NEDAV

WIR VERSTEHEN DIE ZEICHEN DER ZEIT

KEEPING PACE WITH THE SIGNAL OF TIME

ASTRID-NG

Work Place with Direction Finder

Multi channel, wideband, interception,
analysis, 500 kHz bandwidth
(2 MHz optional)

ASTRID-NG – at a glance

ASTRID-NG is our work place product fit for the analyst's day-to-day work. Multi channel direction finding, wideband reconnaissance, and a lot of analysis capabilities are reasons why ASTRID-NG is extraordinary.

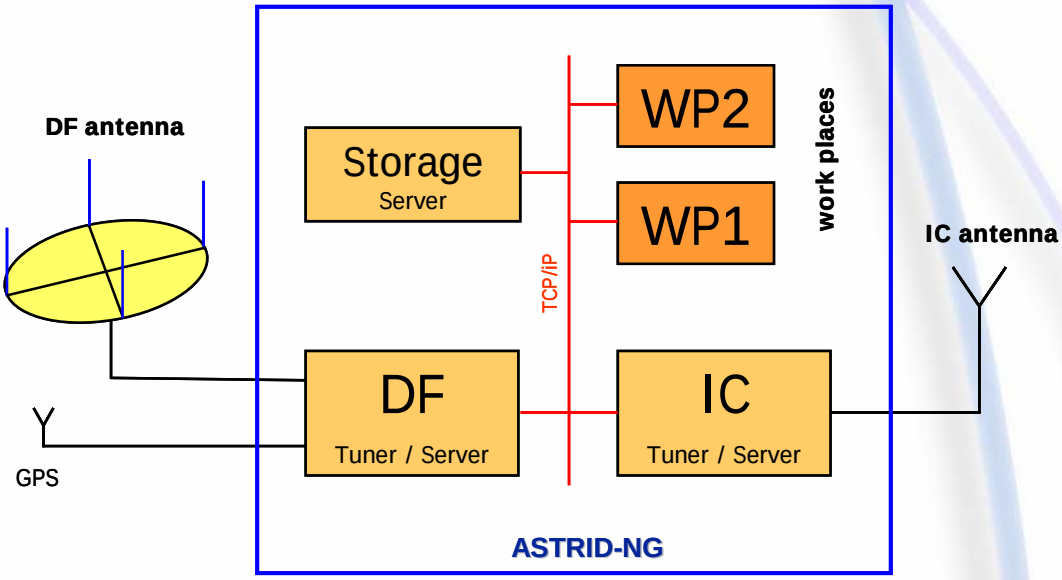
ASTRID-NG is more than one device: It comprises many solutions by software configuration. This is the way how ASTRID-NG takes into account the manifold of the analyst's typical but different tasks. Each configuration can be optimised for a specific task and all configuration data are stored into a setup file. Every time the analyst has a repeating task, he will reload the corresponding setup file and uses his optimised device.

ASTRID-NG comprises our standard modules ComCat tuner, ReProS for data recording and archiving, CCI-DF for online monitoring and analysis, and CCI-Offline for offline analysis with powerful tools like OC-6040. ASTRID-NG provides many analysis and classification capabilities for automated and interactive investigations. Beside this, ASTRID-NG is open to include customer specific analysis software. There are two comfortable interfaces available: either implementation of your software as virtual device following our interface specifications, or use of our MATLAB XML interface.

ASTRID-NG is characterised by the following features (partially options):

- Multi channel direction finding (Watson Watt) and wide band HF interception with 500 kHz real-time bandwidth (2000 kHz on request)
- 500 kHz wideband recording on hard disk e.g. for 300 minutes and disc long-term archiving (2000 kHz, additional storage capacity on request)
- Fast switch for operators between online and offline mode
- Open for customer specific software (virtual device, MATLAB)
- Quick view on wideband signal while interception and recording, audio monitoring (listening-in)
- Robust demodulation of ASK, FSK, PSK, hybrid, QAM
- Extraction of narrowband segments and signals
- Automated hopper detection and de-hopping
- Support for identification of related hoppers, e.g. by the use of DF results
- Automated signal classification and activity list
- Modulation type analysis
- Additional analysis products available as plug-ins, e.g. OFDM analysis
- Software defined radio technology
- Client-server concept makes system extensions easy, e.g. additional work places
- Already introduced to customers
- Easy to understand and to operate

Application for semi mobile use. ASTRID-NG comprises (from top): Synchronisation devices, four ComCat tuners, antenna connection board, LAN switch, DF server, Intercept server, power supply. Work places (not visible) are connected by LAN.



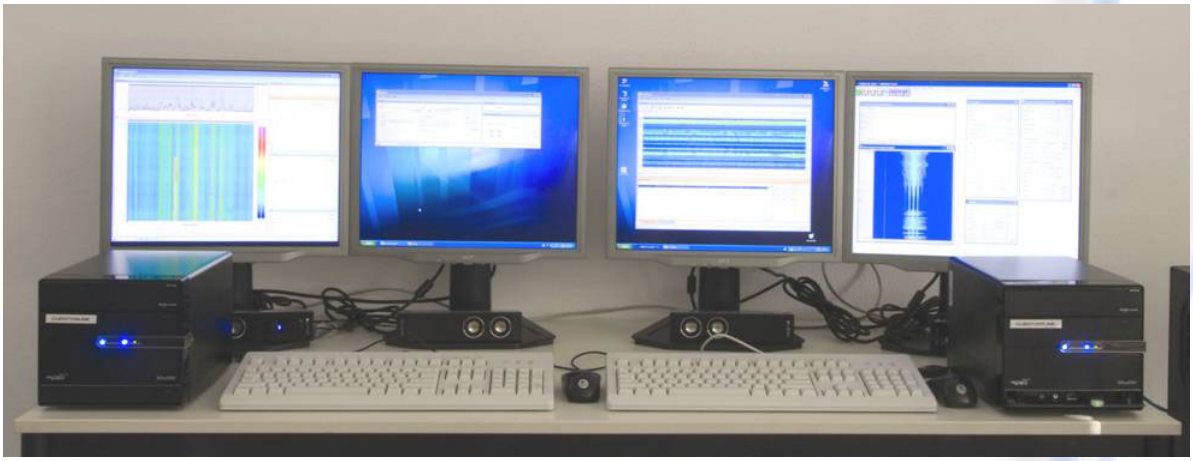
ASTRID-NG comprises tuners and server for direction finding, tuner and server for intercept antenna, and a free number of work places, e.g. two. Server and work places (clients) are connected via TCP/IP network. Each server is designed for data recording, includes archiving functionality and quick look capability through navigation data.

An Adcock direction finding antenna, provided by MEDAV or by the customer, is connected to three ComCat tuners. Each tuner calculates at least power spectral density. DF spectra are evaluated by the DF server. Navigation spectra are calculated by the IC server. GPS antenna is optional required for time synchronisation of the system (DF tuners; DF and IC system).

The intercept antenna, also provided by MEDAV or by the customer, is connected to its related ComCat tuner, which performs the calculation of power spectral density and complex base band (CBB) signal.

(DF) Tuners can be located on a major distance to the related server, e.g. a few kilometres. Then a fibre optic LAN is suitable to connect tuners to the server. In this case, LANtime is required for synchronisation.

Work places



Two work places are suitable to perform both tasks in parallel: Online monitoring and offline in-depth analysis. It is opportune to use two TFT displays for each PC, and to separate displays for visualisation and parameter setting. PCs used are connected to servers by LAN (local area network). Supported operating systems are Windows and LINUX (VM mode).
Additional work places can easily be integrated into the network.

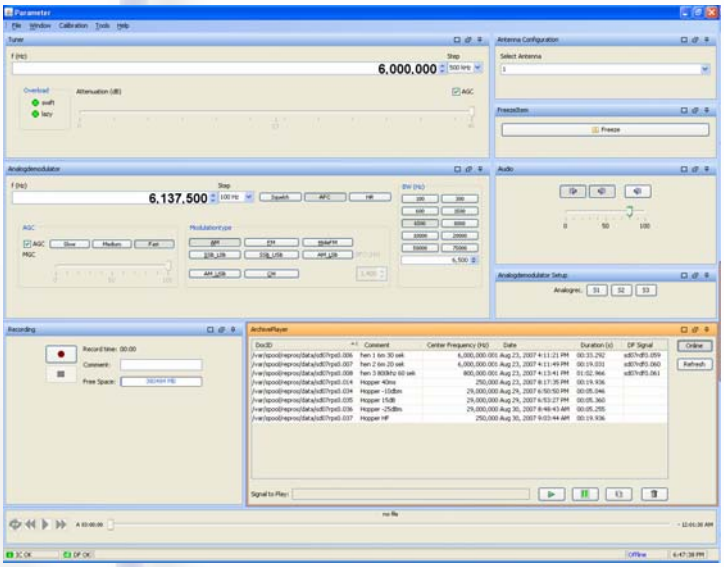
Online monitoring, analysis & listening-in

Wideband DF and Intercept display

ASTRID-NG lets the user select any frequency band up to the maximum band width of the system, 500 kHz (2000 kHz optional) within the HF band of 100 kHz to 30 MHz for display in real time as a spectrum and colour spectrogram (**panorama display**).

Azimuth information is displayed as spectrogram whereby colour represents the related azimuth. Statistical details of the azimuth are available by calculation and display of histogram.

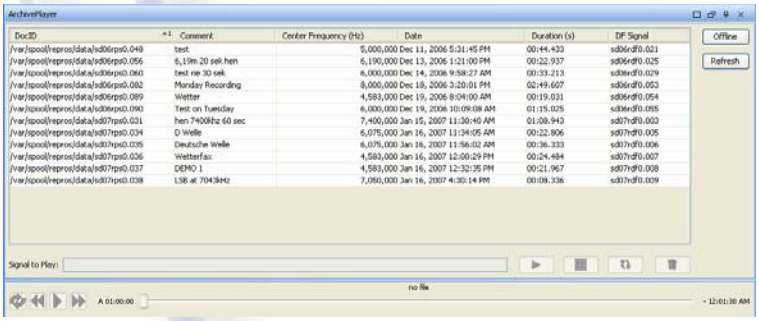
For more detailed analysis, subspectra can be selected for display in an enlarged view (zoom) by means of a window cursor or direct keyboard input. All zoom operations can be reversed individually (zoom-out).



Parameter and Audio Monitoring User Interface

The listening-in function is intended for quick radio surveillance. The user simply specifies the frequency, either by clicking on it with the mouse in the spectrum or spectrogram, or by entering a radio frequency directly.

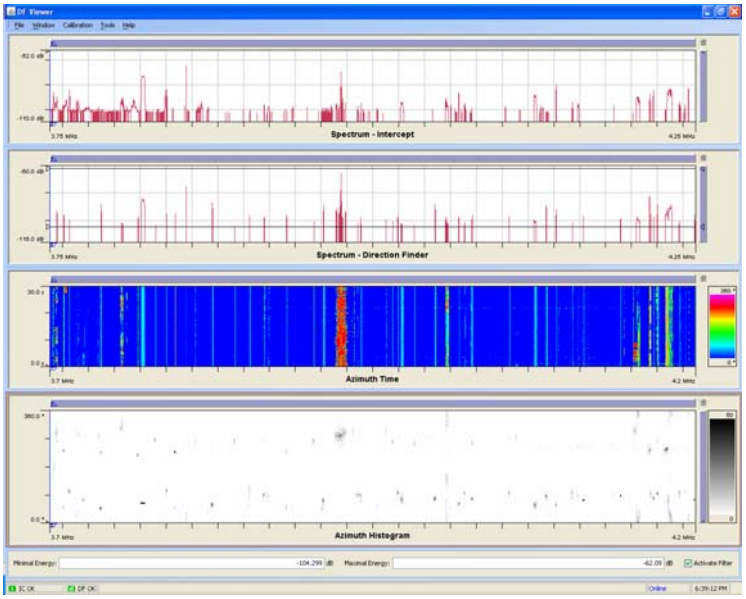
After selecting the appropriate modulation type, the demodulated audio signal is output to the loudspeaker. Typical analog demodulator parameters like bandwidth, BFO, etc. can be set. Settings of demodulation can be stored and recalled for a quick operation.



Parameter Panel Archive Player

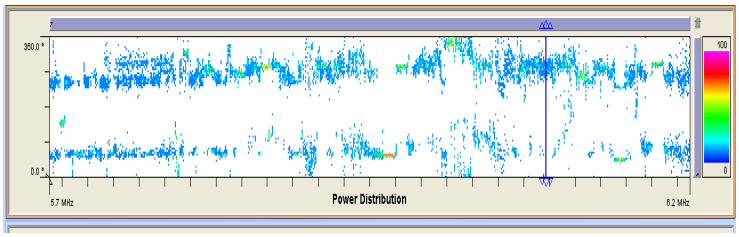
The online hard disk recording mode is used for recording up to 300 minutes of signal scenarios during actual operation. After starting hard disk recording, the actual scenario including all DF and intercept data is continuously stored on the DF and Intercept server.

Online wideband multi-channel direction finding

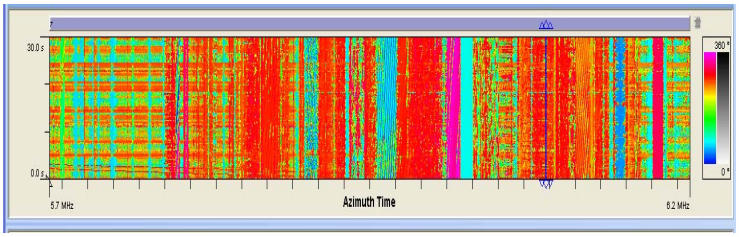


Display with spectra from Intercept and Adcock antenna, Azimuth spectrogram and Azimuth histogram.

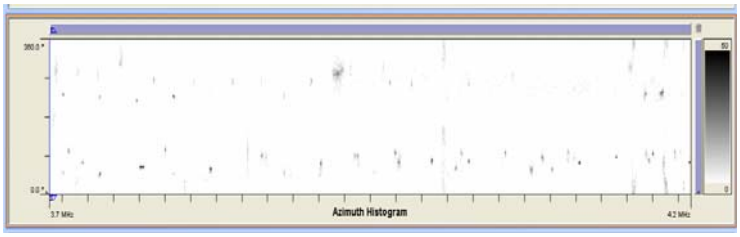
In the 2nd viewer horizontal cursors are visible. These cursors are tools to describe the sector of interest for histogram evaluations (see below).



DF Display: Power Distribution (colour: power)



DF Display: Time over Frequency (colour: Azimuth)



DF Display:Azimuth over Frequency (colour: occurrence)

The simultaneous real-time display of frequency and directional information that ASTRID-NG provides in various display modes, offers advanced tools to effectively direction-find

- frequency constant and
- frequency agile transmitters

at low directional error, over the whole 500 kHz window selected.

The traditional display combination shows frequency and direction finding (DF) information. The operator can select between the intercept channel and the DF channel for spectra and spectrogram displays (top two graphs).

The third display shows the colour spectrogram of the azimuth.

DF information can be presented in three different graphs:

- Azimuth over Frequency
- Time over Frequency
- Azimuth over Time

Differences in the signal power received from various transmitters can be easily identified in the spectrum presentation.

But frequency agile or intermittent transmitters are hard to detect.

With the use of the Azimuth histogram (colour resp. grey scale = rate of occurrence) the operator can solve this problem. Now it is possible to separate signal mixtures in the wideband scenario by using the DF information.

In order to avoid swamping with data from all directions, ASTRID-NG provides facilities for defining a sector of interest (azimuth range). Signals that do not originate from the sector of interest will not appear in the frequency displays either.

Offline analysis, classification, demodulation

ASTRID-NG comprises many offline analysis capabilities of wideband and narrowband signals and can be extended by optional plug-ins. ASTRID-NG provides fast access to data stored on DF and Intercept servers, quick navigation through these data, segmentation and interactive or automated analysis, classification and demodulation.

Hopper analysis

Offline Wideband Analysis with the CCI-Offline User interface

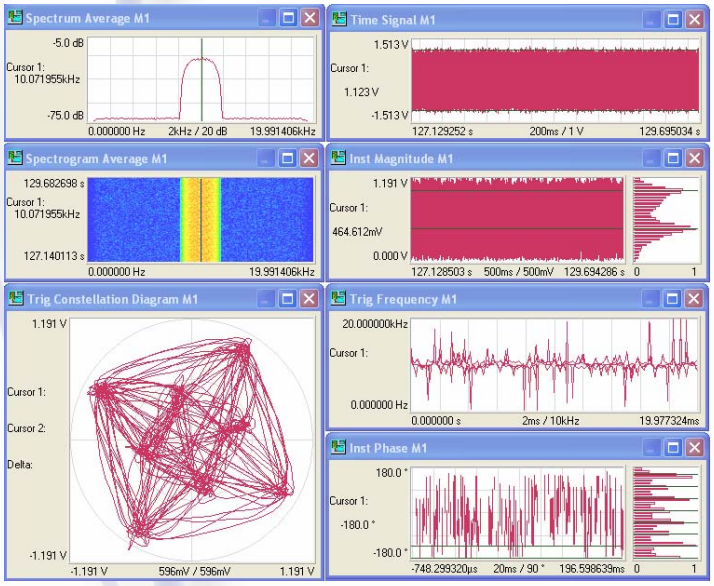
DF information can be used for Hopper evaluation.

Analysts use ASTRID-NG to recover the originally narrowband signals from frequency agile transmitters (frequency hoppers). Signals that are spread over hundreds of kHz in the HF band, can be detected and converted back to just a few kHz.

The first step in the processing is the automated Hopper Detection via Matched filter technique. The algorithm looks for a fitting pattern in the time and frequency domain. Result is a detection list of the detected hops.

Each emission detected in the visualization can be segmented interactively and extracted to post-processing tools. Results are narrowband signals for a following analysis and processing.

Interactive modulation type analysis



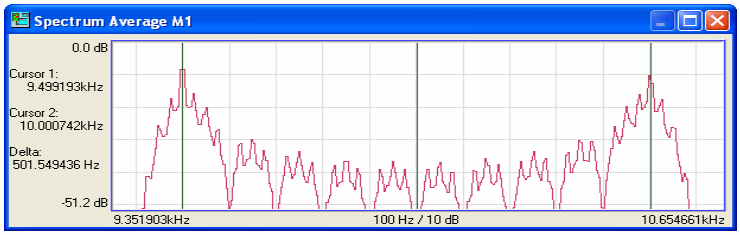
Displays of narrowband modulation type analysis

In addition to spectrum and colour spectrogram displays ASTRID-NG offers several narrowband features that are particularly useful in the offline analysis of digitally modulated signals:

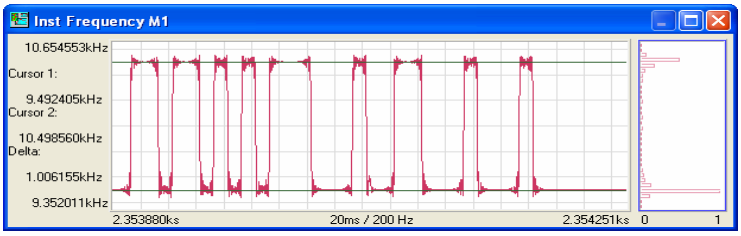
- instantaneous magnitude display
- instantaneous frequency display
- instantaneous phase display
- constellation diagram (phase star)

Analysing the instantaneous values (magnitude, frequency, phase) and lining them up over the transitions is a proven method to extract the precise carrier frequency and modulation rate.

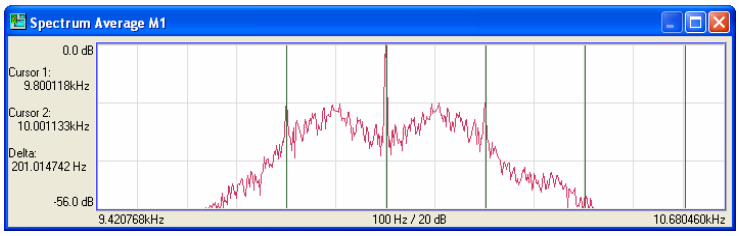
With suitable experience and effort, analyses can be performed in such detail that even finger-printing type data can be extracted.



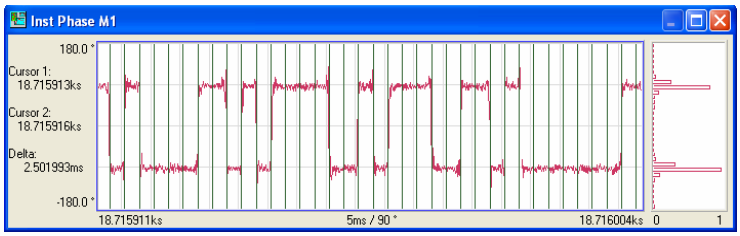
Determining the carrier frequency of FSK signals using spectral analysis of the time signal (after exponentiation)



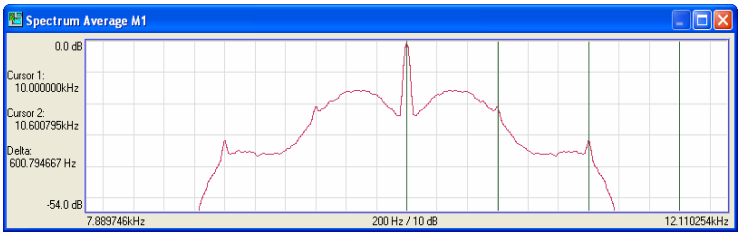
Determining the shift of FSK signals with a small modulation index by reading off the instantaneous frequency



Determining the carrier frequency, modulation type and modulation rate of PSK signals using spectral analysis of the time signal after exponentiation



Determining the modulation rate by using the harmonic cursor in the instantaneous phase trace



Determining the modulation rate of PSK signals using spectral analysis of the instantaneous magnitude

As long as the signal carrier frequency has been found with sufficiently high accuracy, constellation diagrams can be obtained that are characteristic of the signal, supplying extra information about the modulation type.

Computation and subsequent spectral analysis of the magnitude can be used to measure the modulation rate of signals where the magnitude collapses at the transition between two symbols (e.g. PSK signals). This technique is particularly robust and is also suitable for very noisy signals.

Passing PSK signals through non-linear operations (raising to the power of 2/4/8) before spectral display, often enables the carrier frequency, modulation rate and modulation type to be determined without significant effort, even for noisy signals.

Two cross-hair, harmonic or bonded cursors are provided in each display for taking display readings.

Any frequency band within the bandwidth of the imported signal segment can be defined by keyboard input, drag & drop or marker. The so defined band can then undergo further analysis in real time or offline.

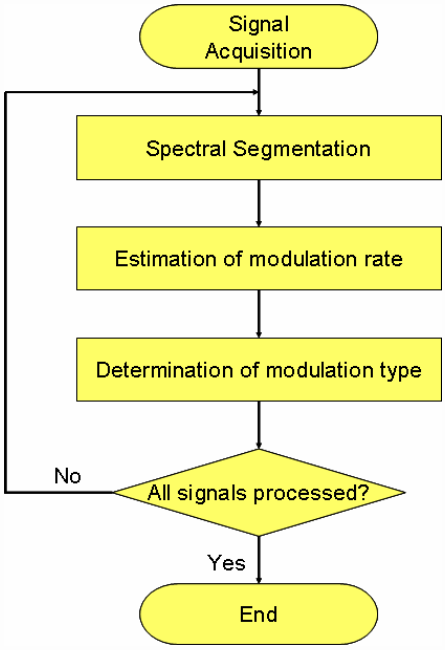
Interesting details in non-stationary or noisy signals may be revealed by making suitable changes to averaging parameters (linear averaging, exponential averaging, peak-hold, number of averages). Gain, frequency resolution, dynamic range can also be varied and band rejection filters introduced to aid analysis.

Demodulation of digital modulated signals

Automated classification of transmission scheme and modulation type

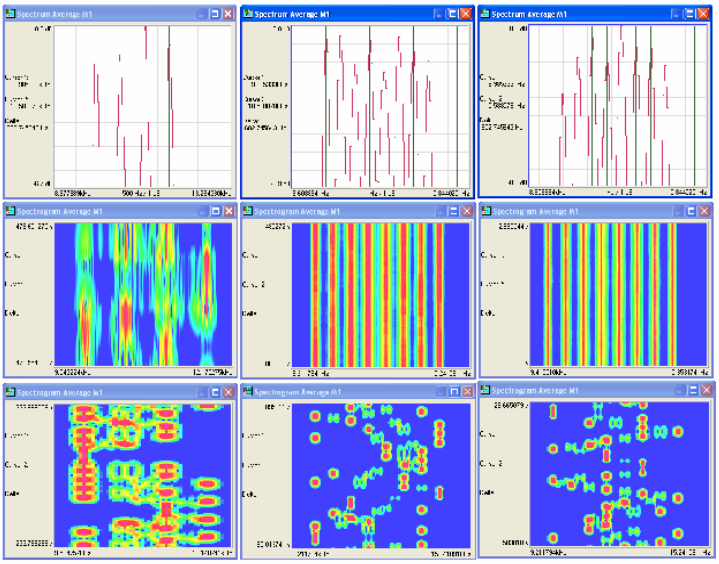
ASTRID-NG provides special functions for classifying narrowband, digitally modulated single-carrier and multi-carrier signals automatically with high hit certainty for the digital modulation type (refer to figure) and transmission scheme.

Classification is performed offline on the extracted narrowband signal. Each activity is listed with its centre frequency, bandwidth, power, modulation rate, modulation type and transmission scheme.



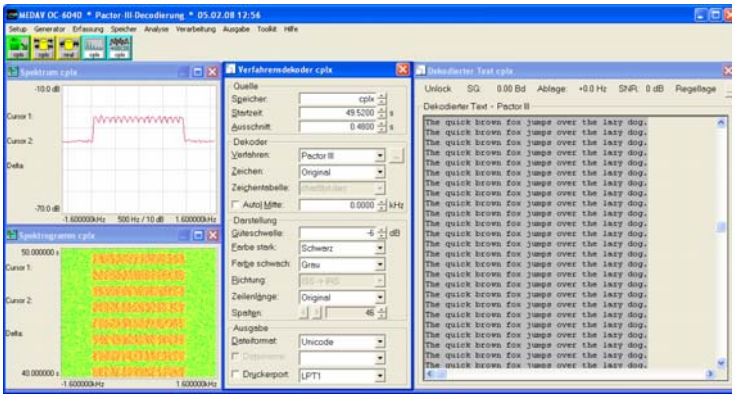
Demodulation

ASTRID-NG contains various demodulators for demodulating numerous generic types of digitally modulated narrowband signals. These have been designed for optimum flexibility and robustness. In order to cope with poor signal quality caused by fading and atmospheric interference in the HF band, the demodulators are able to compensate for large differences between specified and actual value of frequency and/or modulation rate.

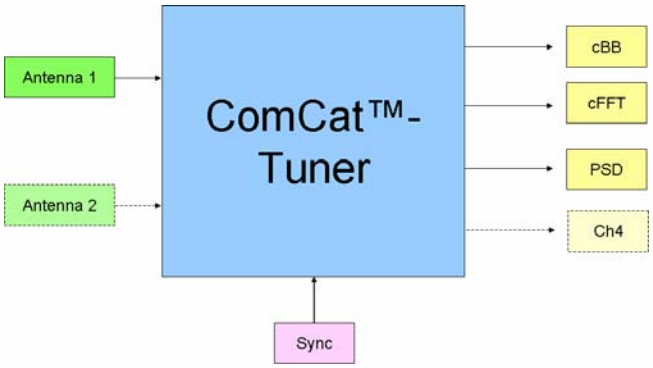


Universal Analyzer OC-6040

ASTRID-NG uses **OC-6040 for in-depth analysis**. OC-6040 is a powerful analyser with a lot of standard features and optional plug-ins, e.g. signal generator, OFDM analysis, demodulation and decoding.



ComCat Tuner



ASTRID-NG configuration:

cBB:	complex base band (raw data) for intercept channel
cFFT:	complex FFT for DF channels
PSD:	power spectral density for all channels
Ch4:	not used for intercept line used for internal calibration in DF lines

Antenna 1: Intercept or an Adcock line (NS, OD, BW)
Antenna 2: not used for ASTRID-NG application

Sync: synchronisation of DF tuners, e.g. GPS

ComCat tuner is a standard tuner within MEDAV's product portfolio, suitable for the complete HF range from 100 kHz up to 3 GHz with synchronisation capability.

ComCat tuner is not only a wideband tuner with a digital down converter but also a powerful computing device.

ComCat tuner is software defined radio. This means that all parameter setting is performed by software. The tuner has four output channels. User may select complex base band, complex FFT or power spectral density for each output channel.

User may connect two antennas to ComCat tuner to extend the total frequency range. The tuner is equipped with an internal switch to control and optimise the input channel.

ReProS and Storage Server

ReProS:

Storage capacity: 300 minutes to hard disk array ReProS is realized on LINUX platform.

Storage server:

Storage capacity and long-term archiving is usually customised, e.g. 3 TByte.

ReProS is a standard recording and archiving device within MEDAV's product portfolio.

ReProS is designed for data management, online recording and to serve work places for offline analysis. Navigation data supports fast surfing through the huge amount of data, e.g. to search for special activity in the signal recorded.

ReProS provides computing power to calculate DF spectra and navigation data (intercept line).

Antennas and calibration

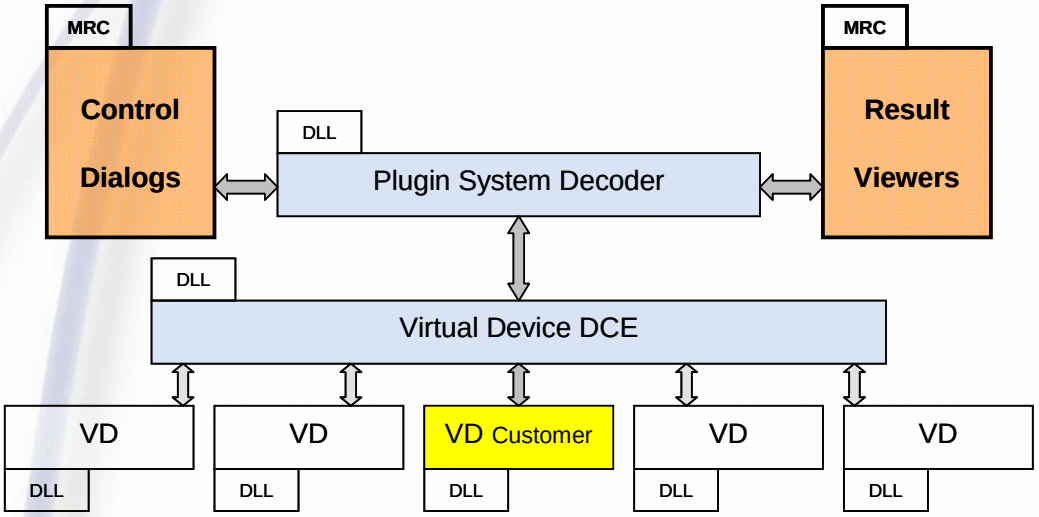
Customer can use his Adcock and Intercept antenna available (refer to specifications), or MEDAV may provide suitable ones.

ASTRID-NG can basically be extended for other direction finding techniques, e.g. interferometer DF, or for location of transmitters.

Calibration of DF antenna used is requested.

MEDAV offers corresponding service and maintenance support.

How to integrate own software modules



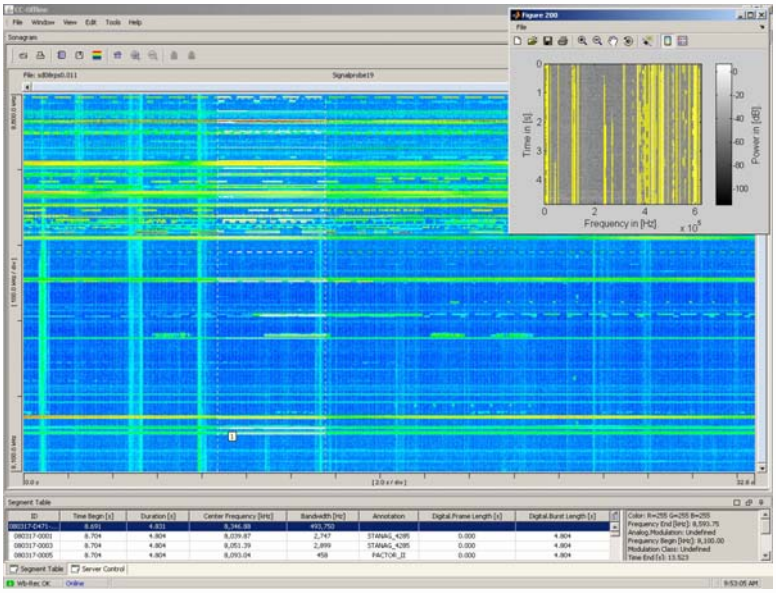
Customers can integrate third party software or own software for offline analysis through the VD Virtual Device interface. Specification is available on request. Benefits of this approach to extend the system's analysis capability are that operator panels follow the system design concept and analysis parameters are synchronized.

Another comfortable possibility is the integration of MATLAB programs. MATLAB is a very popular and powerful tool for algorithm development.

A MATLAB interface is available on ASTRID-NG to support the development of new algorithms and the application at the analyst's work place.

The MATLAB interface uses CCI-Offline for access to the signal archive (ReProS), from the beginning of development on. While development process, MATLAB visualisation tools will be used.

After finishing the design process MATLAB runtime code will be generated and operated as CCI-Offline plug-in. Results can be displayed under MATLAB and stored as XML files. CCI-Offline can import these XML files for further processing.



The MATLAB interface to CCI-Offline is a powerful tool to design and to apply own algorithms to ASTRID-NG.

The complete bi-directional exchange of signal data and results between CCI-Offline and MATLAB runtime code makes ASTRID-NG open and fit for fast and comfortable extension of analysis capabilities.

Use of that interface for design purpose requires MATLAB R2007A including tool box "MATLAB builder for JAVA".

Configuration approaches

ASTRID-NG is configurable in hardware and software.

- **Work places**

  Sometimes two work places may not be sufficient to monitor and to exploit the signal scenario recorded. Then it makes sense to integrate additional PCs or notebooks into the LAN as additional work places (please ask for minimum requirements to PC specification). Each extraordinary PC needs a software licence for the corresponding software. Due to the client-server system of ASTRID-NG, this extension is easy to customise.

- **Servers**

  Hardware configuration of servers available may be upgraded. Please provide us with your specifications.

- **Analysis plug-ins**

  ASTRID-NG comprises a set of analysis features in its modules CCI-DF, CCI-Offline and OC-6040. The standard set of functionality can be upgrade by optional software products (plug-ins) for demodulation, decoding, bit stream generation, signal generator et al.

- **Configuration of CCI-Online**

  CCI-Online uses parameter panels and several displays for system control, monitoring, listing-in and demodulation of analogue modulated signals. User can configure the different operator panels and displays to become his best “configuration” approach for specific tasks. Any such configuration can be stored into a setup file. Setup files can be reloaded, if the related tasks occur again, or as a starting point for a new task.

- **Configuration of CCI-Offline**

  CCI-Offline uses parameter panels and several displays for system control, navigation through wideband data, segmentation etc. User can configure all panels and displays similar to CCI-Online.

- **Configuration of OC-6040**

  Configuration capabilities of OC-6040 are very powerful. OC-6040 is a toolbox for the design of application (signal) related analysis tasks. The opportunity of configuration increases the degree of freedom and improves economics. Configuration is performed by software. Definition of special analysers, connecting of analysers and multi channel realisations are possible.

Technical Data

- **Signal acquisition (by ComCat-Tuner)**
  Channels: 1 (intercept) & 3 (Adcock DF)
  ADC: 120 MSamples / sec
  Dynamic range: 85 dB (SFDR)
  Gain Control: Automatic / manual
  Impedance: 50 Ω
  Connectors : N-type - female

- **Spectral analysis (CCI-DF)**
  Frequency range: 100 kHz - 30 MHz
  Frequency zoom
  Analysis bandwidth: 500 kHz (2 MHz on request)
  Frequency resolution: 153 Hz
  User-definable centre frequency
  Displays: colour spectrogram / spectrum
  Averaging: by smoothing
  Mode of operation: online / offline

- **Audio monitoring (listening-in)**
  Demodulation:
  AM / USB / LSB / FM / CW with selectable BFO
  Transmitter selection: mouse click & marker / input
  Volume: manual, AGC

- **Signal recording & archiving (ReProS)**
  Mode: online parallel to actual operation
  Stored signals: intercept & DF
  Bandwidth: 1 x 500 kHz (CBB) Intercept
  3 x 500 kHz (DF spectra)
  Storage capacity (ReProS):
  max 300 minutes @ HD-array
  Storage Server capacity: 3 TByte
  Long-term archiving (work places): @ Blu Ray Disc

- **Spectral analysis (CCI-Offline)**
  Frequency range: 100 kHz - 30 MHz
  Navigation: in time and frequency window
  Interactive Segmentation
  Plug-In: Audio Listening-In & OC-6040
  Displays: Colour panorama spectrogram
  Mode of operation: offline

- **Hopper Detection & Dehopping (Plug-in CCI-Offline)**
  Frequency range: 100 kHz - 30 MHz
  Input bandwidth of non-linearized signal: 500 kHz
  Mode of operation: interactive offline

- **Wideband multi-channel direction-finding**
  Method: multi-channel DF (Watson-Watt)
  Frequency range: 100 kHz - 30 MHz
  Frequency zoom
  Bandwidth: 500 kHz / non scanning
  Zoom in frequency & time window
  Azimuth range: 0 - 360°
  Azimuth zoom:
  Sector width: 1 – 360°
  User definable centre of azimuth sector
  Bearing error: max 2° RMS (depending on antenna)
  Displays:
  amplitude vs. frequency (spectrum)
  time vs. frequency/colour = amplitude (spectrogram)
  azimuth vs. frequency/colour = rate of occurrence
  time vs. frequency / colour = azimuth
  azimuth vs. frequency / colour = power
  Mode of operation: online / offline

- **Cursors for taking display readings**
  Number: two per display window
  Type: simple (measurement), signal (demodulation), harmonic (multi cursor grid)

- **Narrowband analysis of modulation type**
  Frequency range: 100 kHz - 30 MHz
  Frequency zoom
  Analysis bandwidth: 90 Hz – 30 kHz
  Frequency resolution: 75 MHz – 610 Hz
  User-definable centre frequency
  Window functions:
  Rectangular, Hamming, Hann, Blackmann, Taylor
  Displays:
  Colour spectrogram / spectrum
  Instantaneous magnitude / frequency / phase constellation diagram
  Processing: exponentiation (2 / 4 / 8)
  Mode of operation: offline (narrowband)

- **Automated signal classification**
  Frequency range: DC – 30 kHz
  Output of results as: list on screen, file
  Mode of operation: offline (narrowband)

- **Demodulation of digital modulated signals**
  Demodulator bandwidth: max. 30 kHz
  Demodulation: absolute, differential, CCITT
  Number of channels: 1 - 64
  Total baud rate: 1 - 4800 Bd
  Displays: status, eye pattern, const. diagram
  Mode of operation: offline (narrowband)

- **Fibre optic interface (for DF sensor) in case of distributed system**
  Type: LAN
  Cable length: max 2 km

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