DECODIO SPECTRUM MONITORING SYSTEM

TETRA | DMR | DPMR | NXDN
TETRAPOL | P25 | D-STAR
SIGNAL EXTRACTION
LOCALIZATION | ANALYSIS

Decodio

www.decodio.com

Detect | *Decode* | *Visualize*

DECODIO SYSTEM

The **Decodio Spectrum Monitoring System** is a full-featured software solution for signal analysis and professional mobile radio (PMR) communication decoding. With a set of integrated software components covering signal acquisition and processing (RED), localization (TDoA), logging (BLUE), alarming (PINK), data analysis (ORANGE), and an open plug-in architecture (GREEN), Decodio offers a flexible solution for tactical signal analysis as well as spectrum monitoring using distributed, remote-controlled receivers.

APPLICATIONS

• THREAT DETECTION	• QUALITY OF SERVICE	• VOICE LOGGING
• SPECTRUM MONITORING	• SIGINT/COMINT	• LOCALIZATION
• DRIVE TESTING	• TEST AND MEASUREMENT	• AUTOMATIC ALERTS

Decodio RED

ACQUISITION, RECORDING, DECODING AND STREAMING

Decodio RED is the main software component of the Spectrum Monitoring System and provides core signal processing and decoding features.

SIGNAL ACQUISITION
General-purpose spectrum analyzers or RF receivers are used to acquire baseband IQ data with an instantaneous bandwidth of up to 200 MHz. Multiple receivers can be used in parallel to increase the working bandwidth.

### SIGNAL EXTRACTION, RECORDING AND STREAMING
Narrow-band channel extraction, demodulation and decoding is performed using modern software-defined radio techniques running on a conventional computer. The maximum number of decoded channels depends only on the available CPU power. Typically, on a modern desktop PC, up to 512 channels of arbitrary bandwidths can be processed in real-time, including extraction, recording and decoding. Server-grade hardware further extends the number of channels which can be processed in parallel.

SIGNAL ANALYSIS
Decodio RED combines manual signal analysis functionalities with automatic emission detection and classification in an easy-to-use interface. Time and frequency domain measurements as well as burst analysis are done intuitively using overlays and markers, allowing the operator to quickly respond to changes in the RF environment.

DIGITAL PMR SUPPORT
Besides the standard analog modulations, full support for TETRA, Tetrapol, DMR, dPMR, NXDN, P25 and D-STAR is available, including broadcast parameters, metadata as well as voice and data decoding. Optional modules for encrypted content handling are also available.
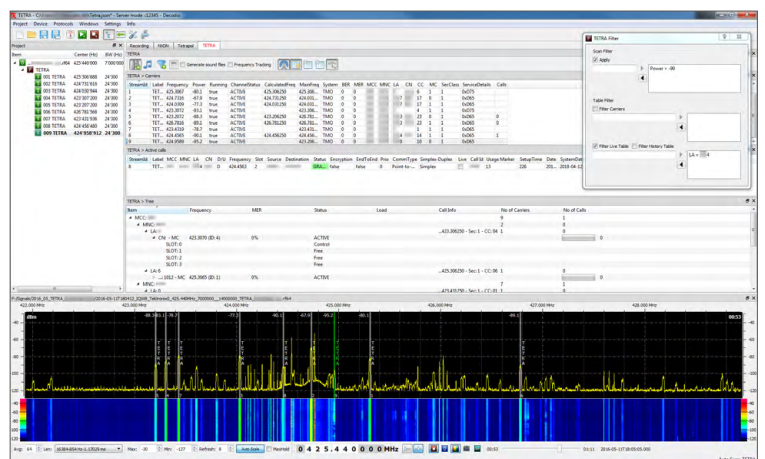
Parallel extraction and real-time decoding of digital channels with automatic emission detection
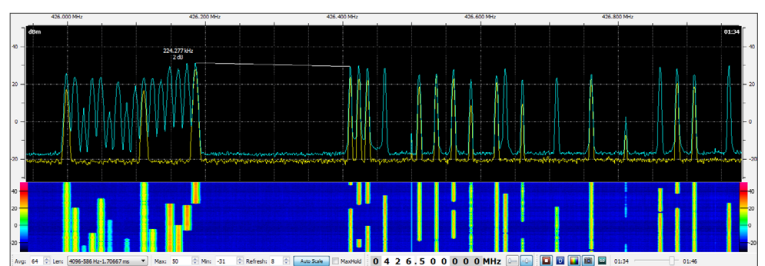
Spectrum with measurement cursors and overlay

HIGHLIGHTS

- PC-based software solution with efficient signal-processing capabilities
- Support for multiple receivers
- Open interfaces (e.g. TCP/UDP input and output streams, VITA 49)
- Large number of parallel monitoring channels
- Advanced digital PMR decoding

## SYSTEM INTEGRATION, DISTRIBUTED DEPLOYMENT, REMOTE CONTROL

The **Decodio system** supports fully distributed deployments, where signal acquisition, processing and visualization are done in different physical locations.

The connections between the various components are optimized for low capacity data links. Signal acquisition and processing are performed in the same location and only decoded information and control commands are exchanged with other sites, thus maintaining reliable operation even with poor network connectivity.

The system is ideally suited for use with a VPN running over a mobile data connection (3G/4G) or via tactical data links.
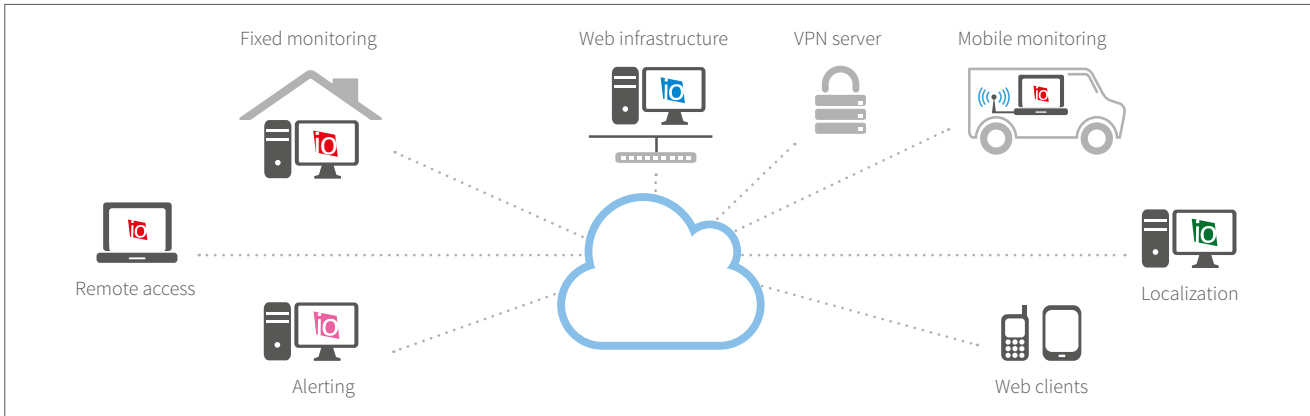

Decodio RED SYSTEM ARCHITECTURE
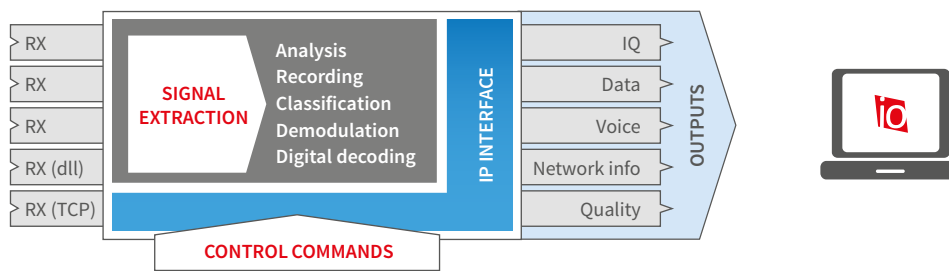
Remote control is possible either through Decodio's native graphical interface or through an open TCP control interface which covers every aspect of the software, including independent streaming of extracted channels via TCP/UDP, both as IQ data and demodulated waveform.
This makes it possible to easily deploy remotely operated, autonomous signal acquisition stations running on headless machines.

Flexible interfaces for signal input and output provide easy scalability for a larger monitoring bandwidth, more channels and multiple sensor locations. The various components of the Decodio system form a constellation of interoperating signal sources, processing units and visualization elements, offering:

- emitter localization coupled to direction-finding equipment
  (**Decodio RED** & **TDoA**)
- long-term call, metadata and power logging
  (**Decodio RED** & **BLUE**)
- automatic spectrum and network monitoring
  (**Decodio RED** & **PINK**)
- PMR protocol analysis and statistical visualization
  (**Decodio RED** & **ORANGE**)
- API for custom algorithm implementations
  (**Decodio RED** & **GREEN**)

Decodio's software is easy to integrate and can bring the potential of its high-performance channelization capabilities and software-defined radio concepts into existing spectrum monitoring infrastructure in no time.
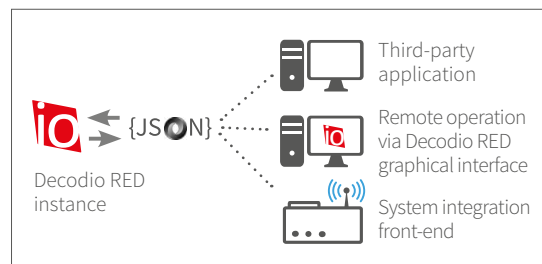
IP interface using JSON-based commands for remote operation and system integration
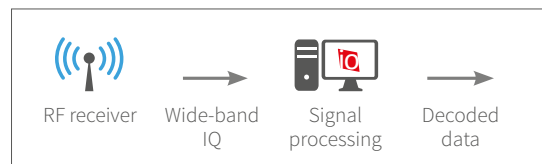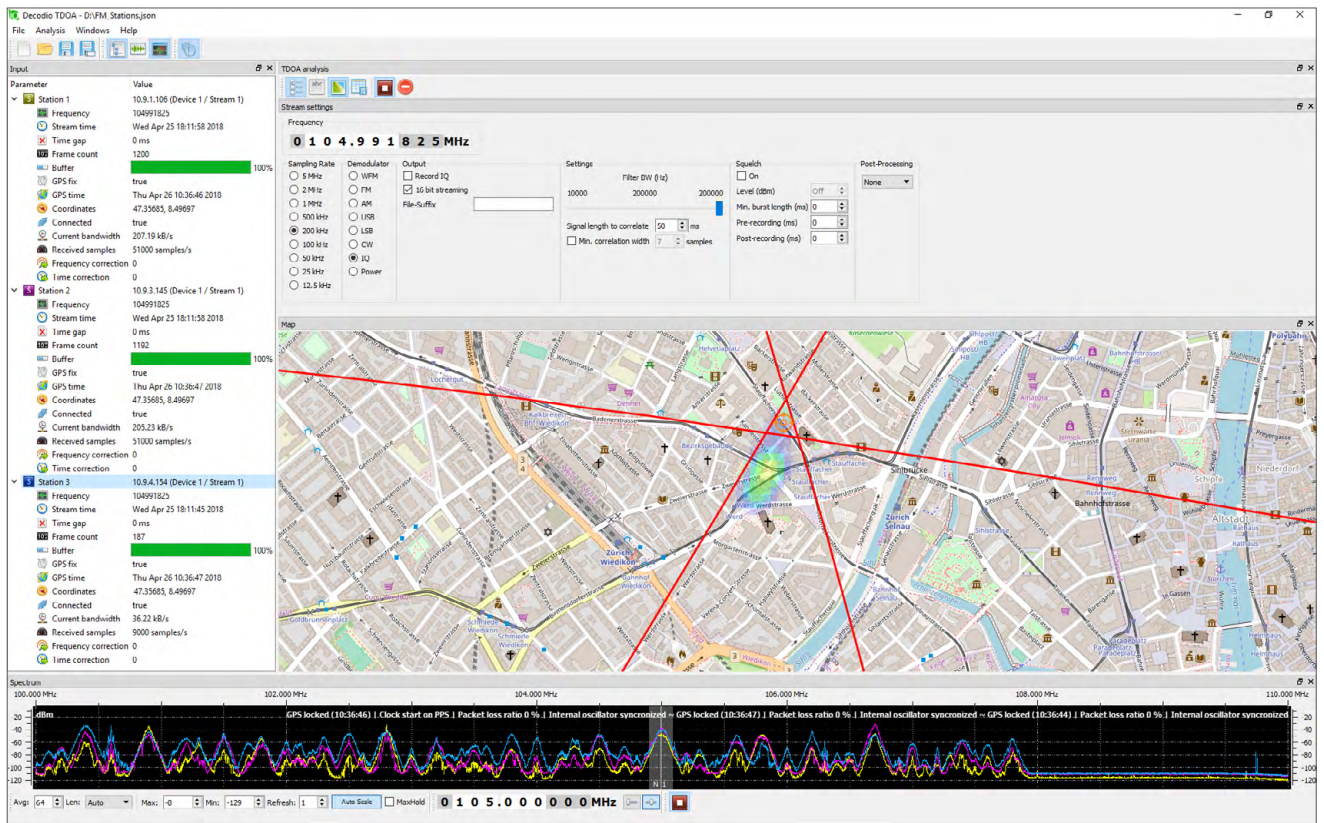

Remote control protocol optimized for slow network links such as mobile data connections
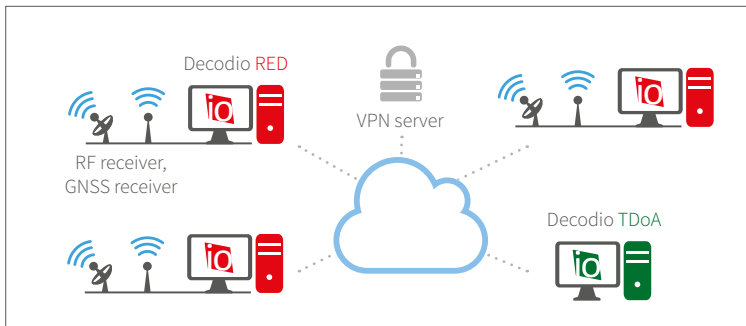
HIGHLIGHTS

- JSON-based control interface for system integration
- Remote-control via native graphical interface
- All outputs available in remote control mode
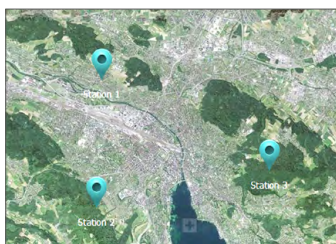
Decodio TDoA

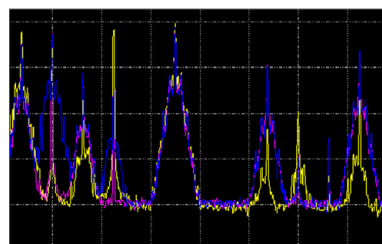## EMITTER LOCALIZATION

Easy-to-use graphical user interface

Precise visualization of the location estimation and easy accuracy assessment

Ready for mobile deployment: the position of the acquisition stations on the map is continuously updated

Overlay of the spectrums from the various acquisition stations for quick visual evaluation

Decodio TDoA is an emitter localization solution based on time difference of arrival measurements.

A central instance of Decodio TDoA gathers data streams coming from multiple interconnected Decodio RED instances which are kept synchronized by GNSS receivers, and computes position estimations in real-time by cross-correlating the incoming signals.

The operator can easily tune the receivers and change the settings of all acquisition stations simultaneously through Decodio's easy-to-use and well-known graphical interface.

Thanks to novel signal-processing algorithms, both frequency and time synchronization errors between acquisition stations are taken into account to derive the most precise estimation.

Decodio TDoA features automatic burst detection and supports individual time slot localization of time-multiplexed channels (TDMA). It can also display data coming from DF equipment alongside the TDoA results for improved accuracy.

HIGHLIGHTS

- User-friendly interface for real-time operation
- Suitable for a wide range of signals
- Optimized for slow data links
- Suitable for mobile acquisition stations
- Support for various RF receiver models
- Data fusion with DF measurements

Decodio BLUE

## DATABASE AND WEB-BASED VISUALIZATION
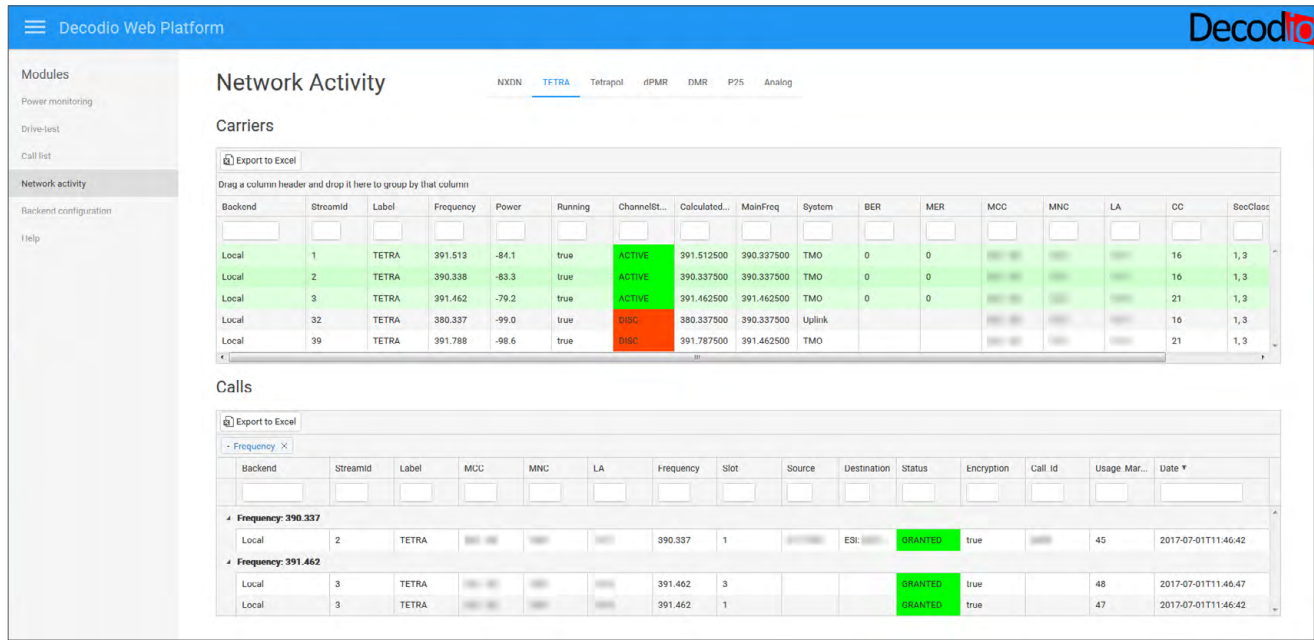
Real-time, centralized view of the network activity from multiple acquisition stations

Decodio BLUE is a web server and database application offering logging and browser-based visualization of the data generated by Decodio RED.

Decodio BLUE connects to multiple instances of Decodio RED and saves the decoded data and signal properties in a centralized database. Saved parameters include base station broadcast parameters, call information, short data messages, position reports as well as signal power and demodulation quality.

The web interface provides a live overview of the ongoing calls being decoded in the Decodio RED instances, and a view of the call database with advanced filtering and sorting features, chart display and call playback.

A plot showing signal power as a function of time makes it possible to perform long-term frequency occupation measurements (power logging) based on distributed monitoring sensors. When position data is available in Decodio RED, signal power and quality can be visualized on a map.
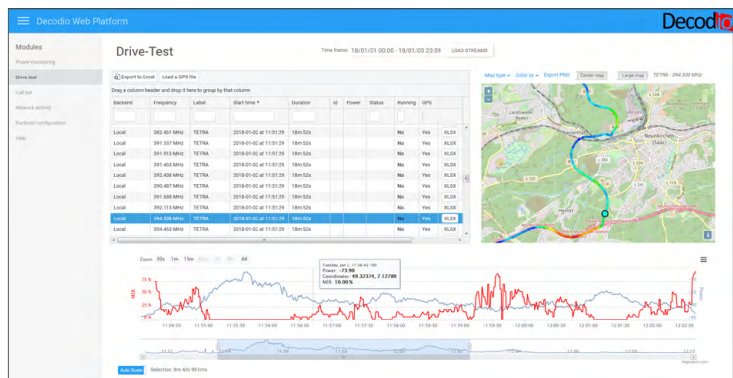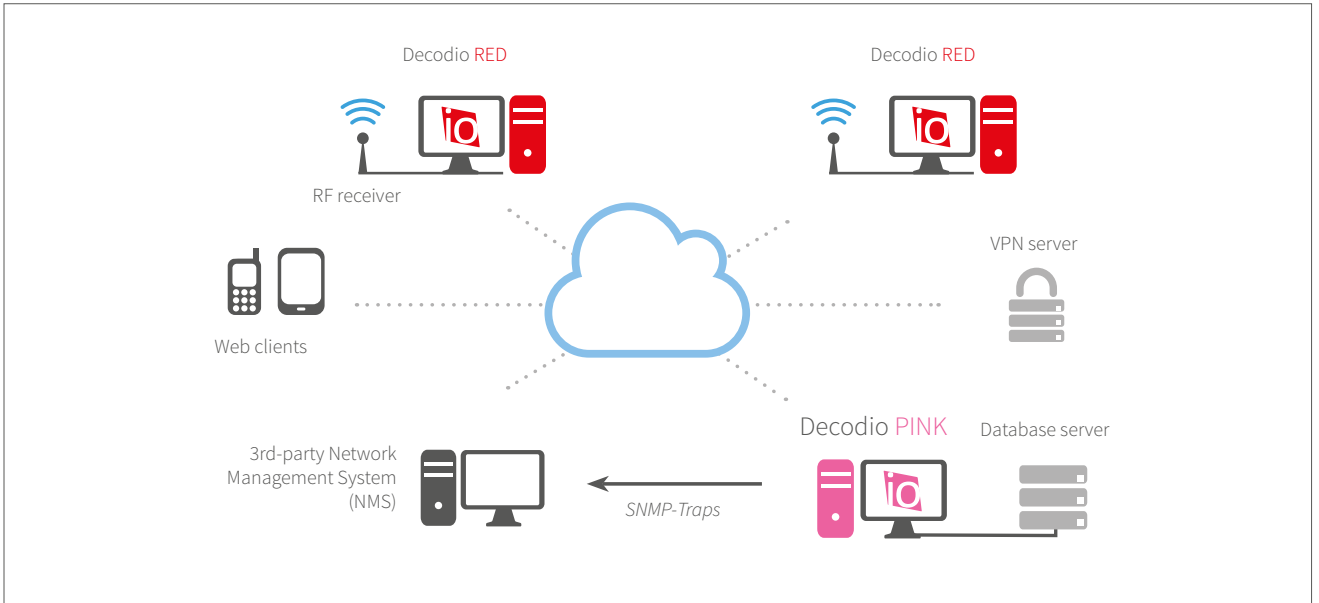

Signal power and quality visualization in time and space for network coverage mapping and long-term base station monitoring
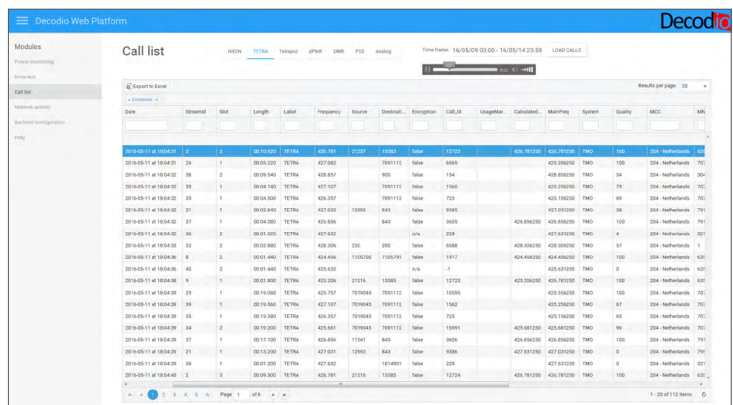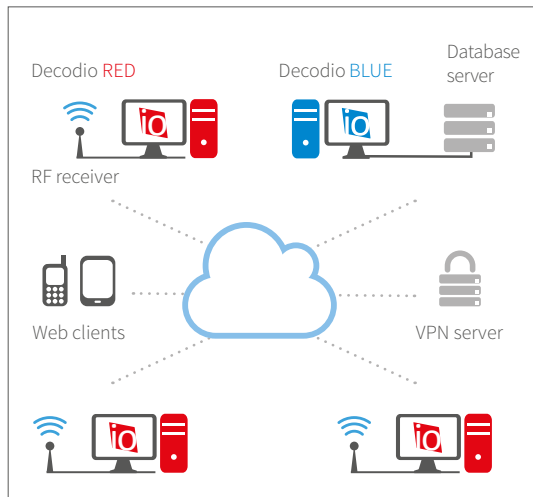
Call list with integrated player

HIGHLIGHTS

- Web-based interface for multiple distributed sensors (RED)
- Call history visualization and playback in web browser
- Signal power and quality logging

Decodio PINK

NETWORK MONITORING AND ALERT TRIGGERING

Decodio PINK is an automated monitoring component which continuously collects decoded information and measurements from multiple instances of Decodio RED.

It triggers an alert whenever a decoded parameter breaks a list of user-defined rules. Such rules can involve any metric or parameter available in Decodio RED, such as signal strength and quality, network parameters or call metadata.

This allows for precise event detection, accurate quality-of-service assessment or threat detection. The list of active alerts as well as a history of past alerts are accessible in a web interface and saved in a database for statistics and report generation.

Decodio PINK can be configured to automatically respond to an alert with a series of actions, such as sending an SNMP trap to a network management system (NMS), sending user-defined TCP messages, or starting an IQ-recording job.

Along with each alert, detailed context information is saved, including start and end time, decoded data fields breaking the rule and response taken.

Decodio PINK also monitors the Decodio RED instances and automatically reports sensor failures and disconnections.

HIGHLIGHTS

- Flexible alerting framework for quality-of service and threat detection
- User-defined trigger conditions
- Interaction with existing infrastructure (e.g. countermeasure, alarming, network management systems)
- Easy monitoring of large-scale networks

Overview of the active alerts and history of events in a web browser

```
[Quality level monitor]
CONDITIONS = Power LESS_EQUAL_THAN -70
TRIGGERS = MER GREATER_THAN 4
ACTIONS = LOG_RULE_NAME::High MER despite high power

[Channel Load]
CONDITIONS = stream/Label EQUAL TETRA && stream/LA EQUAL 1
TRIGGERS = Load GREATER_THAN 35

[Capacity Info for LA 39]
CONDITIONS = LA EQUAL 39 && TotalSlots NOT_EQUAL 0
TRIGGERS = FreeSlots LESS_THAN 2

[TETRA unknown LA]
CONDITIONS = Origin EQUAL MonitoringStation2
TRIGGERS = LA NOT_EQUAL 12
ACTIONS = SEND_SNMP_TRAP::HOST::192.168.1.177::PORT::162::MESSAGE::Unknown LA

[Tetrapol source filtering]
CONDITIONS = Label EQUAL Pol
TRIGGERS = Source EQUAL 491503212
```
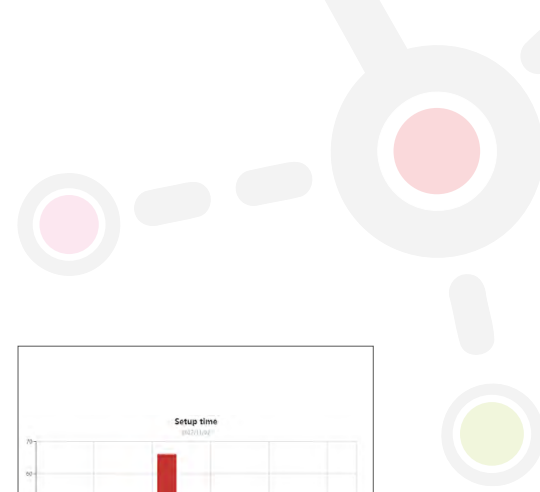
User-defined rules with an easy-to-write syntax

SNMP traps can be sent to a network management system such as OpenNMS

Decodio ORANGE

## PROTOCOL ANALYSIS AND DATA VISUALIZATION

Decodio ORANGE is an offline visualization tool for decoded PMR protocol data, with a convenient interface to display results in the form of charts and data tables.

Using the protocol data unit (PDU) and measurement values generated by Decodio RED, a wide range of analysis modules give the user a deep understanding of a PMR network's behavior. Network load and capacity bottlenecks can be quickly analyzed with visualizations such as number of calls by network cell, number of calls by logical group, call duration distribution or control channel usage.

Furthermore, several pivot table-based analysis modules enable the user to combine different metadata types and study their relationship (such as for example call type by source and destination ID or call length by talk group).

The available charts also include histograms for the visualization of call setup time and call length distribution.
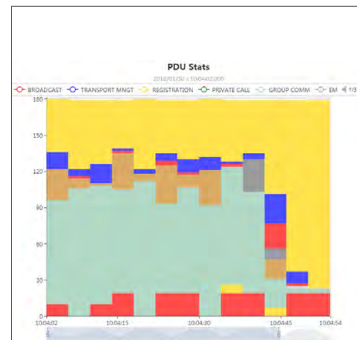
The collected data and generated charts can be exported for easy integration into an existing workflow or for documentation purposes.
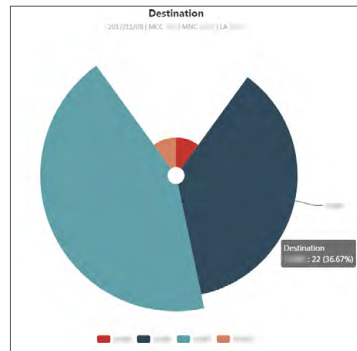
Call statistics visualized as pie charts
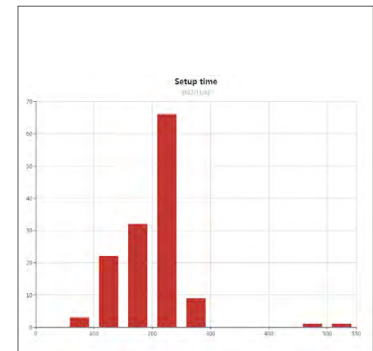
Call setup time and call duration distribution

Type of protocol data units transmitted over time

Call capacity (available and occupied slots) in a TETRA cell

HIGHLIGHTS

- Comprehensive data visualization
- Network load metering
- Pivot table analysis
- PDU statistics

Decodio GREEN

APPLICATION PROGRAMMING INTERFACE

Decodio GREEN provides a plugin-based C/C++ application programming interface (API) to Decodio RED and is the perfect tool for custom signal processing and acquisition.

An IQ output interface allows the user to retrieve one or multiple narrow-band channels from Decodio RED in IQ form, process the data and visualize the results in a dedicated graphical interface or directly inside Decodio RED. It is the perfect solution for custom signal processing and measurement of multiple channels.

An IQ input interface makes it possible to feed signal data in IQ form into Decodio RED, thus enabling the use of otherwise unsupported signal sources such as custom RF receivers.

A crypto-interface gives the possibility to run proprietary and non-disclosable encryption algorithms against the data coming from Decodio RED.

HIGHLIGHTS

- Processing of multiple IQ streams simultaneously
- GUI widgets for output visualization
- Plugin architecture
- Crypto-interface
- Support for custom RF receivers

TECHNICAL DATA

Frequency range	9 kHz – 7 GHz (optional 14 GHz)
Maximum real-time bandwidth per receiver	200 MHz (40 MHz for portable systems)
Maximum number of parallel narrow-band channels	Depends on license and processing power (typically 512)
Narrow-band channel bandwidth	12.5 kHz to 5 MHz
Digital protocols	TETRA, DMR, dPMR, NXDN, P25, D-STAR, Tetrapol
Analog demodulation	AM, FM, LSB, USB, CW, IQ-recording
Signal analysis	Modulation classification, symbol rate, manual measurements
Emission detection	Instantaneous within the real-time bandwidth
IQ Inputs	VITA 49, Decodio-streaming format, IQ-files
Supported receivers	Available on request
Remote control interface	JSON based IP interface
Operating system	Windows (Linux on request)

Decodio TDoA

Minimum number of sensors	3 (one central Decodio TDoA instance)		
Signal bandwidth	Variable from 12.5 kHz - 2 MHz		
Maximum number of signals	16		
Minimum data connection rate	Not applicable, adaptive streaming		
Supported TDoA sensors	Available on request		
	Signal	Bandwidth	Accuracy, typical
Typical accuracy*	FM Broadcaster	100 kHz	125 m mean error w. 50 m std. deviation
	TETRA	25 kHz	200 m mean error w. 75 m std. deviation
	Tetrapol	10 kHz	250 m mean error w. 100 m std. deviation

*Accuracy depends on emitter location, multipath environment, signal length, signal bandwidth, SNR and receiver locations.

DECODIO SYSTEM
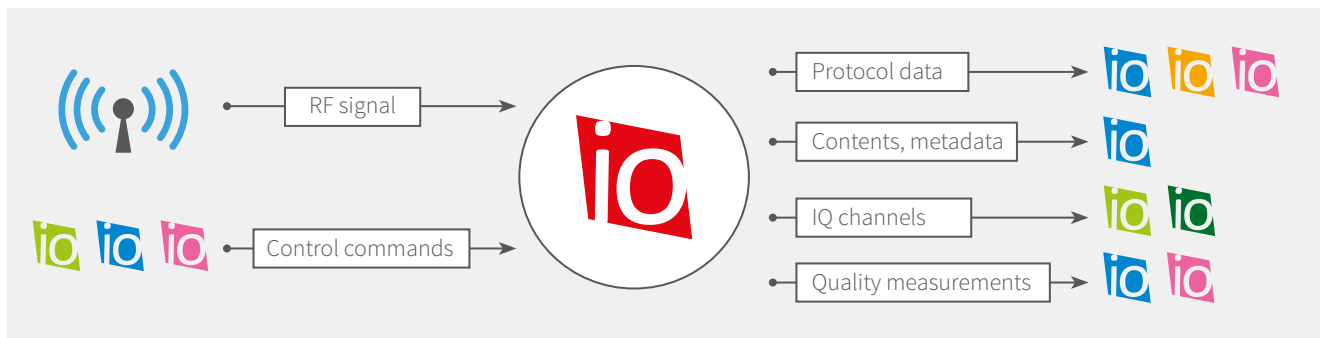
ABOUT

Decodio AG is a technology company, specialized in the areas of digital signal processing, signals intelligence and radio monitoring, with its offices located in Zürich, Switzerland.

Decodio develops radio technology software solutions, including a full-featured spectrum monitoring system, with a focus on digital VHF/UHF PMR communication.

Thanks to various open interfaces and a flexible, distributed architecture, Decodio's software solutions integrate seamlessly into existing systems.

The company was founded in 2012, and has been committed to providing innovative solutions to both end-users and system integrators in the fields of spectrum management, network monitoring, voice logging and SIGINT-COMINT.

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