The **Decodio Spectrum Monitoring System** is a full-featured software solution for signal analysis and professional mobile radio (PMR) communication decoding. Based on a collection of integrated components, the system covers all aspects of spectrum monitoring, from distributed signal acquisition to content analysis.

### APPLICATIONS

<table>
<thead>
<tr>
<th>Threat Detection</th>
<th>Quality of Service</th>
<th>Voice Logging</th>
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<tr>
<td>Spectrum Monitoring</td>
<td>Sigint/Comint</td>
<td>Localization</td>
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<tr>
<td>Drive Testing</td>
<td>Test and Measurement</td>
<td>Automatic Alerts</td>
</tr>
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</table>

### ACQUISITION, RECORDING, DECODING

**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 are used to acquire baseband I/Q data with an instantaneous bandwidth of up to 80 MHz. Multiple receivers can be used in parallel for extended wideband coverage.

**Signal Extraction**
Narrow-band channel extraction, demodulation and decoding are based on modern software-defined radio techniques. Up to 256 channels of arbitrary bandwidths can be extracted and decoded in parallel on a conventional computer.

**Signal Recording and Streaming**
Multiple narrow-band channels can be simultaneously saved to disk and exported as network streams in both I/Q and demodulated form.

**Digital PMR Support**
Besides the standard analog modulations, full support for TETRA, Tetrapol, DMR, dPMR, NXDN, P25 and D-STAR is available, with full support for broadcast parameters, metadata as well as voice and data contents.

### HIGHLIGHTS
- Support for multiple simultaneous receivers
- Support for network input and output streams (e.g. VITA 49)
- Large number of parallel monitoring channels
- Network infrastructure-independent operation
- Emission detection
- Real-time recording and listening
- Crypto-interface
Remote control is possible either through a graphical interface or through an open network interface, which provides seamless integration of the system into existing infrastructures.

Flexible interfaces for signal input and output provide easy scalability for higher monitoring bandwidth, multiple locations or more channels. The various components of the Decodio System form an array of signal sources and processing units which provide:

- **long-term call logging** (Decodio RED & BLUE)
- **emitter localization** (Decodio RED & TDoA)
- **automatic PMR network monitoring** (Decodio RED & PINK)
- **automatic recording with remote access** (Decodio RED)
- **coupling with direction-finding equipment** (Decodio RED & TDoA)

The core signal-processing software can run on a head-less machine and be remotely operated through a TCP interface based on JSON messages or through Decodio's graphical application. This makes it possible to build remotely-operated, autonomous signal acquisition stations.

Decodio's signal-processing software is easy to integrate and can bring all the potential of its high-performance channelization capabilities and software-defined radio decoders into existing solutions.

The system is ideally suited for operation through a VPN over a mobile data connection (3G/4G) or via tactical data links.
Decodio TDoA is an emitter localization application based on time difference of arrival measurements.

Narrow-band signals are streamed from multiple interconnected Decodio RED instances which are kept synchronized by GNSS receivers.

A central instance of Decodio TDoA gathers data streams coming from a minimum of 3 acquisition stations and computes position estimations in real-time by cross-correlating the incoming signals.

The infrastructure is optimized for slow connections such as mobile data links connected to a VPN.

Multiple signals or channels can be monitored simultaneously with independent squelch levels, for intuitive localization of intermittent 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.

Various visualization tools provide a clear visual indication of the accuracy of the position estimations, and result lists can be generated for further analysis, with date, time, coordinates and confidence index.

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

Precise visualization of the location estimation and easy visual assessment of the accuracy.

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

Flexible channel definition, with comprehensive parameters.

HIGHLIGHTS

- User-friendly interface
- Suitable for a wide range of signals
- Optimized for slow data links
- Real-time operation
- Position of the acquisition stations automatically updated
- Support for various RF receiver models
- Report generation feature
Signal power and quality visualization in time and space for network coverage mapping and long-term monitoring of base stations

Export Excel-compatible files as well as Google Earth-compatible KML files

Advanced call filtering and search features to browse the call database

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 for the data generated by Decodio RED.

An instance of Decodio BLUE can connect to multiple instances of Decodio RED and log the decoded parameters and signal properties in a database. Such parameters include PMR broadcast parameters, call information, short data messages, position reports as well signal power and demodulation quality.

The data can then be accessed through a web interface where signal quality and power can be displayed as time series and calls can be searched and filtered based on various criteria (such as source and destination ID and network parameters).

Decodio BLUE can also be used as a browser-based drive-testing solution: when GPS data is available, signal power and quality can be displayed on a map for easy coverage mapping.

It is the perfect tool for long-term frequency occupation measurements and power logging.

**HIGHLIGHTS**

- Signal power and quality logging
- Web-based frontend, no software installation required for clients
- Call database
- Visualization on maps (coverage, position reports, emitter localization)
- Call playback in web browser
NETwORK MONITORING AND ALERTING

Decodio PINK is an automated monitoring component allowing fast response to issues in a PMR network or unexpected RF signals.

An instance of Decodio PINK connects to multiple instances of Decodio RED and continuously monitors the channels (quality, power, decoded data).

Alarms are triggered whenever a decoded parameter breaks a given set of rules.

Rules can involve any metric or parameter decoded by Decodio RED, such as signal strength and quality, network parameters or call metadata. This allows for precise event detection and accurate quality-of-service assessment or threat detection.

Alerts are accessible through a web interface and saved in a database for statistics and report generation.

Triggered alarms include SNMP traps to an existing NMS infrastructure as well as TCP messages.

HIGHLIGHTS

- Flexible alarm triggering for quality-of-service and threat detection
- User-defined triggering logic
- Interaction with existing infrastructure (e.g. countermeasure, alarming)
- Data acquisition and fusion from multiple sensors

NETwORK PROTOCOL ANALYSIS

Decodio ORANGE is an offline visualization tool for PMR protocol data, extending the features of Decodio RED.

It features advanced protocol data unit (PDU) visualization tools for various digital protocols, making it suitable for PMR network troubleshooting, statistical analysis of capacity usage and call traffic.

Information such as calls by network cell, calls by logical group and PDU type can be visualized as time series and give a precise overview of the network activity over time.

Generated data can be exported and edited in spreadsheet programs such as Microsoft Excel for easy integration into an existing workflow.

HIGHLIGHTS

- Protocol-specific metrics
- Call statistics
- PDU traffic statistics
- Plot export feature
Decodio GREEN is an application programming interface (API) for custom post-processing of the channels extracted by Decodio RED.

Narrow-band I/Q data is retrieved from multiple instances of Decodio RED and provided to the user through an easy-to-use C API.

A graphical interface with programmable widgets is provided for visualization and experimentation.

Decodio GREEN is the perfect tool to use custom decoder implementations in conjunction with Decodio RED.

It is also used for synchronization measurements in single-frequency networks (simulcast): Decodio GREEN evaluates the time synchronization and frequency offset between signals acquired from two Decodio RED instances.

**HIGHLIGHTS**

- Post-processing of multiple channels simultaneously
- Programmable widgets for output visualization
- Plugin architecture
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 solutions in radio technology including spectrum monitoring systems with a focus on VHF/UHF digital PMR transmission standards.

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**TECHNICAL DATA**

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>9 kHz - 6 GHz (optional 14 GHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum real-time bandwidth per receiver</td>
<td>80 MHz (27 MHz for portable systems)</td>
</tr>
<tr>
<td>Maximum number of parallel narrow-band channels</td>
<td>256</td>
</tr>
<tr>
<td>Narrow-band channel bandwidths</td>
<td>variable from 8 kHz to 20 MHz</td>
</tr>
<tr>
<td>Digital protocols</td>
<td>TETRA, DMR, dPMR, NXDN, P25, D-STAR, Tetrapol</td>
</tr>
<tr>
<td>Analog demodulation</td>
<td>AM, FM, LSB, USB, CW, I/Q</td>
</tr>
<tr>
<td>Emission detection</td>
<td>&lt; 2 seconds</td>
</tr>
<tr>
<td>Remote control interface</td>
<td>JSON based IP interface</td>
</tr>
<tr>
<td>Supported receivers</td>
<td>Available on request</td>
</tr>
<tr>
<td>Operating system</td>
<td>Windows</td>
</tr>
</tbody>
</table>

### Decodio TDoA

<table>
<thead>
<tr>
<th>Minimum number of sensors</th>
<th>3 (one central Decodio TDoA instance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal bandwidth</td>
<td>variable from 12.5 kHz - 2 MHz</td>
</tr>
<tr>
<td>Maximum number of signals</td>
<td>16</td>
</tr>
<tr>
<td>Minimum data connection rate</td>
<td>Not applicable, adaptive streaming</td>
</tr>
<tr>
<td>Supported TDoA sensors</td>
<td>Available on request</td>
</tr>
</tbody>
</table>

#### Typical accuracy*

<table>
<thead>
<tr>
<th>RF signal</th>
<th>Protocol data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control commands</td>
<td>Contents, metadata</td>
</tr>
<tr>
<td>I/Q channels</td>
<td>Quality measurements</td>
</tr>
</tbody>
</table>

*Accuracy depends on emitter location, multipath environment, signal length, signal bandwidth and signal-to-noise ratio.

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**DECODIO SYSTEM**

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Decodio develops solutions in radio technology including spectrum monitoring systems with a focus on VHF/UHF digital PMR transmission standards.

Our PC-based decoding, recording and signal analysis solutions combined with our own database and distributed architecture enable a seamless integration into existing systems.

The company, founded in 2012, delivers innovative applications for spectrum management, network monitoring, voice logging and SIGINT-COMINT for both end users and system integrators.

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**ABOUT**

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