HyperCSM

A powerful carrier monitoring system

HyperLoc / HyperMon   Integrated geolocation and monitoring solution
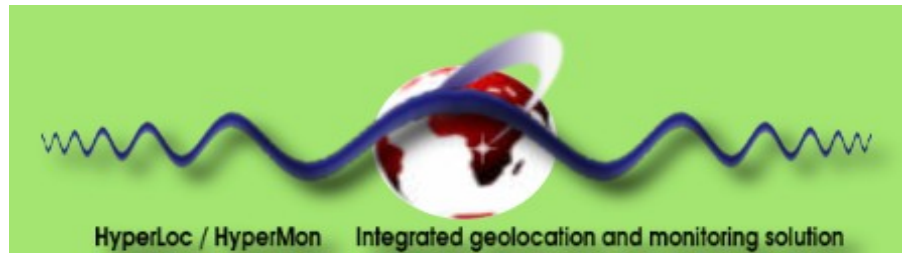
NovaGrid S.A.S.   Release 3.2, January, 2015

Context

In the domain of signal monitoring, it is necessary not only to detect a signal but also to tell what the signal is and try to access to the information content.

The solution NovaGrid offers is one of the fastest and "smartest" ever done, to detect, analyse and classify, at the same time, the multitude of signals conveyed by communications satellite transponders or by the HF communication bands. To be successful in providing the best quality of service, react to intrusions, NovaGrid supports you in solving these complex tasks by providing all-inclusive solution for analysing, characterizing and monitoring most types of signals in all frequency bands. All the computations are done in software on generic processors.

Our solution is based on 'state-of-the-art' digital signal processing techniques and a new type of graphical user interface (GUI) for easy and intuitive use. This powerful tool, is able to analyse a complete satellite transponder or an HF terrestrial band at a very high speed. The types of signals analysed range from simple analog AM or Morse signal (HF) ... to modern digital signals like DVB-RCS (satellite) or OFDM (WLAN). As new communication standards regularly appear in all bands, our modern solution is easily extensible and adaptive. Therefore, it is also a development environment, allowing the setup of DSP solutions to treat any new problem that will inevitably appear. The software is associated to several SQL databases for storing and retrieving analysed signal parameters, communications standards, monitoring plans, etc...

The software package runs on one or several standard PCs depending on the configuration of the proposed CSM solution. The software is a 'state of the art' design, oriented towards ease of operation.

CSM software

Data acquisition and display

The starting point of any CSM solution is data acquisition. HyperCSM get data using TCP requests to the HyperSpectrum software. HyperSpectrum make measurements, carriers and interference detection and carrier checking. HyperCSM send alarms if necessary, defines the frequency plan and manage alarms display.

Several supervisor modules (HyperCSM) can run simultaneously (connecting to the same instance of HyperSpectrum) providing high performances in the surveillance and measurements of a high number of transponders as well as Satellite Monitoring and spectrum analysis.

Databases

The software comes along with a common database with HyperMon and HyperSpectrum :

- A "satellite database" that contains most of the geo-synchronous and geo-stationnary telecommunication satellites currently declared.

- For each entry, it provides the ephemeris, the coverage in uplink and downlink, the transponder matrix, etc ... Of course, the user is allowed to create new items in this database or to modify already existing items.

- A "transmitters" database for storing analysis results (standard, bit rate, carrier frequency, hour and date of analysis, ...),

- A "monitoring plans" database.

- The possibility of exporting the results (XML, spreadsheet, ...)

- The possibility to automatically fill in the database with all the measurements and parameters acquired during a blind spectrum analysis of the different transponders.

Carrier Monitoring

High level description

The main features are the following :

- Conformity test according to the frequency plan

- Detection and reporting of the unknown or unauthorized signals

Data generated by these functions are managed in a SQL database containing a list of satellites and any related data.

Checked carrier selection

Traffic carriers are registered in the database. The registration can be done manually or using the HyperMon blind analysis capabilities. The surveyed
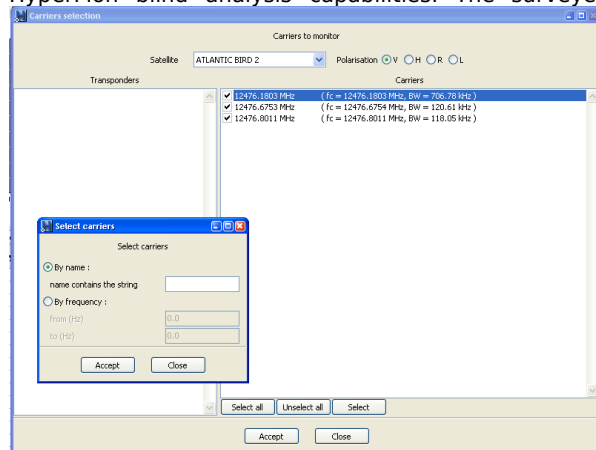

carriers are then chosen browsing the database. Up to 1000 carriers can be checked with the same instance of HyperCSM.

Checked carriers

Surveyed carriers are displayed in a specific spreadsheet. Each line corresponds to a given carrier and its properties are displayed (center frequency, bandwidth, C/N and EIRP). The sampled spectrum is displayed on the top of the window and the display parameters are controlled locally. This display change in real time and a colour code is used to inform about each carrier status :

- [Green] authorized/declared carrier is present and in conformity with database,

- [Orange] first stage of non conformity,

- [Red] confirmed non conformity of the authorized/declared carrier (sends alarm if configured).

With only a mouse click, the user can remove the carrier from the surveyed carriers list.
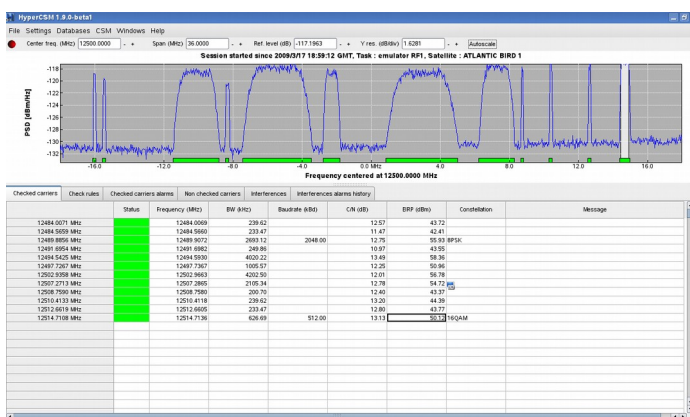
Focus (or 'on-demand measurement') :

A on-demand measurement on a carrier selected by operator allows to estimate and follow the complete set of parameters of this carrier continuously and at a high rate thanks to a dedicated higher priority supervisor dedicated to this carrier. With this type of supervisor the '*line-up*' operations can be done

The focus display shows : real time values for each parameters (center frequency, bandwidth, C/N and PIRE), real time constellation display, real time «carrier under carrier» display and alarms history.
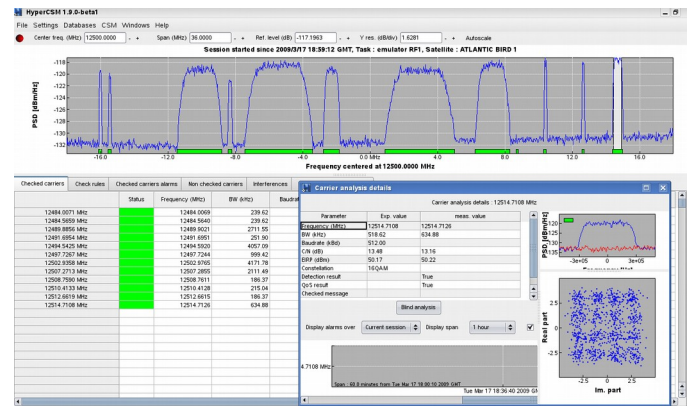
Measurements

For the « commercial telecommunication satellite » the modulations monitored are Single Carrier (SC). Measured parameters are:

| parameter	unit	description	precision	comment
EIRP	dBm		+/- 0.5 dB	
Fc	Hz	Center frequency	+/- 0.5% or 0,01%	Relative to BW
BW	Hz	Carrier bandwidth	+/- 1%	Relative to BW
N0	dB	Noise density	+/- 0.5 dB	
C/N0	dB	Carrier to noise density ratio	+/- 0.5 dB	
C/N	dB	Carrier to noise ratio	+/- 0.5 dB	
Eb/N0	dB	Bit energy to noise density ratio	+/- 0.5 dB	Digital com only
Modulation		All MPSK and MQAM for carrier checking. All modulation scheme for blind analysis.		
SNR loss		QoS option		
Bit rate	b/s	QoS option		
Baud rate	Bd	QoS option		
CuC	dB	Carrier under carrier detection (QoS option)		

The measurement rate is :

- RF : up to 100 carriers / s

- QoS : up to 20 carriers / s

- All parameters in "blind" mode : up to 30 carriers / min.

Alarms reporting

When a carrier does not match with the frequency plan (checked rules are defined by the user), an alarm is triggered. All alarms for checked carriers

are displayed in an « alarms history » graphic over a period up to one month.

A double click on the alarm shows the carrier properties at the alarm event time. A blind analysis is possible using a remote TCP access to HyperMon.
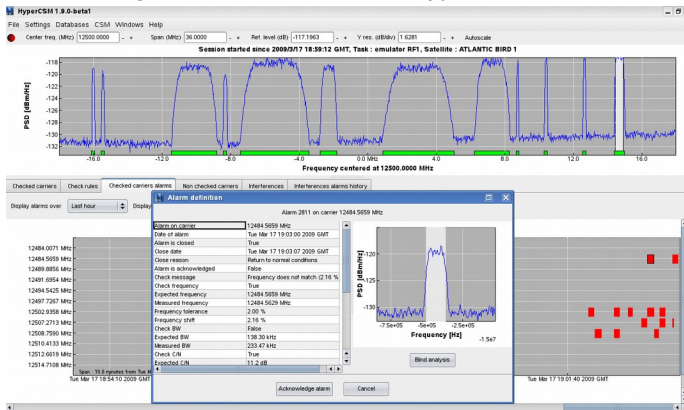
Non surveyed registered carriers

A specific spreadsheet is reserved to display all registered carriers which are not checked. This spreadsheet shows registered detected carriers (grey lines) and registered carriers which are not detected (white lines). With a mouse click, a given carrier can be checked (it will be display in the checked carriers spreadsheet).
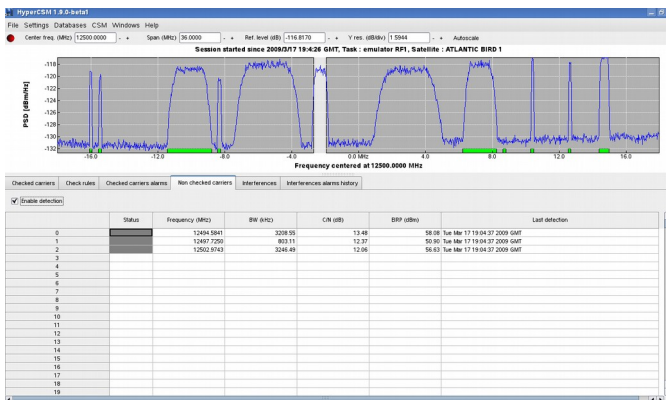

Interference detection

As the supervision is attached to the database (containing frequency plan, carrier authorization, scheduling, ...) the system is capable to detect the non authorized carriers (interferences). A complete analysis in blind mode is done on this carrier and an alarm along with the results of the analysis is raised.

The same color code is used for interferences :

- [Orange] first stage of interference detection,
- [Red] confirmed interference detection (sends alarm if configured).

Each interference can be analyzed with HyperMon and registered as a known carrier (this carrier will then appear in the registered carriers spreadsheet).

A alarms history is available showing all interference detection alarms over a period up to one month.
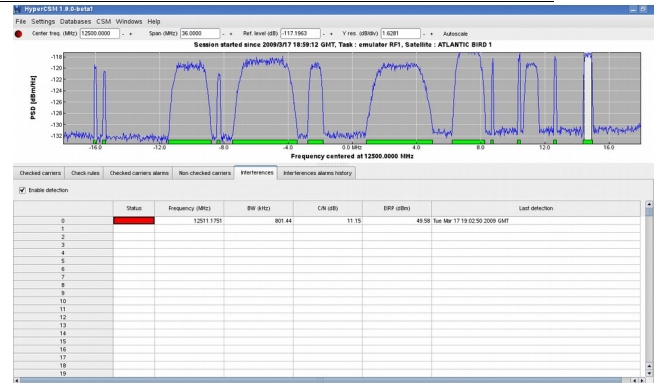
Monitoring task and carriers definition

The task definition is saved in the database and can be reloaded. By default, HyperCSM works in a «best effort» mode. The user can define the periodicity of measurements.

The carriers definition could be done using two modes :

- **Normal Mode**
  In order to define a MT on a particular frequency band, the monitored transmitter(s) must be declared in the « Transmitters » database.

- **Quick Mode**
  This mode takes advantage of analysis capabilities of the software. It allows to obtain, after a complete analysis of an acquisition (HyperMon), a reference state. With one click, all analysis results of each carrier could be stored in the database as the declared frequency plan. Carriers could also be defined by loading an XLS or CSV format file.

Alarms policy

Alarms are triggered when interference detection or if a carrier does not match the frequency plan. For surveyed carriers, the supervised parameters are the following :

Parameters	Units	Mode
Center frequency	Hz	Absolute or relative excursion
EIRP	dBm	Absolute excursion
Carrier Bandwidth	Hz	Absolute or relative excursion
C/N	dB	Absolute excursion
SNR	dB	Absolute loss threshold
CUC	dB	Absolute threshold
Modulation	<string>	Exact match
Symbol rate	Bd	Exact match

These alarms are automatically included in the database associated with the HyperCSM. Alarms can be trigger a simple «beep», sending an e-mail or launching an executable program. A sample can be recorded for each alarm if it is requested by the user.
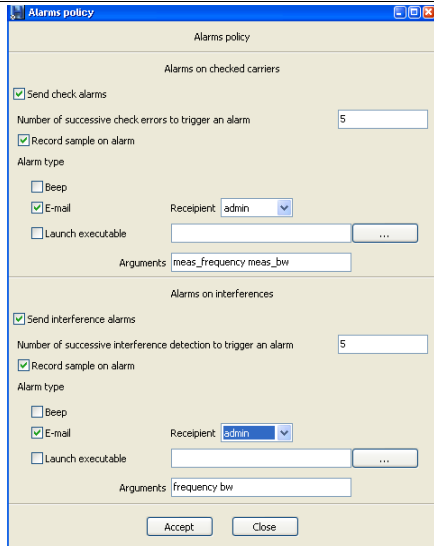
PSD (Power Spectral density)

before adaptive cancellation
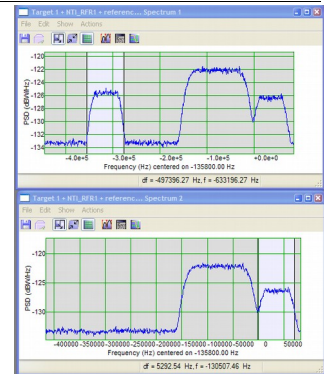
PSD after adaptive cancellation

Operator's management

The operator is identified by a login:

- Administrator :
  - Extended rights,
  - Database management (load, save, ...),
  - Users management.
- User :
  - Rights limited to his account,
  - Usual functions of the application
  - Record of user's actions into a Logfile.

Alarms given by the CSM must be acknowledged and the operation is recorded into the database along with the user name and a time stamp.

All alarms could be acknowledged or/and closed through the «alarms history» window.

Calibration

After a precise calibration of all the reception chain, the Power Flux Density or PFD can be calculated (with a precision that depends on the calibration). In this case the system can provide:

- EIRP satellite associated to a carrier,
- Surveillance and alarm on the EIRP

The software works without emission of reference pilot signal. Calculation of distance and free space attenuation is facilitated by ground station and satellite databases, and orbitography codes. Models of attenuation by gas, clouds, water and rain allow to tune the precision of the attenuation value of satellite-ground station.

Carrier under carrier analysis

As it is shown on the example above, for all linear digital modulation (double-talk detection), the system is capable to do a adaptive cancellation and to analyze what is under. If an unexpected signal is present then the software can determine in a total blind mode analysis the characteristics of this signal.

Software Licenses

Depending on Customer's needs different software licenses can be proposed. They are:

Basic

Data base including user defined input data and system output data:

- Definition of satellites (name and position) made of a set of transponders (polar, bandwidth, conversion)
- Description of a transponder frequency plan as a set of occupancy rules with tolerances in a given bandwidth
- Definition of receiving ground stations with a set of RF access and associated RF equipment and calibration data, location.
- Acquisition cycles and actions to be triggered by alarms
- Set of CSM front end logical equipment
- Description of transponder measured contents
- Records of compliance with dates and alarms

Software functions:

- Control of acquisition or calibration sequence using the RF logical configuration and equipment drivers
- Blind analysis of a set of transponders (100 carriers per second and per acquisition)
- Automatic spectrum breakdown in individual carriers, for each carrier estimation and display of RF parameters based on sole spectrum shape analysis (BW, EIRP, CF, R, C/N).
- Reference signal (CW or modulated carrier) for frequency calibration.
- Check of a transponder content toward a frequency plan, raising of warning and alarms
- Learning of a transponder content from an acquisition (analysis, manual filtering of nominal values and tolerances, storage in database).

Monitoring and displays

- GUI for data base acquisition (satellite, ground station, frequency plans,...)

- Database filling from XLS or CSV format files

- Multi-users display capability

- Quick look operation page showing instantaneous compliance bar graphs of a set of transponders.

- Spectrum viewer and detailed content of each transponder.

- GUI for fetching and display of events and alarms, stored measurements.

- Alarms and associated actions (acknowledgement, visual and sound, message, e-mail sending, launching program, ...)

QoS

Additive features in data base :

- Waveform descriptions (spectrum shape, modulation scheme)

- Standard definitions (name, set of nominal values and default tolerances for a waveform)

- Frequency plans completed information with standards or waveform definitions for each carrier

Additive analysis capabilities

- Check of a waveform, 30 carriers per minute (RF parameters plus exact symbol rate, modulation scheme, Eb/No, BER, all estimated from demodulation)

- Analysis limited to most basic satellite waveforms (PSK, QAM) and standards (IBS-IDR, DVB-S, GMRS1 and 2)

- Learning of additive data, same as above.

Additive features for display

- Display of additive data (constellation graph,

carrier under carrier...)

Advanced Analysis

Additive features in data base

- Records of associated measures and events

Additive capabilities

- More detailed blind analysis (up to modulation scheme)

- *More extensive waveforms available (OFDM, CPM, ...), and standards (DVB-S2, DVB-T) for aided and blind analysis.*

Operating systems

HyperCSM 3.2 works under :

- MS Windows 2000 / XP / Vista / 7 /8 windows server 2003 and 2008,

- Linux RedHat / CentOs 6.2, 6.3, 6.4, Open Suse 11.4, Debian 7, Fedora 18-21.

Support

- Technical assistance,

- Operators training.

- Software warranty and maintenance,

- Software enhancement proposals.

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