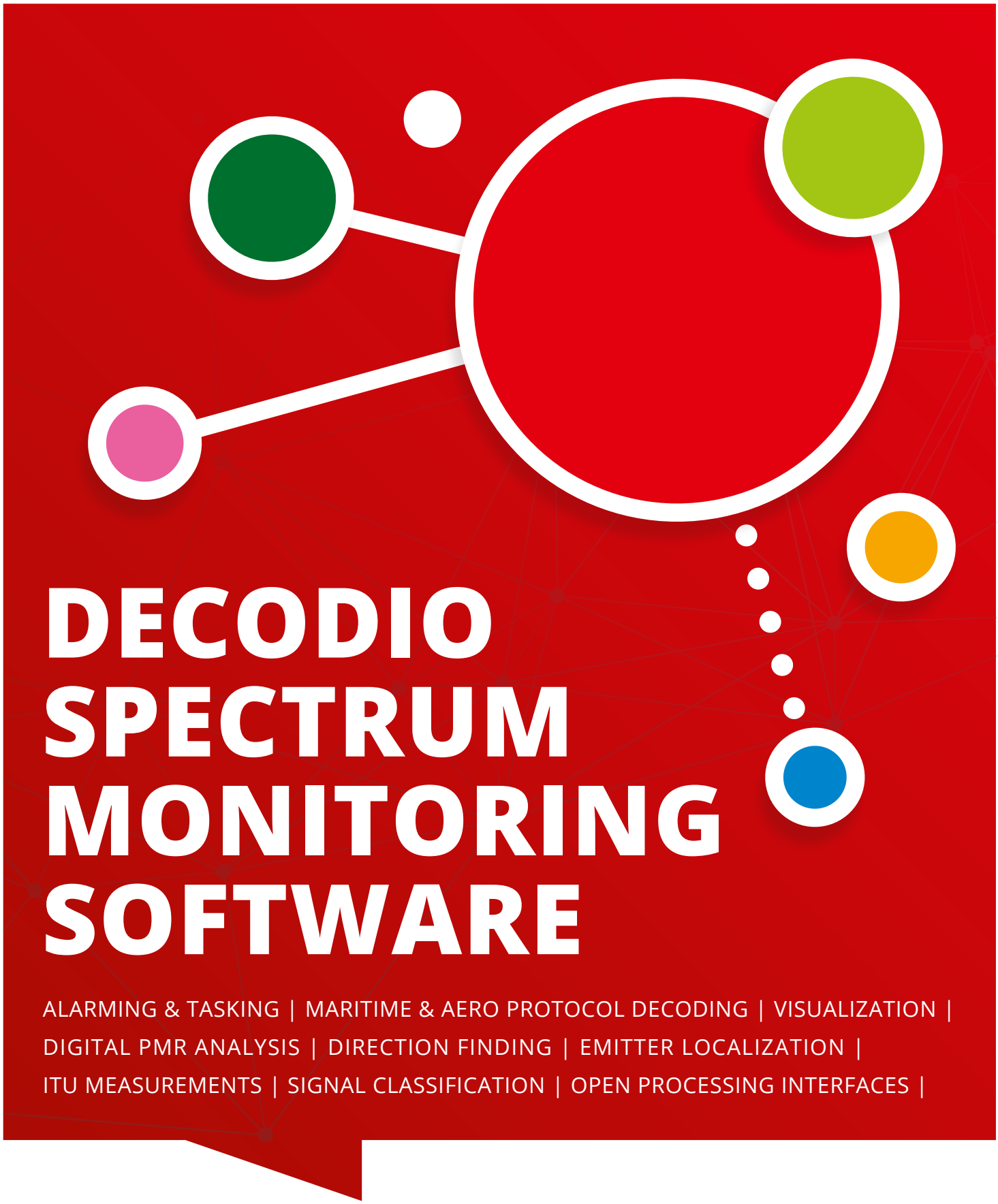


# DECODIO SPECTRUM MONITORING SOFTWARE

ALARMING & TASKING | MARITIME & AERO PROTOCOL DECODING | VISUALIZATION | DIGITAL PMR ANALYSIS | DIRECTION FINDING | EMITTER LOCALIZATION | ITU MEASUREMENTS | SIGNAL CLASSIFICATION | OPEN PROCESSING INTERFACES |

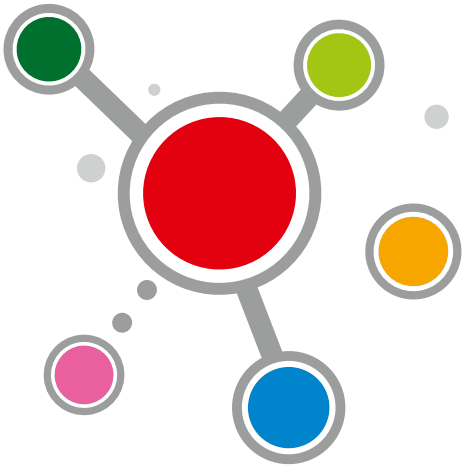
Decodio

www.decodio.com

**DETECT | DECODE | LOCALIZE**

# DECODIO SOFTWARE OVERVIEW

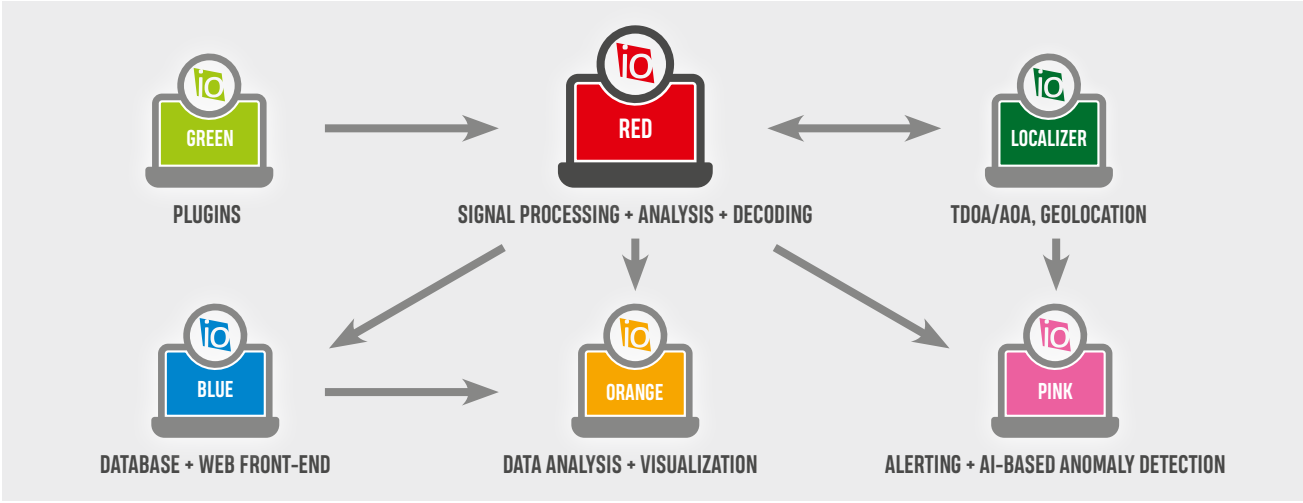
## Flexible, agile, and innovative



We place these tenets at the forefront of our software design, providing field-proven and innovative systems for electromagnetic spectrum operations (EMSO). In this way, we ensure that you stay ahead of the fast-paced changes within the contested electromagnetic spectrum.

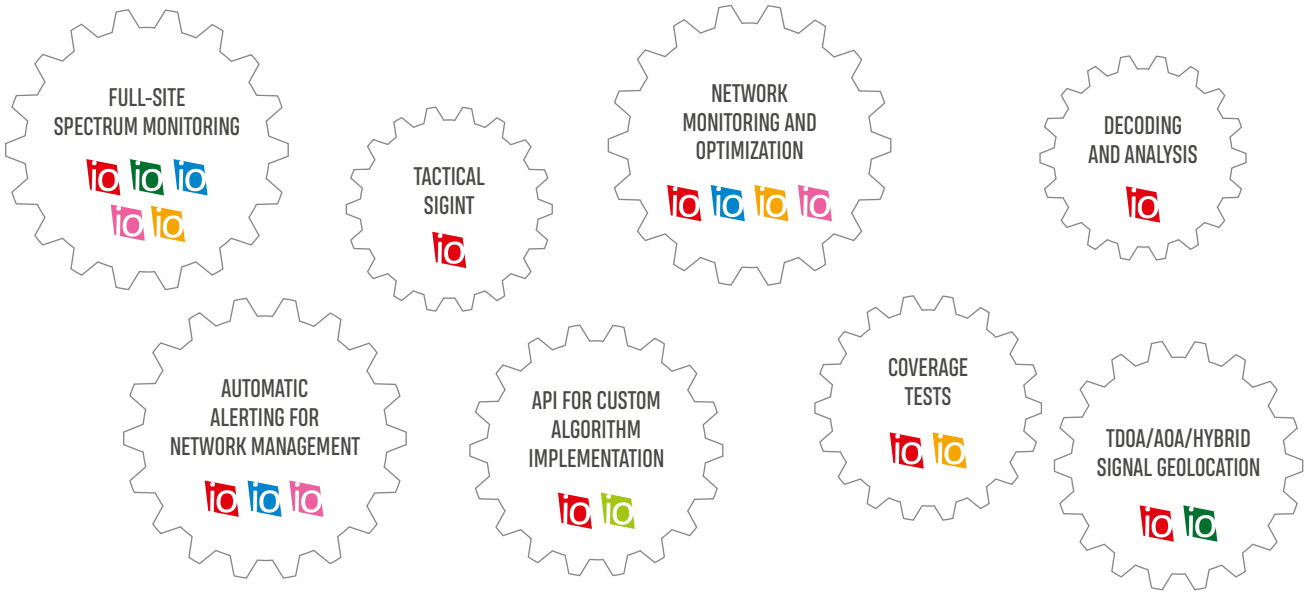
Decodio software is lightweight enough to run on laptops and regular PCs, which makes it suitable for mobile operations. We integrate an ever-increasing number of spectrum monitoring receivers, low SWaP software-defined radios, and direction-finding (DF) receivers from top industry names.

Our software can be easily integrated into existing systems and monitoring sites. We provide an open API for control, data exchange, and logging via TCP/UDP connections (e.g., using ASTERIX or JSON ) or files (e.g, text or PCAP).

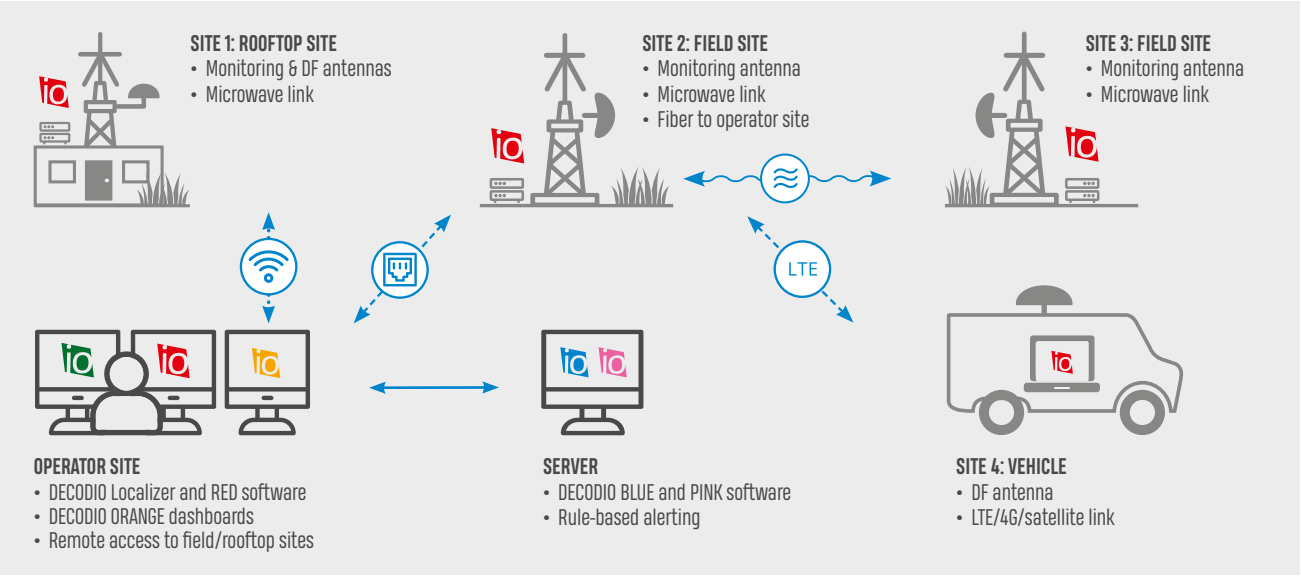



## Custom software pairings and configurations

EASILY MATCH DECODIO SOFTWARE TO YOUR NEEDS



## Endless deployment and remote configuration options




Link together deployed sensors using multiple network pathways and a VPN. Upgrade your established spectrum monitoring sites or place additional expeditionary field sensors, vehicles, or manpack devices in hard-to-reach places.

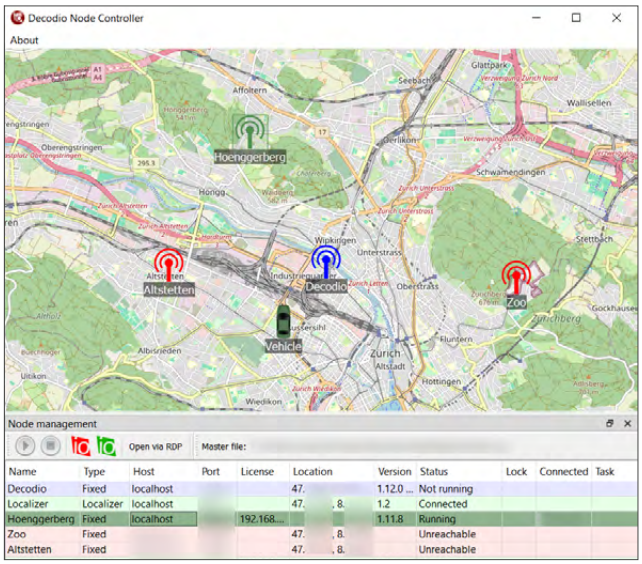
Decodio software enables a single user to remotely access distributed sites across vast distances. Signal acquisition and processing are performed at the same location—only decoded data and control commands are exchanged with other sites. This ensures reliable operations even over unstable or limited networks like satellite links or radios designed for mobile ad-hoc networks (MANETs).

## Full-site monitoring

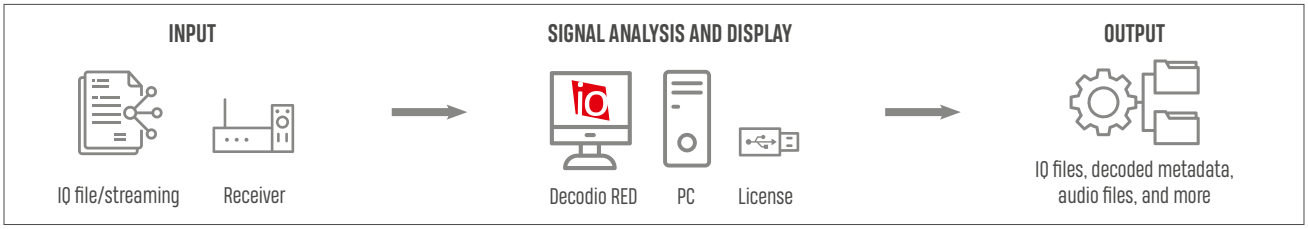
**CONTROL**: Access Decodio RED either locally or remotely. The remote interface supports even low-bandwidth network connections, through which you can verify and change the activity of your site. You can also choose to control RED through a JSON API interface over a TCP connection, which enables a flexible GUI-less operation.

**MONITOR**: See the status of your entire network at a glance through our NODE CONTROLLER command window. You can verify the health of your stations, see their location on the map, check which users or devices are connected to each station, and directly connect to your RED or Localizer sites—everything from one place.

**RELY**: Decodio RED automatically restarts after power outages and reloads all your tasks to ensure continuous operation even in challenging environments.




*Decodio Node Controller: Monitor and command the status of your entire network at a glance*



# DECODIO RED

## The Swiss army knife of spectrum monitoring

- Runs on laptops, PCs
- Supports hundreds of parallel analog and decoding streams
- Decodes voice and data radio protocols including PMR, aeronautical, and maritime
- Displays decoded locations on maps
- Integrates 20+ RF and DF receivers
- Supports open interfaces (e.g., TCP/UDP input/output streams, VITA 49)
- Outputs advanced protocol information for encryption analysis
- Easily integrated into existing systems
- Automates tasks
- Compatible with Windows 10/11, GNU/Linux (Debian and Ubuntu)

### COMPREHENSIVE DECODING

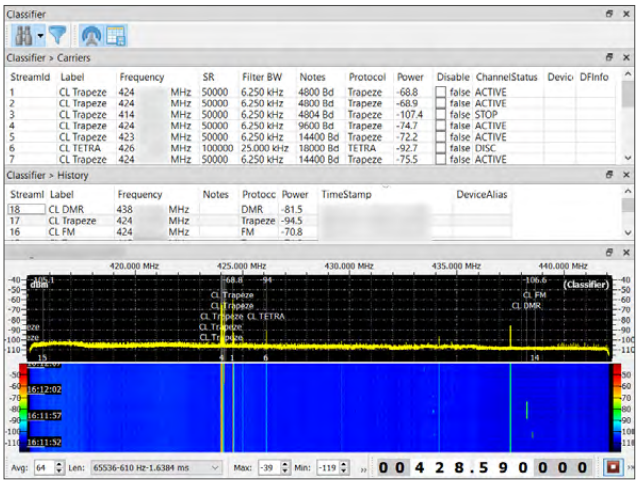
RED supports standard analog modulations and full decoding of voice, content, payload, and metadata for all major PMR/LMR protocols (TETRA, TETRAPOL, dPMR, DMR, NXDN, P25 and more), as well as aeronautical and maritime modes (ADS-B, VDLM2, ACARS, AIS). Never miss important transmissions thanks to our automatic signal detection, classification, and decoding.

### SIGNAL EXTRACTION, RECORDING, AND STREAMING

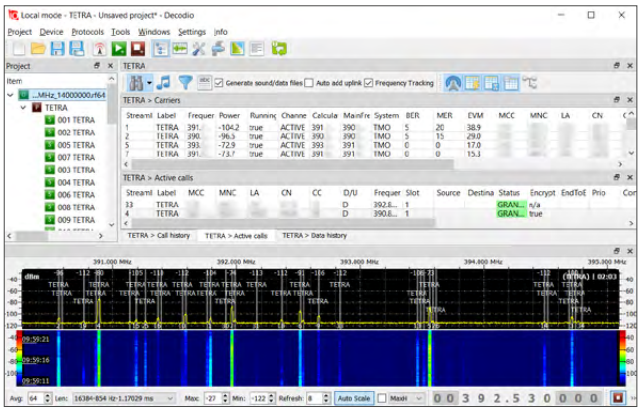
Extract narrowband channels, demodulate signals, record narrowband or wideband streams for offline analysis—all using modern software-defined radio (SDR) techniques. RED is a powerful software that supports up to 500 analog and decoding streams in parallel (depending on the CPU performance).

### DIRECTION FINDING

Control your single or multichannel DF receiver remotely directly from within Decodio RED. Analyze the results with lines of bearing and heat maps displayed on customizable maps.



*Signal analysis using the advanced protocol classifier*



*Automatic TETRA decoding and metadata display*

### SIGNAL ACQUISITION

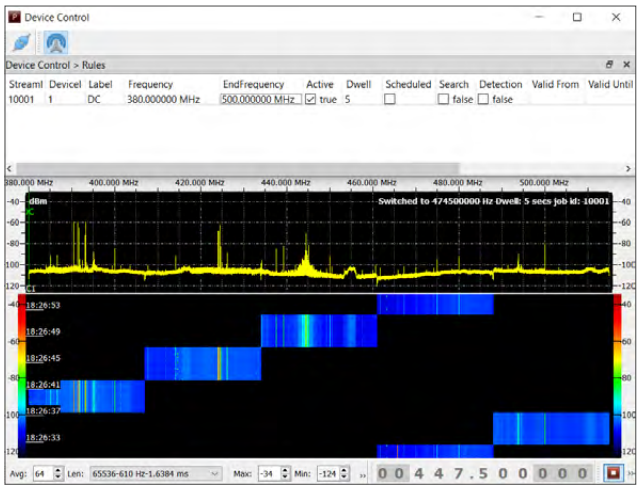
RED integrates 20+ RF and DF receivers from top industry vendors, allowing you to easily interface the software with your existing hardware. Besides RF receivers with up to 100 MHz of instantaneous bandwidths, RED also supports as inputs saved IQ files and VITA 49 network streams. You can easily adjust the settings of supported receivers, scan large portions of the frequency spectrum, or overlap spectrum snapshots from different receivers.

### SPECTRUM PLANNING AND REGULATION

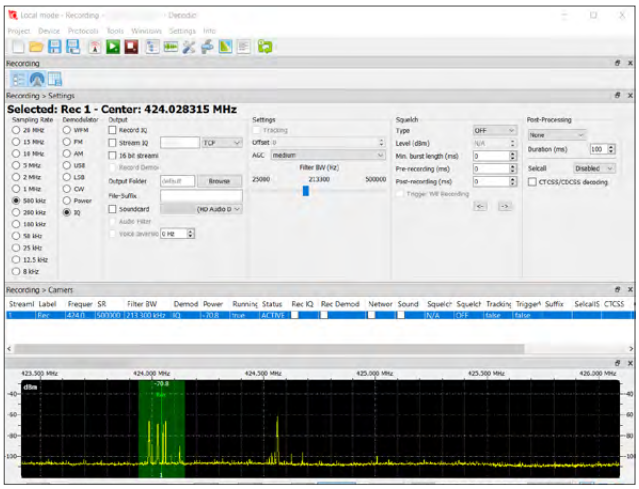
Create custom markers in the live spectrum display. Load spectrum plans from spreadsheets or licensed databases. Quickly mitigate interference and jamming with our automatic emissions detection and signal classification tools. Improve your quality of service by regulating your licensed users and assigned frequencies.

### ITU MEASUREMENTS

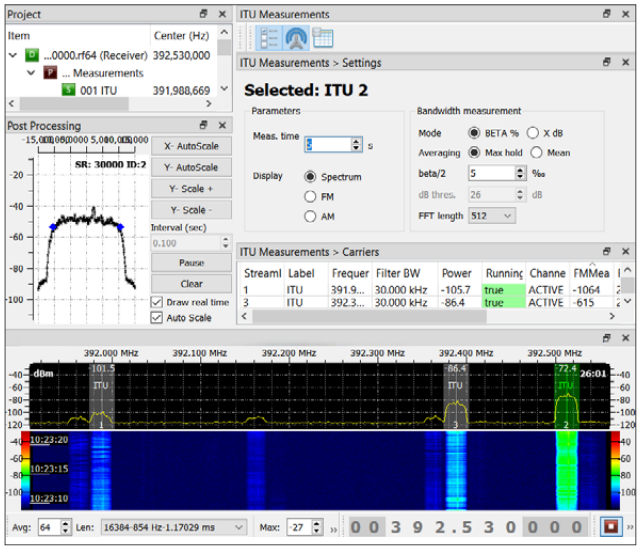
Conduct measurements such as: burst durations, zero-crossing for symbol rate estimation, autocorrelation, DFT, or cepstrum. Use signal cursors to measure and display estimated values. The measurements are in line with ITU Requirements SM.328, 337, 443, 854, 1600, 1880, 2117.



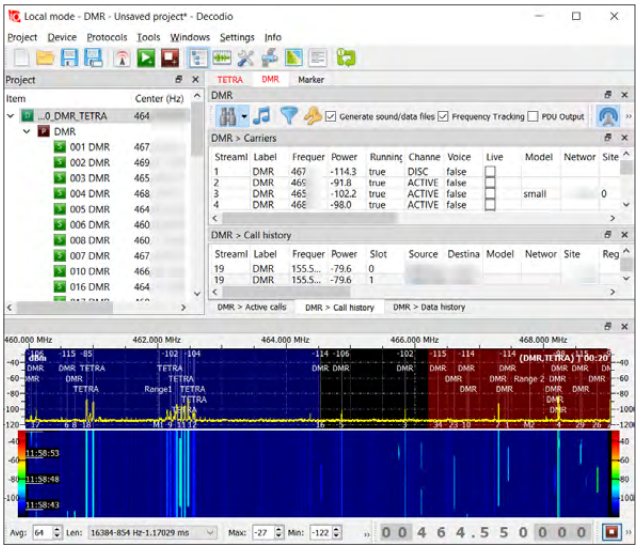

*Analyze a large frequency range that exceeds the real-time bandwidth of the receiver using the panorama view*



*Record narrowband or wideband channels for later further processing*

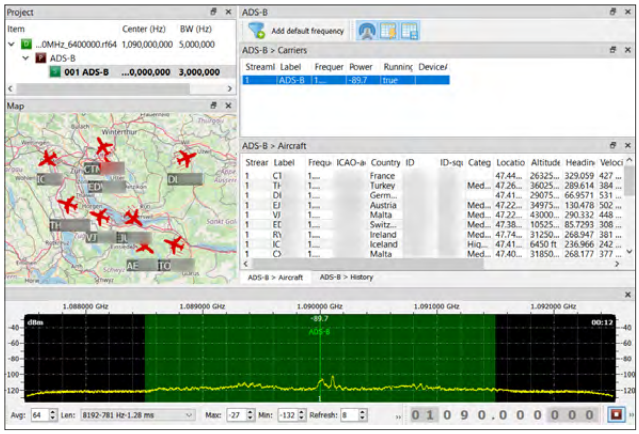



*Perform multichannel ITU measurements including time-domain analysis*



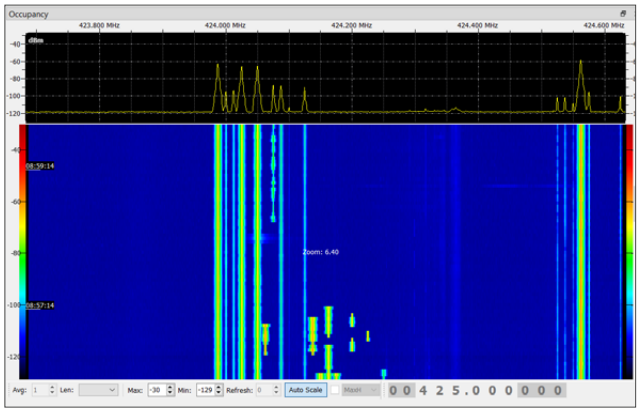

*Decode TETRA and DMR transmissions using a predefined spectrum plan*


*Perform multichannel direction finding and visualize the lines of bearing of all the desired channels*

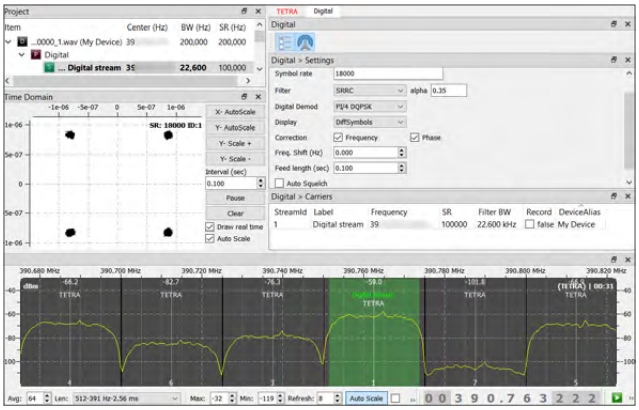


*Easily display and save decoded air and maritime transmissions (ADS-B, ACARS, VDLM2, FLARM)*

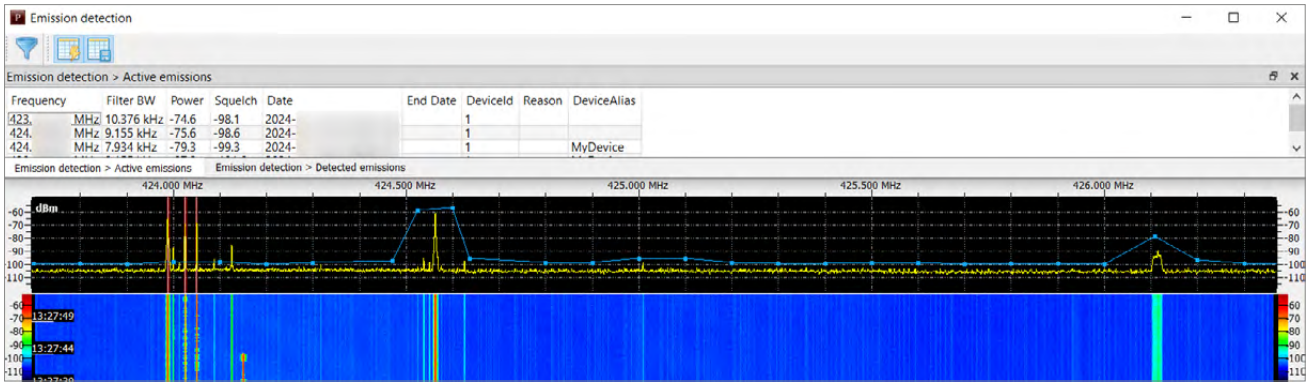
*Protect yourself against spoofing by decoding AIS directly from your receiver*



*Generate aggregated occupancy reports over a long period of time (weeks or months) to gain insight into the spectrum usage with minimal data storage*



*Demodulate and analyze IQ symbols using our digital demodulation module, which provides many options for time-domain plots, filters, and modulation schemes*




*Detect active emissions using automatic noise masks or easily-editable custom masks*

## Decodio RED subproducts

**ReX**

RED software but without decoders. Analog demodulation and IQ recording.

**NET**

Single-protocol decoder version of RED for network operators (e.g., NET for TETRA).

# DECODIO GREEN

## API for custom signal processing and acquisition

- Multichannel processing
- Multiple plugins in parallel
- API for custom cryptographic and signal processing algorithms
- Seamless integration into the graphical interface of Decodio RED

**Decodio GREEN** provides plugin-based C/C++ application programming interfaces (API) to extend the analysis capabilities of Decodio RED. Boost Decodio RED with custom plugins that implement advanced cryptographic processing, new demodulators and decoders, or application-specific signal analysis.

### IQ OUTPUT API

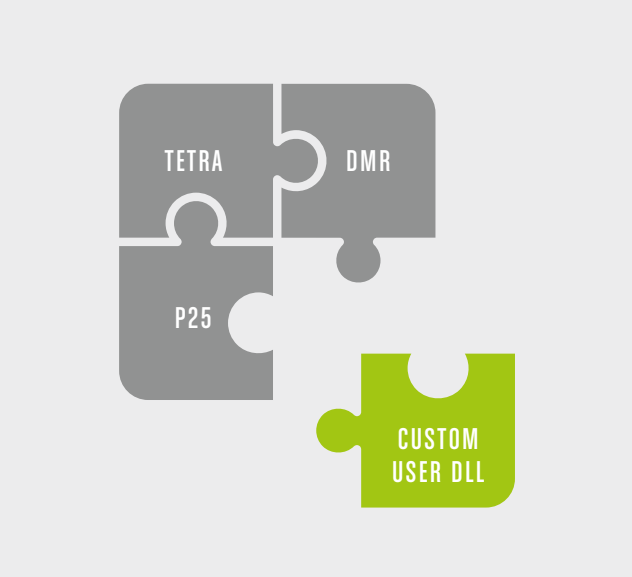
Use the IQ output API in Decodio GREEN to retrieve narrowband IQ channels from Decodio RED, perform demodulation and decoding, and send back the results.

Decodio GREEN is the perfect solution to perform custom signal processing using Decodio's high performance channelization capabilities.

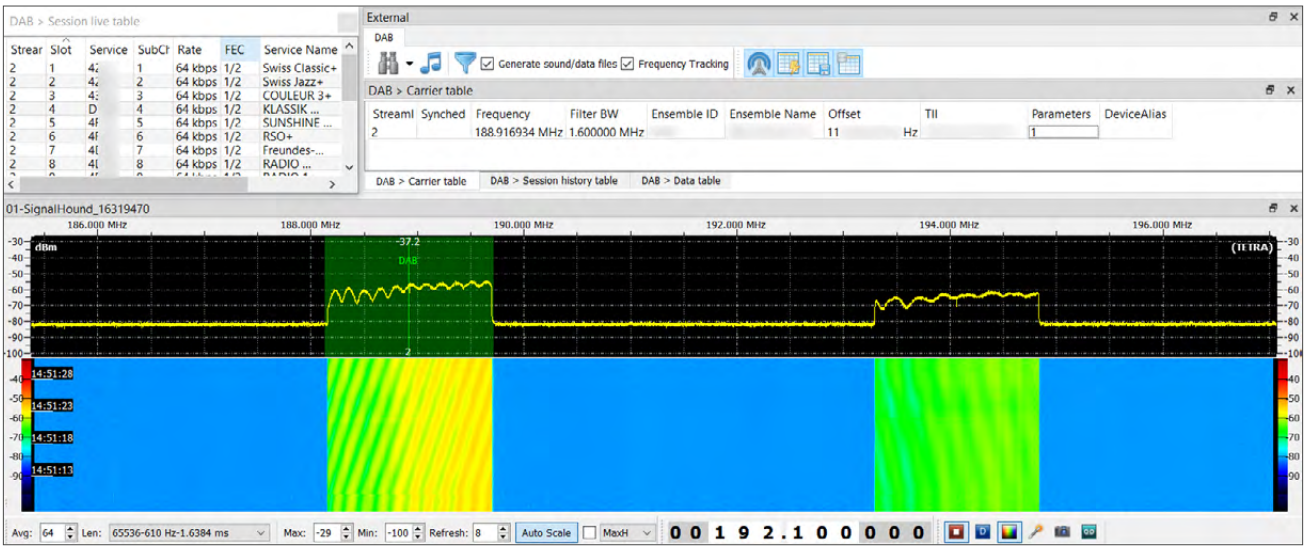
All standard features are available to custom plugins, including live audio and automatic carrier detection. Besides, multiple plugins can be loaded and used simultaneously.

### CRYPTO API

Available for TETRA, P25, and DMR, the cryptographic API makes it possible to seamlessly integrate custom decryption algorithms for voice and data payload. This allows you to go beyond the standard decryption features of Decodio RED while relying on its highly efficient demodulators and decoders.




*Green enables users to program their own Dynamic Link Library (DLL) protocols into RED*




*Example of a custom DAB decoder added through the interface provided by Decodio GREEN*

# DECODIO BLUE

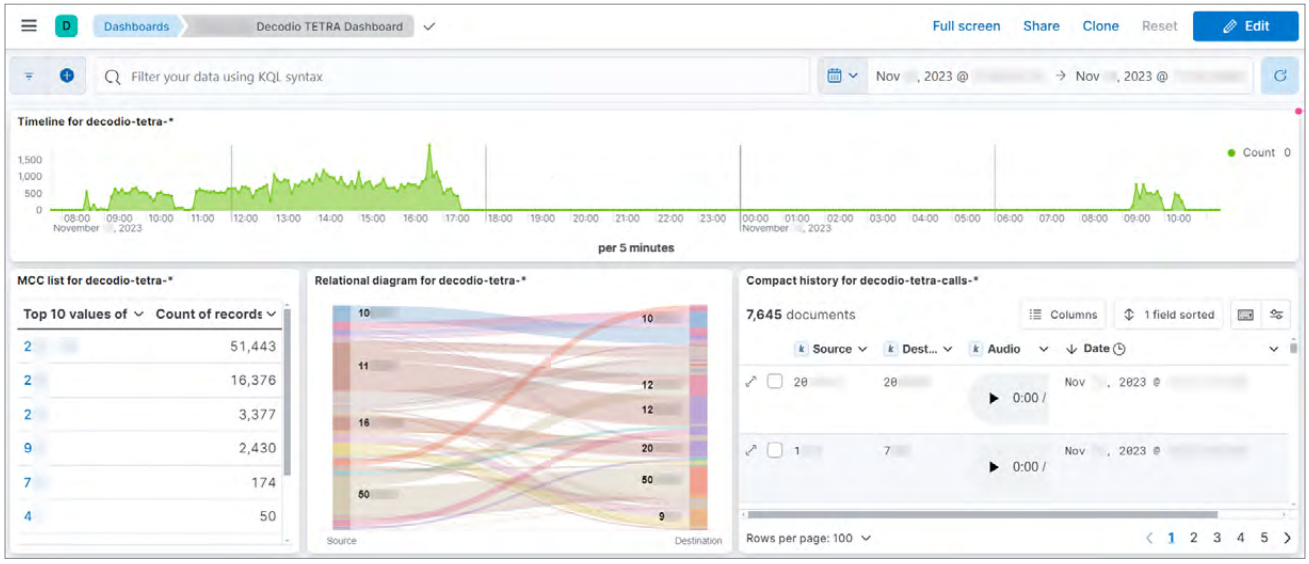
## Database and search engine integration


- Adds database and search engine functionalities to the Decodio suite
- Compatible with the Elastic Stack
- Facilitates big data analytics using protocol, signal, and geographical information

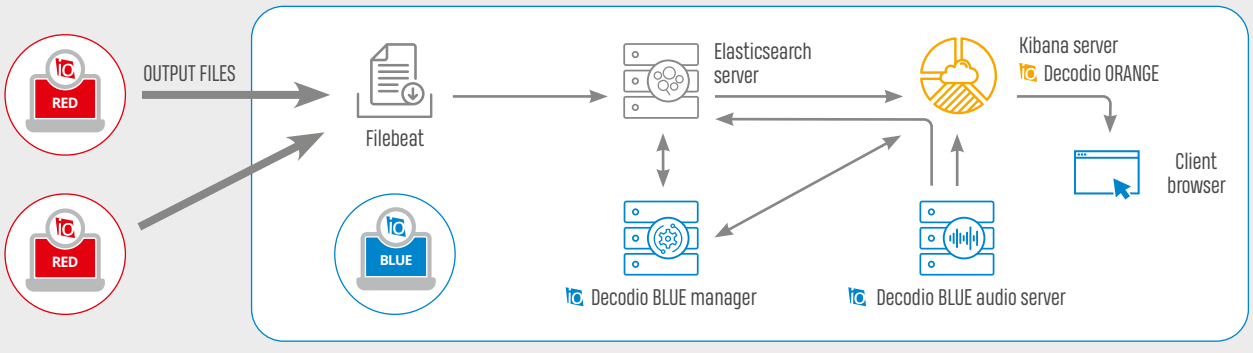
**Decodio BLUE** consists of middleware acting as an interface between the Decodio software components, database systems, and search engines. You can apply big data analytics methods to the data generated by Decodio RED, such as protocol parameters (e.g., broadcast content, call information, voice and data messages), as well as signal properties (e.g., signal power, demodulation quality) and geographical information.

### ELASTICSEARCH COMPATIBILITY

Decodio BLUE is compatible with Elasticsearch and allows the Decodio software suite to be seamlessly integrated into an Elastic Stack. This opens the door to advanced data analysis such as anomaly detection. In addition, the user can leverage the advanced visualization capabilities offered by Kibana through Decodio ORANGE to gain deep insights into the data.




*Custom dashboards created with Decodio BLUE and ORANGE displaying statistics about protocol information*




*Relationship between Decodio RED, ORANGE, and BLUE. The Decodio software suite is compatible with Elasticsearch, Filebeat, and Kibana from the Elastic Stack*

# DECODIO ORANGE

## Advanced data analysis

- Creates intuitive diagrams based on protocol and signal data
- Compatible with Kibana from the Elastic Stack
- Generate charts, tables, maps, and custom graphs
- Analyze load and capacity bottlenecks to optimize your network

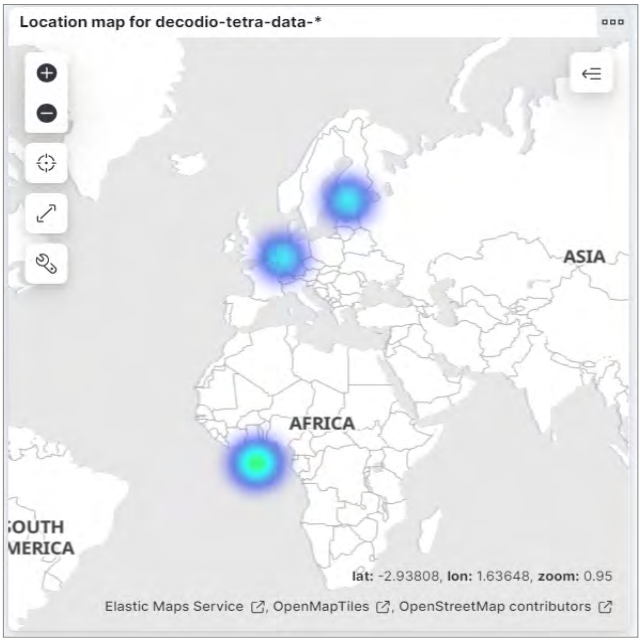
**Decodio ORANGE** is a collection of visualization tools used in conjunction with Decodio RED and Decodio BLUE for intuitive data analysis based on charts, tables, and custom graphs. You can easily analyze decoded data and calls thanks to advanced filtering and sorting options as well as powerful aggregation features.

### CHARTS, PIVOT TABLES, AND MAPS

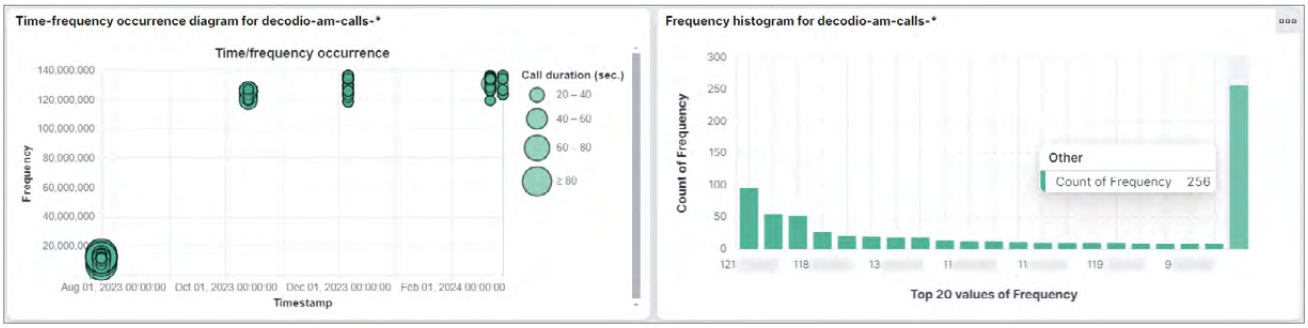
Visualize trends and relationships in your data, using history tables, relational diagrams, time-frequency diagrams and histograms, charts, and many more. Being compatible with Kibana, the visualizations provided by Decodio ORANGE can be easily customized.

### NETWORK OPTIMIZATION

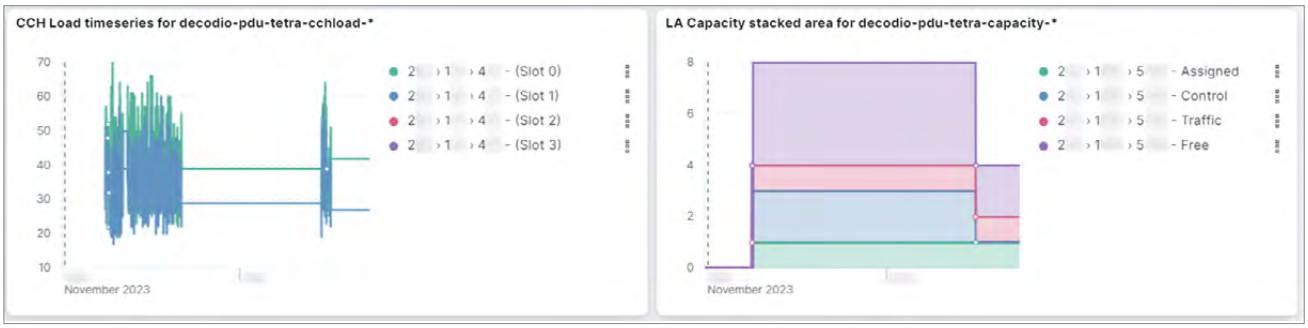
Analyze network load and capacity bottlenecks with specialized graphs that show the number of calls within a network cell, the number of calls by talk group, the call duration distribution or the control channel usage.




*Emitter locations displayed directly on the map*




*Time-frequency statistics for AM calls*




*Load and capacity statistics based on TETRA PDU data*

# DECODIO PINK

## Alerting module for monitoring, QoS, and threat detection

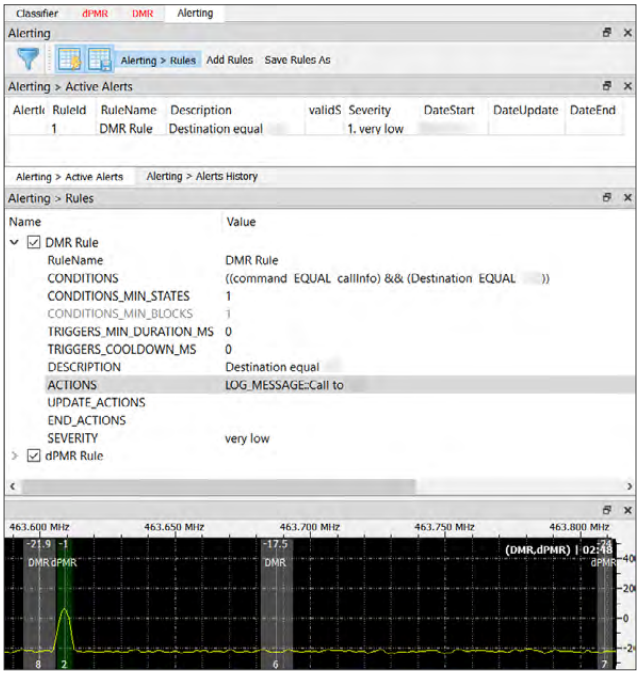

- Alerting framework for quality of service and threat detection
- Interaction with existing infrastructure (e.g., countermeasure, alarming, or network management systems)
- User-defined conditions
- Usable as a single field sensor or as a centralized control site

**Decodio PINK** is an automated monitoring component which triggers alerts based on decoded data and measurements from Decodio RED. Decodio PINK triggers an alert when decoded parameters or measurement values break a list of user-defined rules. Rules can involve any metric or metadata available in RED (such as signal strength and quality, network parameters, caller ID, and more).

Decodio PINK works together with RED, Localizer, and BLUE to offer a reliable alerting framework bridging the gap between network monitoring, emitter localization, big data analysis, and anomaly detection.

### DECODIO PINK FOR NETWORK MONITORING

When an alert is triggered, you can define the desired actions, such as sending an SNMP trap to a network management system, sending TCP messages, or starting a signal processing task (for instance, an IQ recording or a direction finding job). For each alert, you can obtain detailed context information such as the start/end time, the decoded data fields breaking the rule, and the response taken.




*Example: Create an alert whenever there is a call to a specific destination ID*

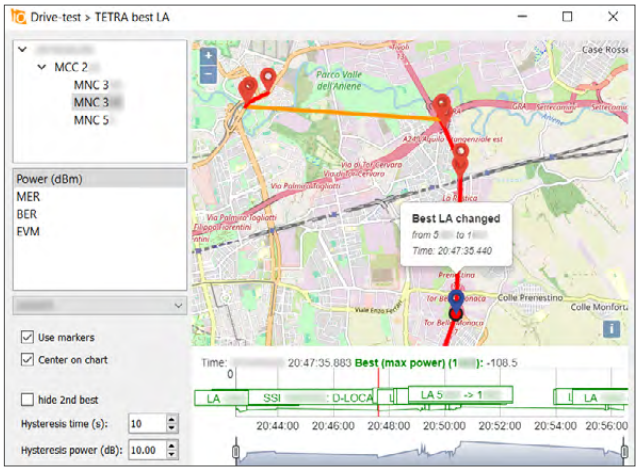
# DECODIO RUNNER

## Drive tests

**Decodio RUNNER** is an advanced mobile drive test solution for network verification, coverage assessment, and troubleshooting that combines the signal analysis capabilities of RED and the visualization tools of ORANGE. Save space in your vehicle when using just a PC to run our software and a GNSS-enabled receiver.

### APPLICATIONS

- Perform real-time coverage tests
- Obtain cartographic information with power and quality values
- Verify your network plan by analyzing the real-world network coverage
- Find interfering channels and signals




*Drive-test: TETRA best LA*

# DECODIO LOCALIZER

## Accurate and reliable emitter localization

- Multichannel TDOA, AOA, or hybrid localization
- Support for 20+ RF and DF receivers
- Live, interactive map
- Data logs in a user-friendly format
- Easy integration with existing infrastructures
- Offline analysis and replay


**LOCALIZER DISPLAY**

1. RED monitoring stations
2. Display stations and locations on the map
3. View the overlapped and synchronized spectrum of all three stations
4. Edit settings of the localization stream

### TIME DIFFERENCE OF ARRIVAL (TDOA) WITH RF RECEIVERS

Control the receivers remotely using Decodio RED. In **Decodio Localizer** you can then display all the stations on a map and select the desired receivers for localization. Decodio Localizer aligns the IQ data in the time domain, correlates the transmissions, and estimates the location of the transmitter. The software also builds a heatmap based on the most probable locations.

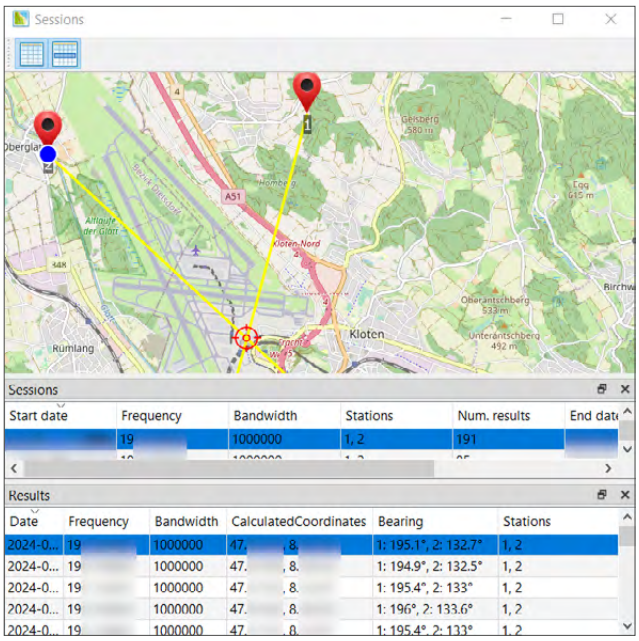
Localization results are saved and can be reviewed and exported offline. Decodio Localizer also uses a protocol-aware localization algorithm for increased accuracy when localizing PMR/LMR, maritime, and aeronautic signals.

### ANGLE OF ARRIVAL (AOA) WITH DIRECTION FINDERS

Decodio Localizer supports several wideband and single/multichannel direction finders and uses them to perform AOA localization. The user can adjust all acquisition parameters such as the center frequency, bandwidth, or DF squelch. If the direction finders support IQ data streaming, it is possible to simultaneously decode and obtain the AOA of a signal.

### HYBRID TDOA/AOA

One or more direction finders can be combined with two TDOA stations to create an advanced hybrid localization system.




*Localization results using DF receivers. The results can be stored in reports for later analysis*

## DECODIO RED TECHNICAL DATA

| RED demodulators and decoders | |
|---|---|
| Analog demodulators | CW, USB, LSB, AM, FM, WFM |
| PMR/LMR decoders | TETRA, DMR, TETRAPOL, P25 Phase 1+2, dPMR, NXDN, MPT 1327, POCSAG |
| Amateur decoders | C4FM, Packet Radio, DSTAR |
| Air and maritime decoders | ADS-B, ACARS, VDLM2, FLARM, AIS, DSC (GMDSS-ATIS) |

| RED features | |
|---|---|
| Max. number of parallel analog/digital channels | 500 channels (also depends on the PC processing power) |
| Narrowband bandwidth | 12.5 kHz up to 20 MHz |
| Filter width for narrowband channels | 8 kHz to 20 MHz |
| IQ inputs | VITA-49, IQ WAV/RF64 files, direct streaming from 20+ commercial RF receivers |
| Operating system | Windows 10, Windows 11, Linux |
| Licensing options | USB dongle-based or server floating license |
| Remote control and access | JSON-based IP interface |
| Output formats | WAV, RF64, HDF5, PCAP, ASTERIX, CSV |

| RED additional components | |
|---|---|
| Signal classifier | CW, FSK, (incl. F7B), DPSK, QPSK, 8PSK, 16PSK, 8QAM, 16QAM and OPSK), OFDM, and several military modes like MIL-STD-188-110, MIL-STD 188-141B or STANAG-4285 (further details on request) |
| Direction finding | Custom maps (street, topo), including elevation data, display single- and multichannel DF lines of bearing |
| Emission detection | Detect and log information about emissions based on user-defined or automatic frequency masks |
| Occupancy | Log the spectrum occupancy over a long period of time |

## DECODIO LOCALIZER TECHNICAL DATA

| | |
|---|---|
| GNSS inputs | NMEA RMC and GGA sentences (COM and UDP) |
| Minimum site configurations | TDOA: 3 sites, AOA: 2 sites<br>Hybrid TDOA/AOA: 2 TDOA and 1 AOA site |
| Network options | Ethernet, LTE/4G, Microwave Point to Point, Wi-Fi, MANET |
| Minimum network speeds | TDOA: 120kBit/s-2MBit/s per site, AOA: 10–30kBit/s per site |

## INTEGRATED RECEIVERS BRANDS

ROHDE & SCHWARZ, NARDA, SIGNAL HOUND, TEKTRONIX, PLATH, NATIONAL INSTRUMENTS, IZT, KEYSIGHT, HACK RF, AIR SPY, RTL-SDR, SDR PLAY

## GENERAL SYSTEM REQUIREMENTS

- ➔ Windows 10 64-bit, Windows 11 64-bit, or Linux
- ➔ Quad-Core Processor min. 3 GHz (e.g., Intel i7-4770)
- ➔ Gigabit Ethernet card supporting Jumbo frames
- ➔ 16 GB RAM
- ➔ Optimum screen resolution: 1920 x 1200
- ➔ Sound card (optional)
- ➔ SSD (recommended, depending on recording requirements)

**Decodio Software is designed and developed in Switzerland.**

SWISS MADE

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Version: 05/24