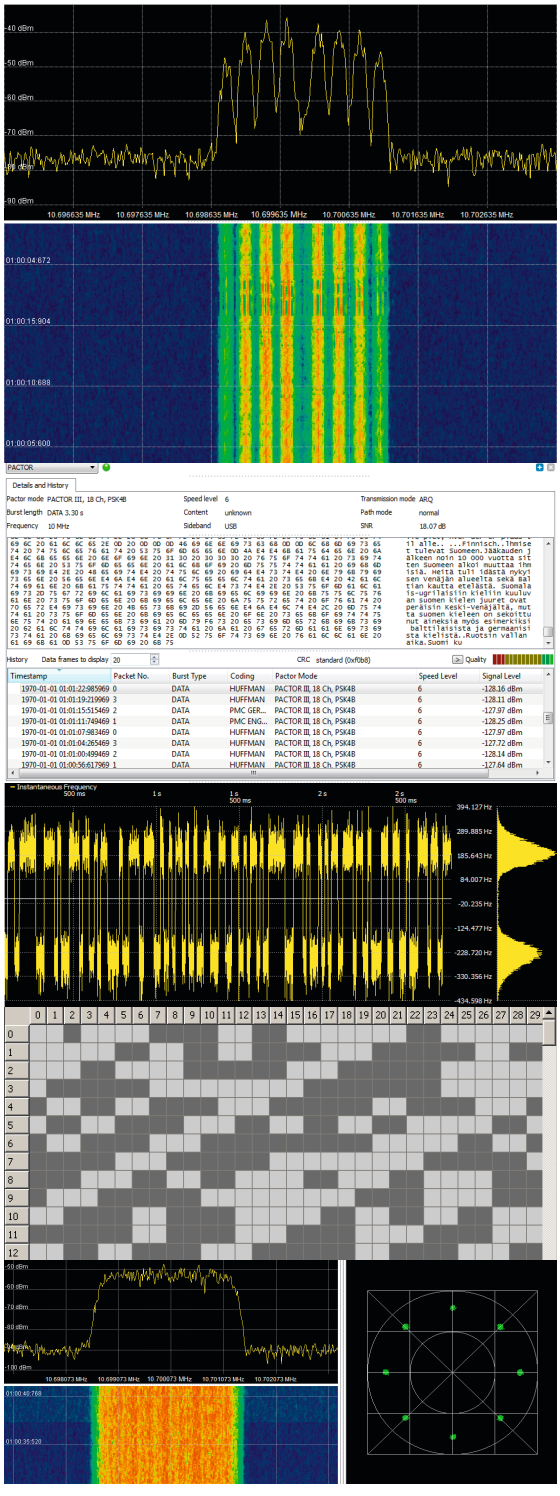
Our motivation: to understand our users' needs and requirements, working closely together with them for knowledge transfer and training in order to provide ideal signal analysis solutions. The result of the demodulator/decoder development will be integrated back into the signal monitoring solution. We provide:

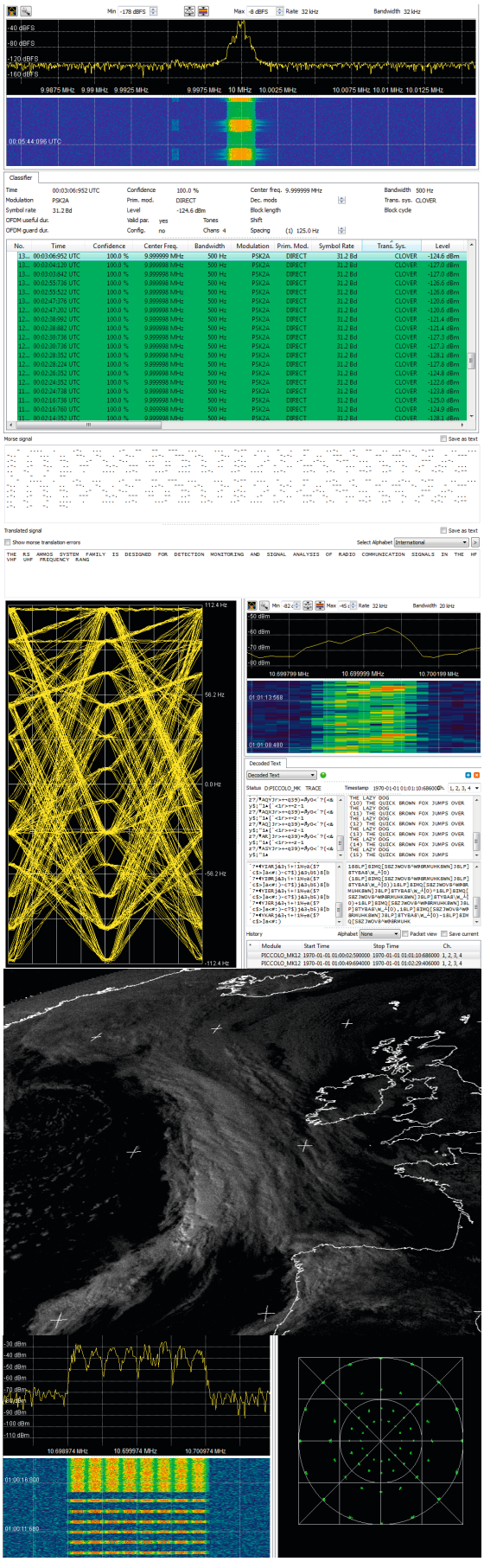
- Detailed manuals and quick start guides to help you get started
- Documented sample and base class functions for the user extensibility open interface configuration and ParamGuiStudio to create the required configuration and parameterization dialogs
- Experienced trainers

Each stage in the workflow is supported by the Rohde&Schwarz signal analysis product family.
Each product is tailored to provide specific functions and applications that cover signal monitoring (online/offline), technical signal analysis, bitstream analysis and demodulator/decoder development.

Signal analysis

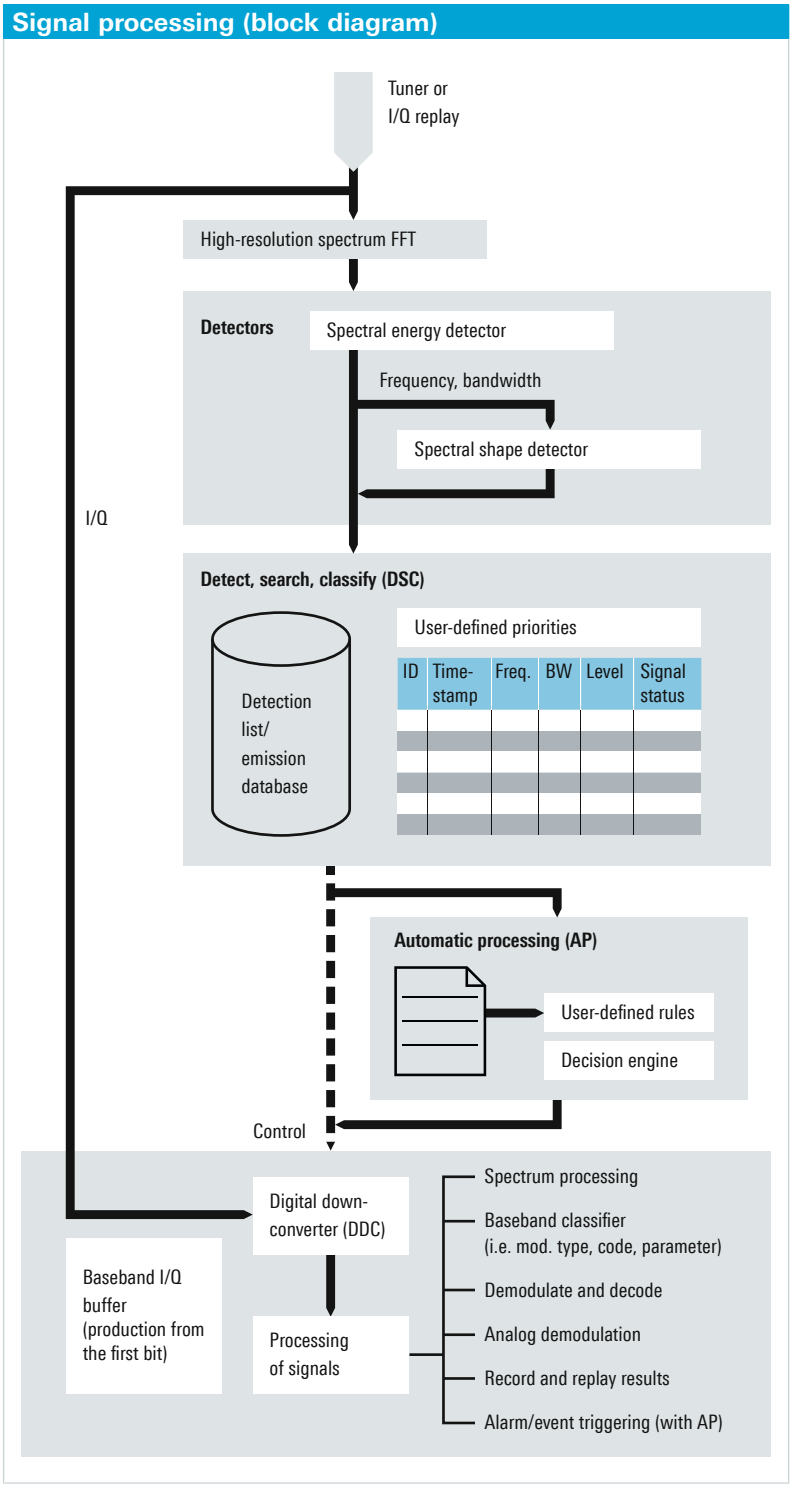
The purpose of signal analysis can be summarized as follows: getting the right information into the right hands at the right time to enable informed and realistic decisions to be made based on current data. Civilian and military users have different and widely varying missions but both rely on the same signal monitoring and processing systems. This section provides a system overview independent of user and use case.





The complete signal processing chain is shown in the figure below. The Rohde&Schwarz signal analysis solution receives I/Q data (live or replayed), and a high-resolution spectrum is computed from this input and fed to the detector. The detector applies a detection threshold to the spectrum, which is adapted to the variable noise floor. The detected emissions can be further processed by the spectral shape detector (SDT), which features a spectral pattern-matching detection technology. Additionally, interception processing channels with baseband classifiers (CL) can be used to automatically recognize the modulation type, the transmission system and the technical signal parameters of each detected signal. The solution provides multichannel capabilities that allow monitoring of a large number of signals simultaneously. The automatic processing (AP) functionality combines the detect, search and classify module with fully automated signal processing based on user-defined rules. This incorporates a variety of functions, including: spectrum processing, baseband classification, demodulation, decoding, recording and alarm/event triggering.

Signal processing (block diagram)



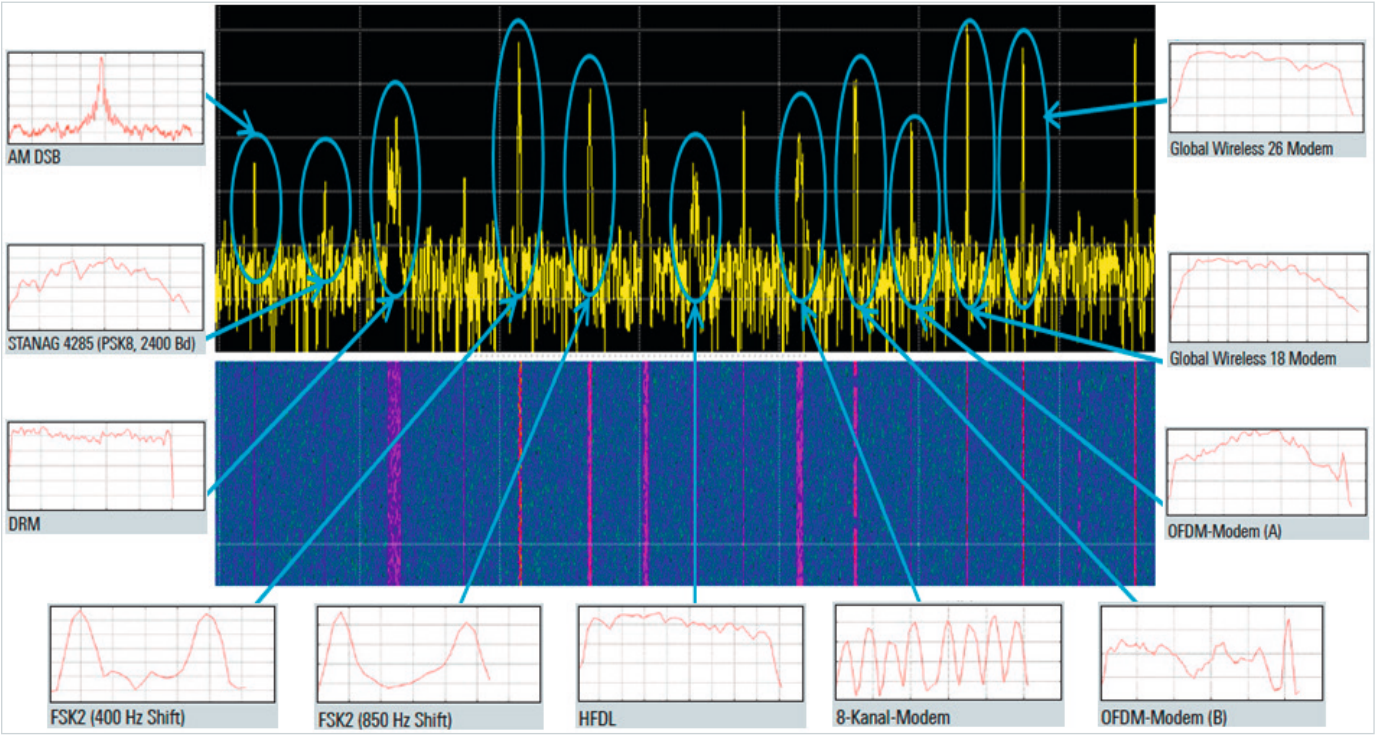
Our highlights

Spectral shape detector

Owing to its spectral matching algorithm, the spectral shape detector implements a high-speed search for known and unknown signals with a processing rate of over 1000 emissions/s. Common shapes are predefined in a generic profile (i.e. CW, AM-DSB, multichannel and FSK signals). User-defined shapes can be generated via the spectral trainer application and combined in custom profiles in order to recognize both known and unknown signals.

The decisions of the spectral matching algorithm are based on many criteria within a comprehensive decision matrix, allowing the similarities between input signals and shape profiles to be reliably assessed. This method is ideal for recognizing and extracting signals of interest, excluding unwanted signals and developing a custom library of identifiable signal types.

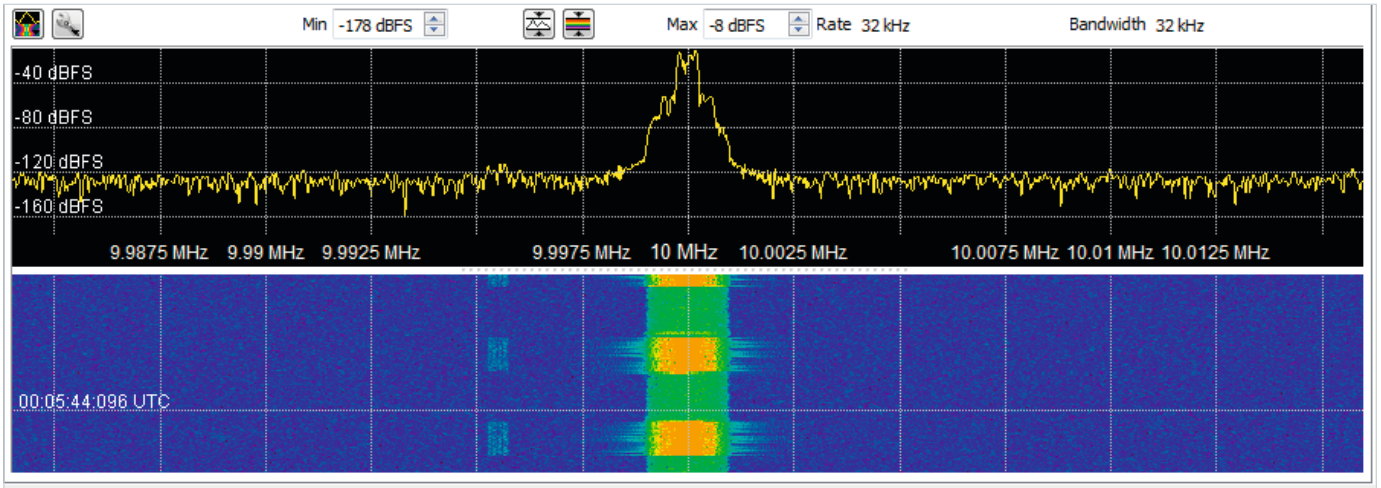
Numerous types of modern communications signals can be recognized by comparing their spectral shapes with predefined reference shapes at very high speed.



Baseband classifier

The baseband classifier is a reliable solution for determining the modulation type, measuring technical parameters and identifying the transmission system of a wide range of analog and digital signals. The baseband classifier is an essential tool for automatic search strategies, as it provides the precise results that are needed to make reliable decisions in the context of the search strategy and signal surveillances. The automatic classification algorithm performs segmentation, modulation analysis and transmission system recognition; this determines the signal's exact center frequency and bandwidth as well as relevant technical signal parameters such as symbol rate, frequency, shift, modulation types, number of OFDM channels and codes.

The classifier continuously measures technical signal parameters such as center frequency, bandwidth, symbol rate, modulation type and transmission system. It recognizes this signal as an HF CLOVER modem with the corresponding parameters.



Classifier

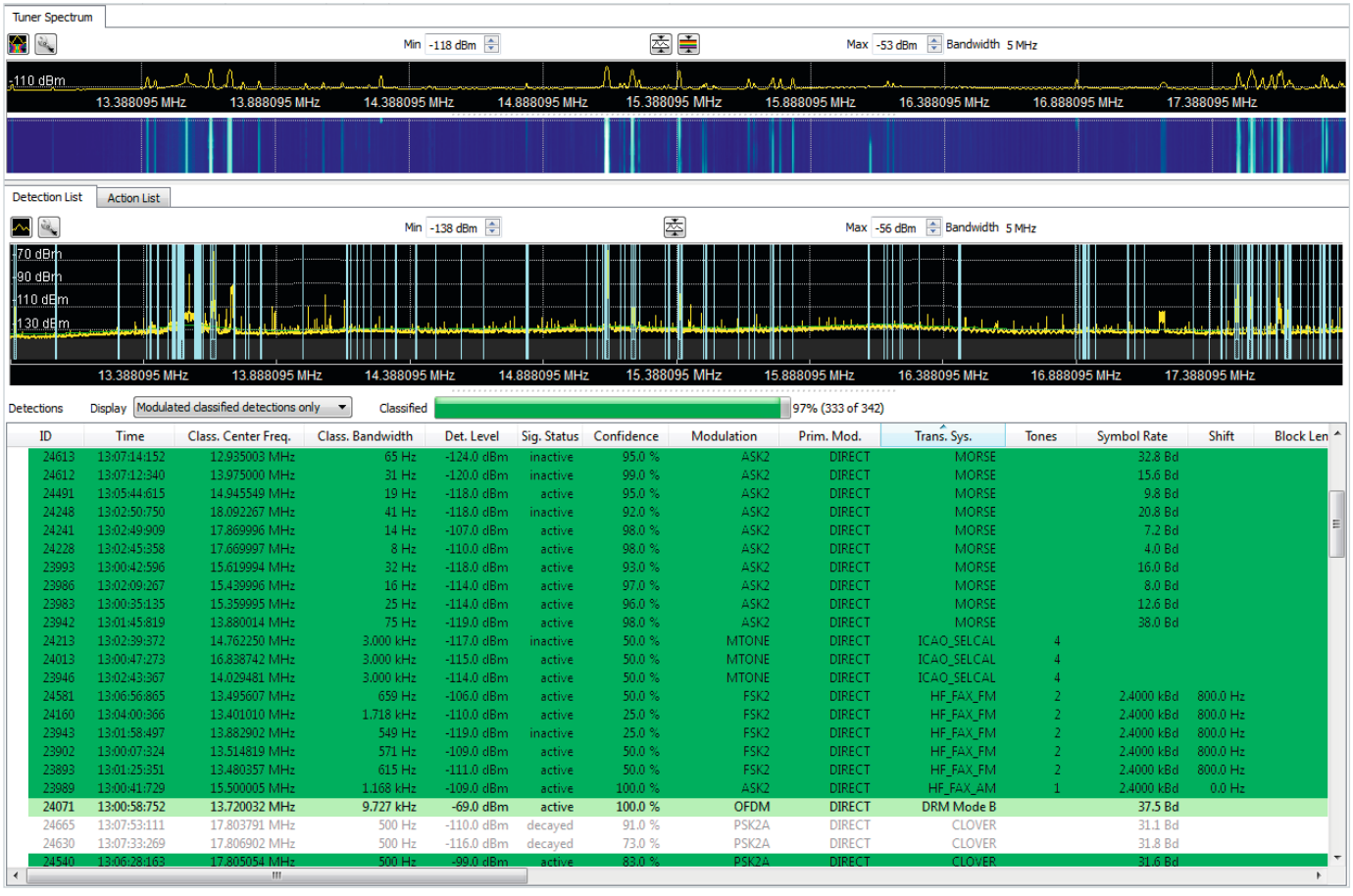
Time	00:03:06:952 UTC	Confidence	100.0 %	Center freq.	9.999999 MHz	Bandwidth	500 Hz
Modulation	PSK2A	Prim. mod.	DIRECT	Dec. mods		Trans. sys.	CLOVER
Symbol rate	31.2 Bd	Level	-124.6 dBm	Block length		Block cycle	
OFDM useful dur.		Valid par.	yes	Tones		Shift	
OFDM guard dur.		Config.	no	Chans	4	Spacing	(1) 125.0 Hz

No.	Time	Confidence	Center Freq.	Bandwidth	Modulation	Prim. Mod.	Symbol Rate	Trans. Sys.	Level
13...	00:03:06:952 UTC	100.0 %	9.999999 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-124.6 dBm
13...	00:03:04:120 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-127.0 dBm
13...	00:03:03:842 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-127.0 dBm
13...	00:02:55:736 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-126.6 dBm
13...	00:02:55:522 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-126.6 dBm
13...	00:02:47:376 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-120.6 dBm
12...	00:02:47:202 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-120.6 dBm
12...	00:02:38:992 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-121.4 dBm
12...	00:02:38:882 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-121.4 dBm
12...	00:02:30:736 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-127.3 dBm
12...	00:02:30:736 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-127.3 dBm
12...	00:02:28:352 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-128.1 dBm
12...	00:02:28:224 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-127.8 dBm
12...	00:02:26:352 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-124.8 dBm
12...	00:02:24:352 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-122.6 dBm
11...	00:02:24:738 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-123.8 dBm
11...	00:02:16:736 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-125.0 dBm
11...	00:02:16:760 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-124.9 dBm
11...	00:02:14:352 UTC	100.0 %	9.999998 MHz	500 Hz	PSK2A	DIRECT	31.2 Bd	CLOVER	-128.1 dBm

Multichannel signal analysis

The typical use case in signal processing and signal analysis is to monitor a large frequency range, which covers the entire HF/VHF/UHF/SHF spectrum, as well as to continuously detect and monitor communications scenarios. Multichannel signal analysis capability that allows simultaneous monitoring of a large number of signals is essential to intercept a densely populated signal scenario and monitor all signals in the frequency ranges of interest (automatic and manual). The multichannel signal analysis solution digitally downconverts signals to simultaneously extract up to 128 HF and 32 VHF/UHF channels, with a realtime bandwidth of up to 20 MHz (HF) and 80 MHz (VHF/UHF) per receiver.

The 5 MHz wide HF signal scenario is processed with more than 100 parallel channels, classifying the technical signal parameters and the transmission system types in parallel. Multichannel signal analysis capability is essential for processing a large number of signals simultaneously in signal scenarios within large frequency ranges.

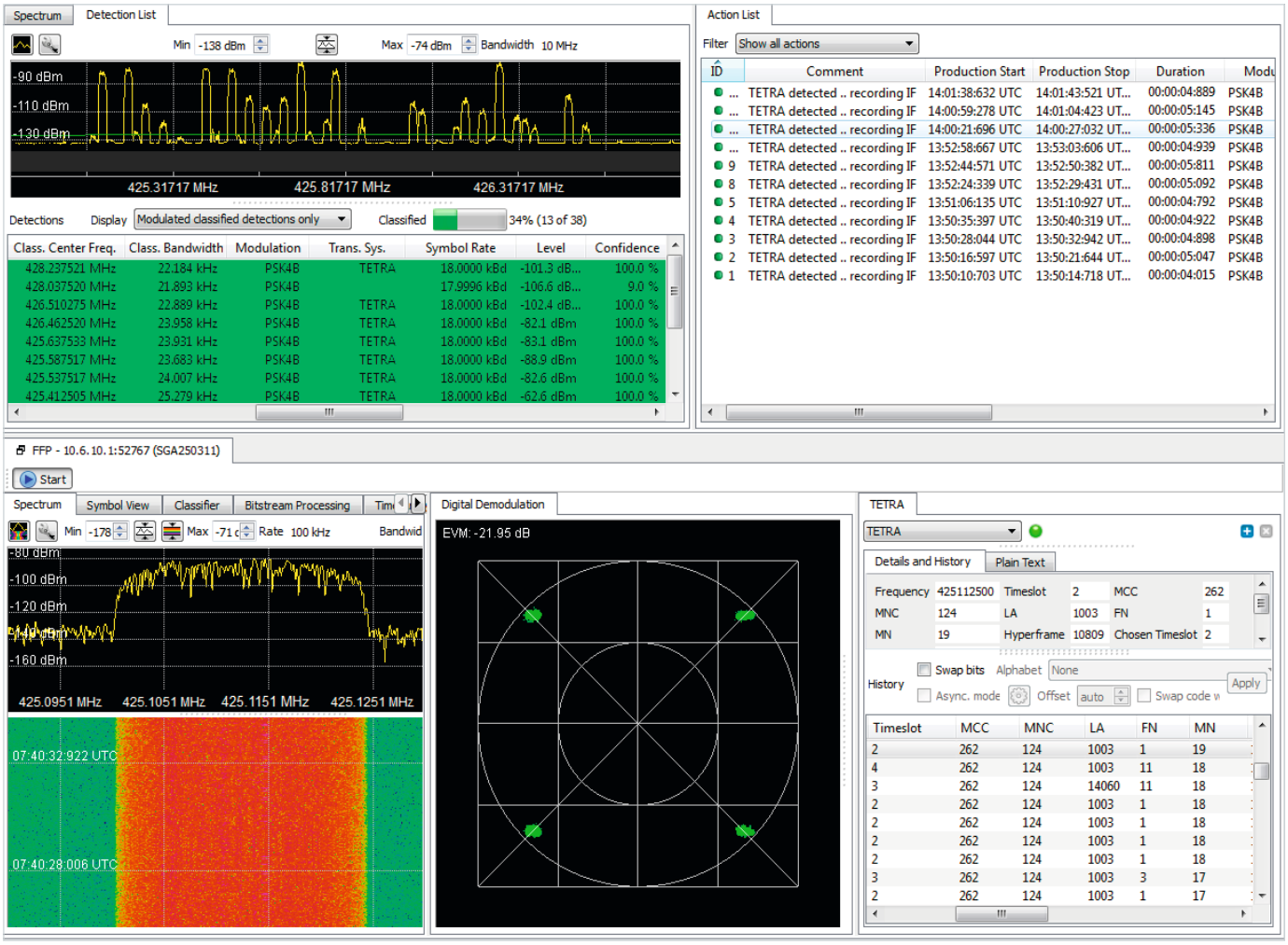


ID	Time	Class. Center Freq.	Class. Bandwidth	Det. Level	Sig. Status	Confidence	Modulation	Prim. Mod.	Trans. Sys.	Tones	Symbol Rate	Shift	Block Len
24613	13:07:14:152	12.935003 MHz	65 Hz	-124.0 dBm	inactive	95.0 %	ASK2	DIRECT	MORSE		32.8 Bd		
24612	13:07:12:340	13.975000 MHz	31 Hz	-120.0 dBm	inactive	99.0 %	ASK2	DIRECT	MORSE		15.6 Bd		
24491	13:05:44:615	14.945549 MHz	19 Hz	-118.0 dBm	active	95.0 %	ASK2	DIRECT	MORSE		9.8 Bd		
24248	13:02:50:750	18.092267 MHz	41 Hz	-118.0 dBm	inactive	92.0 %	ASK2	DIRECT	MORSE		20.8 Bd		
24241	13:02:49:909	17.869996 MHz	14 Hz	-107.0 dBm	active	98.0 %	ASK2	DIRECT	MORSE		7.2 Bd		
24228	13:02:45:358	17.669997 MHz	8 Hz	-110.0 dBm	active	98.0 %	ASK2	DIRECT	MORSE		4.0 Bd		
23993	13:00:42:596	15.619994 MHz	32 Hz	-118.0 dBm	active	93.0 %	ASK2	DIRECT	MORSE		16.0 Bd		
23986	13:02:09:267	15.439996 MHz	16 Hz	-114.0 dBm	active	97.0 %	ASK2	DIRECT	MORSE		8.0 Bd		
23983	13:00:35:135	15.359995 MHz	25 Hz	-114.0 dBm	active	96.0 %	ASK2	DIRECT	MORSE		12.6 Bd		
23942	13:01:45:819	13.880014 MHz	75 Hz	-119.0 dBm	active	98.0 %	ASK2	DIRECT	MORSE		38.0 Bd		
24213	13:02:39:372	14.762250 MHz	3.000 kHz	-117.0 dBm	inactive	50.0 %	MTONE	DIRECT	ICAO_SELCAL	4			
24013	13:00:47:273	16.838742 MHz	3.000 kHz	-115.0 dBm	active	50.0 %	MTONE	DIRECT	ICAO_SELCAL	4			
23946	13:02:43:367	14.029481 MHz	3.000 kHz	-114.0 dBm	active	50.0 %	MTONE	DIRECT	ICAO_SELCAL	4			
24581	13:06:56:865	13.495607 MHz	659 Hz	-106.0 dBm	active	50.0 %	FSK2	DIRECT	HF_FAX_FM	2	2.4000 kBd	800.0 Hz	
24160	13:04:00:366	13.401010 MHz	1.718 kHz	-110.0 dBm	active	25.0 %	FSK2	DIRECT	HF_FAX_FM	2	2.4000 kBd	800.0 Hz	
23943	13:01:58:497	13.882902 MHz	549 Hz	-119.0 dBm	inactive	25.0 %	FSK2	DIRECT	HF_FAX_FM	2	2.4000 kBd	800.0 Hz	
23902	13:00:07:324	13.514819 MHz	571 Hz	-109.0 dBm	active	50.0 %	FSK2	DIRECT	HF_FAX_FM	2	2.4000 kBd	800.0 Hz	
23893	13:01:25:351	13.480357 MHz	615 Hz	-111.0 dBm	active	50.0 %	FSK2	DIRECT	HF_FAX_FM	2	2.4000 kBd	800.0 Hz	
23989	13:00:41:729	15.500005 MHz	1.168 kHz	-109.0 dBm	active	100.0 %	ASK2	DIRECT	HF_FAX_AM	1	2.4000 kBd	0.0 Hz	
24071	13:00:58:752	13.720032 MHz	9.727 kHz	-69.0 dBm	active	100.0 %	OFDM	DIRECT	DRM Mode B		37.5 Bd		
24665	13:07:53:111	17.803791 MHz	500 Hz	-110.0 dBm	decayed	91.0 %	PSK2A	DIRECT	CLOVER		31.1 Bd		
24630	13:07:33:269	17.806902 MHz	500 Hz	-116.0 dBm	decayed	73.0 %	PSK2A	DIRECT	CLOVER		31.8 Bd		
24540	13:06:28:163	17.805054 MHz	500 Hz	-99.0 dBm	active	83.0 %	PSK2A	DIRECT	CLOVER		31.6 Bd		

Fully automatic processing workflow

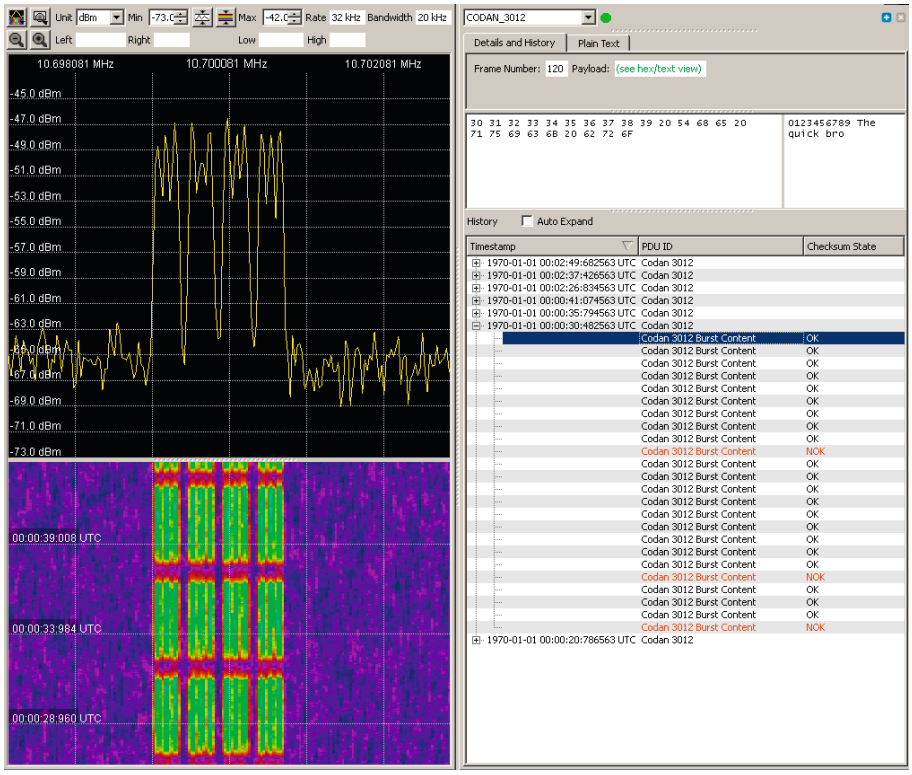
The fully automatic processing of detected signals reduces the workload of a radio monitoring operator. Mundane jobs such as waiting for a certain signal to reappear can be automated, freeing up time for other analysis tasks. Routine tasks such as monitoring a certain frequency range and recording particular known or unknown signals can also be automated. Again, this makes more time available for the operator to concentrate on more important or demanding analysis tasks.

Fully automatic signal processing (e.g. content extraction, recording, notification) with user-defined rules. The action list triggered by certain information is consolidated and displayed. In this example, digital IF recording will be triggered automatically once the TETRA signal is detected. The target signal is replayed to obtain the spectrum view, digital demodulation view (constellation diagram) and decoded TETRA signal with transmission details.

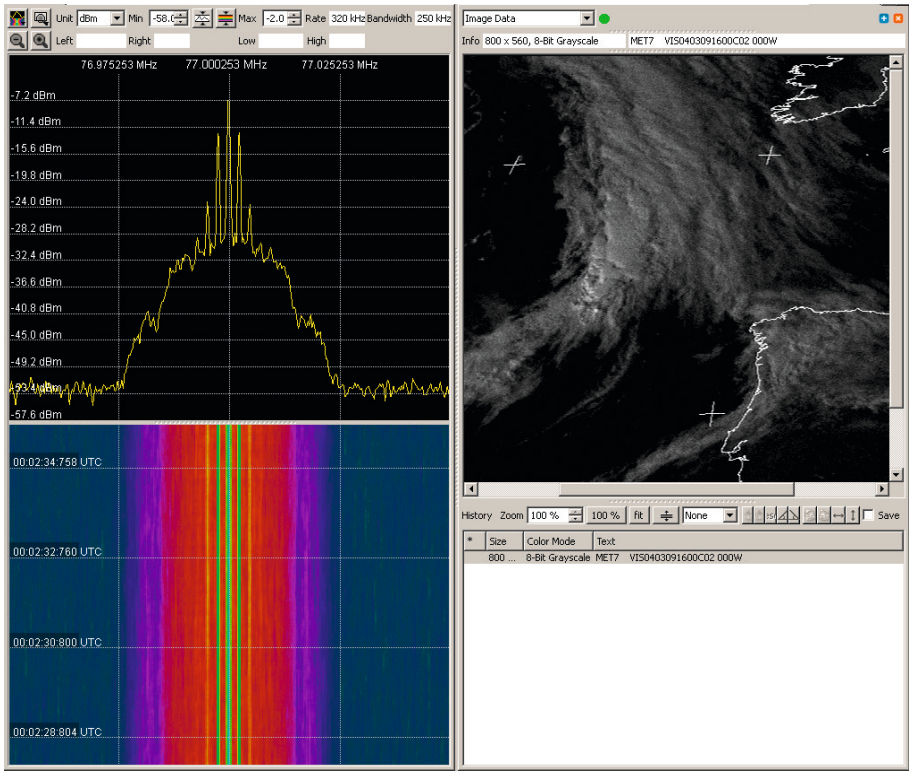


Extensive transmission system library

An extensive library of transmission systems, demodulators and decoders (currently over 150 in total) enables content extraction (i.e. listening to audio, obtaining decoded texts or image files) of numerous transmission methods, including TETRA, dPMR, PACTOR III, CODAN 3012, CLOVER signals, etc.



Content recovery from CODAN 3012 (above) and METEOSAT Wefax signals (below).



Open interfaces

To ensure flexibility, the open programming and extensibility interfaces provide the capability to integrate user-specific modules for signal processing (receiver driver for the third-party receiver, demodulator, decoder, transmission system). Plus, if users have their own GUI, the Rohde&Schwarz solution can be integrated into their platform. As a result, users can independently deploy their own expertise in solutions. The signal analysis solution has an open, documented application programming interface (API) for this purpose.

Open interface to integrate customer-developed signal processing modules such as demodulators, decoders and receiver drivers. The C++ interface for integrating user modules, a detailed and documented integration manual, and training packages for knowledge transfer are provided.

```
//! Create and send a "transmission system result" frame (text message)
int dd_send_text_data(typDDParams *ptrTypDDParams,
                                          typOwnParams *ptrTypOwnParams,
                                          ptypBIGTIME bigtimeTime,
                                          void *voidPtrParent)
{
    char strMsgBuf[80];
    unsigned int uMsgLen, uMsgLen32Bit, uFrameSize;
    char *cDest;

    typTRANSMISSION_SYSTEM_RESULT_FRAME *ptrTextDataFrame;


    // ---------------------- Prepare data ---------------------------------------
    uMsgLen = sprintf(strMsgBuf, "Configuring. Audio: %s  Decimation step: %3u",
        (ptrTypDDParams->eAudioOnOff == GX_AUDIO_ON) ? "On " : "Off",
        ptrTypDDParams->uDecimation);

    // Length of the text message in bytes after 32-bit alignment
    uMsgLen32Bit = uMsgLen/pdemSIZEOF(ptypUINT);
  if(uMsgLen % pdemSIZEOF(ptypUINT))
    uMsgLen32Bit++;  // there a still less than 4 chars available - you need one more 32 Bit Word
```

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