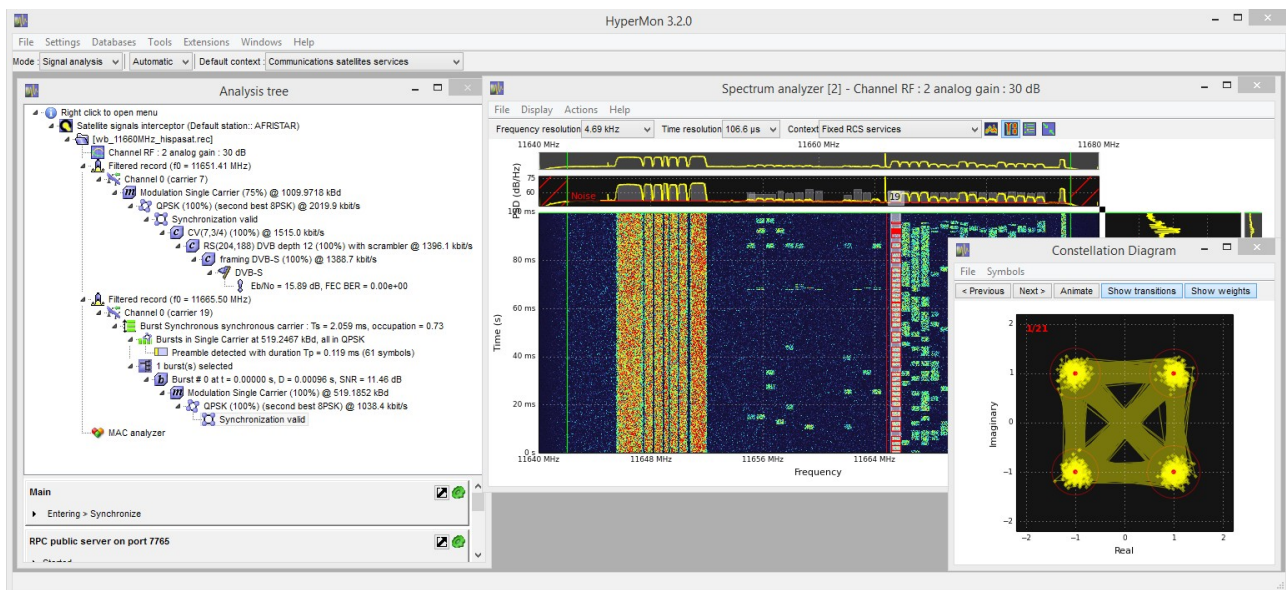


HYPERMON

3.2

SIGNAL ANALYSIS



OVERVIEW

Spectrum monitoring and radio-communication signal analysis are critical tasks, made even more complex due to the wide range of frequency bands and the ever growing number of communication systems used (either standardized or proprietary ones).

HyperMon is the software answer to this problem:

- Compatible with signals ranging from HF to Ku/Ka satellite frequency bands.
- Automated processing: the speed and reliability of applied operations greatly improve the productivity of survey tasks.
- Identification / Classification of signals: the analysis depth depends on context and digitized data quality.
 - RF parameters, medium access (MAC).
 - Modulation, constellation.

- FEC, framing, standard.
- Dedicated processing :
 - Carrier-under-carrier detection (CuC).
 - Double Talk detection (CiC™).
- Advanced GUI :
 - Display of spectra, time/frequency plan, power densities, time signals, constellations...
 - Decision tree which allows manual (step-by-step) processing for difficult cases.
 - Summary display of analysis results with file export capability.

HyperMon identifies on a best effort manner the analyzed signals; it's up to the operator to use this information to select and configure adapted external third-party tools for data production.

DESCRIPTION

CONTEXTS

HyperMon is able to analyze signals in a blind manner, that is to say without prior information about the signal. Nevertheless, as the origin of the signals is usually known (radio or satellite, frequency band), **HyperMon** integrates several analysis contexts: selecting a context allows to increase the speed and reliability of data processing.

- SATELLITE:
 - Fixed satellites services,
 - Communications satellites services,
 - Fixed RCS services,
 - Mobile satellite services,
 - Advanced satellite.
- RADIO:
 - Fixed HF communications,
 - VUHF Radio Networks,
 - Mobile communications,
 - Microwave links.

If no prior information is available, the operator may select the "Undefined" context.

SIGNALS

HyperMon works on samples stemming from the digitization of communication signals.

These samples may be read from a file or directly from a stream delivered by a compatible digitizer.

FILES

HyperMon has its own format called REC (metadata header file and multichannel binary file of IQ complex samples).

Following formats are also automatically processed:

- WAV (non compressed),
- TXT/DAT (proprietary AEROFLEX),
- SIG / ACQ / SDF / BRUT (proprietary),
- BIN : filter to read digitization file in a rather generic manner: header to skip and data format

selection (real or complex IQ, from 8 to 64 bits)...

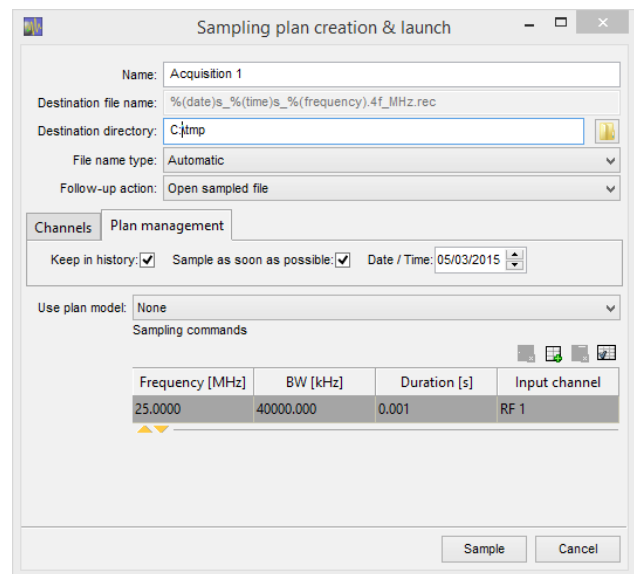
DIGITIZERS

HyperMon has internal drivers to interface with following digitizers:

- IFoIP (v1 & v2) (Zodiac Data Systems),
- BSA (Aeroflex),
- NI (National Instruments),
- IQ audio sampler (PC sound chipset).

The GUI allows to create sampling plans which include one or more commands ; each command describes the RF input, the frequency, the bandwidth and the duration of the digitization task.

Plans can be saved (for later reuse) and also scheduled in time.



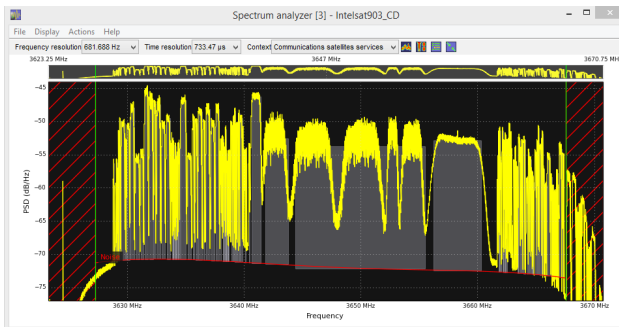
The output generated by a sampling plan is a REC file which has as many channels as digitization commands in the plan.

ANALYZES

DETECTION

After loading data, **HyperMon** displays the frequency spectrum and spot the communication carriers within the whole signal.

This detection is automatic (without any setting by the operator) and rather instantaneous (even when dealing with hundred of carriers).



The operator can use filtering tools, in both frequency and time domains, to manually manage carrier detection.

Following the detection stage, the operator may select one, several or all the carriers and launch the analysis stage on these items.

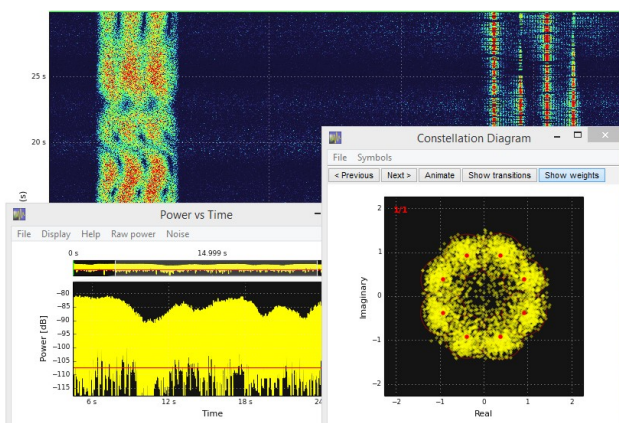
This analysis step is fully automatic and its duration mainly depends on the number of carriers to process and on their type (continuous or burst). On the above example, the 131 detected carriers was analyzed in 160s, i.e. at 0.8 carrier per second rate (PC laptop with I7-4700MQ processor).

CHANNEL ANALYSIS

Depending on selected context, a blind analysis of the propagation channel is performed.

It allows to detect fading channels (in both time and frequency plans) even on burst signals.

Based on the estimation of the propagation channel, complex processing (in particular in HF and V/UHF context) can be launched (blind or aided equalization).



This analysis allows to cope with most difficult propagation channels.

CHARACTERIZATION

HyperMon identifies on a best effort basis the parameters of each analyzed carrier.

The number and type of these parameters depend on many elements: carrier type, context, SNR...

The main parameters are :

- Medium access
No MAC (continuous carriers, TDM), FDMA, (G)TDMA, (S-)ALOHA, CSMA-CA.
- Modulation
SC (single carrier), OQ (Offset quadrature), CPM, FSK2, (O)FDM, analog (HF).
- Constellation
PSK (2, 4, 8 and 16 states), APSK (16 and 32 states), (S)DBPSK, (S)DQPSK, (S)D8PSK, QAM (8 to 4096 states), OOK.
- Error correction code
Convolutional / sequential, Reed Solomon, TPC / LDPC (VSAT modems).
- Framing (VSAT)
IBS, IDR, EDMAC, D&I++, ESC++, SCC.
- Interleaver
Convolutional, block, matrix, helical.
- Scrambler
PRBS, V.35, OM73.

At the end of the analysis, if identified parameters are discriminating enough, the communication standard is identified:

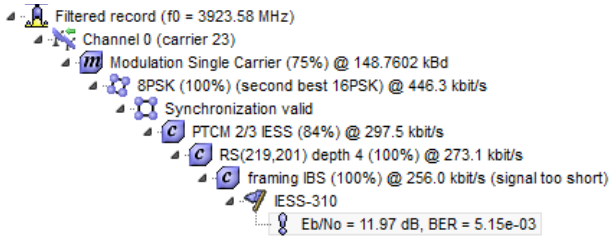
- DVB-S/S2/RCS, IESS 308/309/310, VSAT,
- 802.11a/g/n, DAB, DRM, WiMax, DVB-T...

RESULTS

The analysis results are displayed in two zones: the analysis tree and the carrier list.

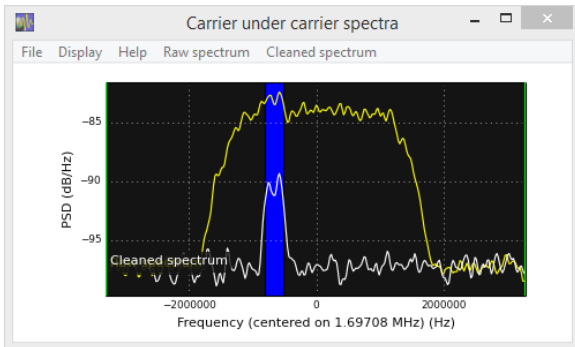
ANALYSIS TREE

It shows a hierarchical view for each performed analysis.



In this view, the operator is able to:

- to restart some actions with access to internal settings:
 - list of candidates for modulation and constellation...
- to launch additional processing:
 - periodic pattern detection in symbol stream,
 - carrier-under-carrier detection,
 - Double Talk detection,
 - signal cancellation...



- to display views:
 - time signal,
 - spectrum,
 - eye diagram,
 - constellation...

CARRIER LIST

It displays the analysis results in a spreadsheet view, each page of this latter corresponding to a medium access method: SC, TDMA...

Each line in a page presents the main parameters of one carrier.

| | Id | Fc | BW | Bit rate | Constellation | Inner code | Framing | Standard |
|----------------|----|-------------|------------|--------------|---------------|------------|---------|-----------------|
| ☑ All carriers | 40 | 3672.78 MHz | 272.52 kHz | 256.000 kb/s | QPSK | TPC 3/4 | OFF | VSAT (de facto) |
| ☑ Not analyzed | 41 | 3673.14 MHz | 484.89 kHz | 511.992 kb/s | QPSK | TPC 3/4 | OFF | VSAT (de facto) |
| ☑ No MAC | 42 | 3673.67 MHz | 498.66 kHz | 448.000 kb/s | QPSK | CV(7,3/4) | OFF | ESS-308 |
| ☑ SC | 43 | 3673.98 MHz | 222.51 kHz | 126.667 kb/s | QPSK | SEQ 1/2 | IBS | ESS-309 |
| | 44 | 3674.7 MHz | 1.11 MHz | 2.048 Mb/s | BPSK | TPC 7/8 | OFF | VSAT (de facto) |
| | 45 | 3675.35 MHz | 219.61 kHz | 256.000 kb/s | QPSK | TPC 7/8 | OFF | VSAT (de facto) |
| | 46 | 3675.53 MHz | 155.11 kHz | 128.000 kb/s | QPSK | SEQ 3/4C | OFF | VSAT (Radyné) |
| | 47 | 3677.03 MHz | 1.97 MHz | 2.048 Mb/s | QPSK | CV(7,3/4) | OFF | ESS-309 |
| | 48 | 3678.94 MHz | 1.91 MHz | 2.048 Mb/s | QPSK | CV(7,3/4) | IDR | ESS-308 |
| | 49 | 3680.85 MHz | 1.91 MHz | 2.048 Mb/s | QPSK | CV(7,3/4) | IDR | ESS-308 |
| | 50 | 3681.97 MHz | 316.01 kHz | 384.000 kb/s | QPSK | TPC 7/8 | OFF | VSAT (de facto) |
| | 51 | 3682.24 MHz | 223.96 kHz | 256.000 kb/s | QPSK | TPC 7/8 | EDMAC | VSAT (Comtech) |
| | 52 | 3682.98 MHz | 1.26 MHz | 2.048 Mb/s | BPSK | TPC 3/4 | EDMAC | VSAT (Comtech) |
| | 53 | 3683.76 MHz | 316.97 kHz | 512.000 kb/s | BPSK | TPC 7/8 | EDMAC | VSAT (Comtech) |
| | 54 | 3685.55 MHz | 628.62 kHz | 1.024 Mb/s | BPSK | TPC 7/8 | OFF | VSAT (de facto) |

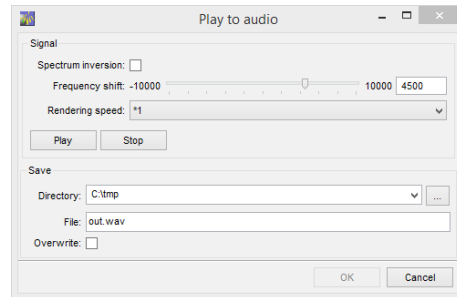
In this view, the operator can export the results (some of or all) into a textual file in CSV format.

TOOLS

AUDIO RENDERING

The samples of a filtered signal can be sent to the PC sound chipset for audio rendering, while adjusting some parameters: frequency offset, rendering speed...

The operator can export the audio signal to a file in WAV format.



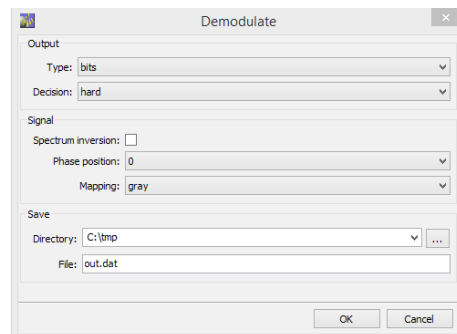
This action is particularly useful in radio (HF and V/UHF) contexts.

DEMODULATION

On carriers with modulation identified as SC or FSK2, it is possible to demodulate the signal.

The operator sets required parameters :

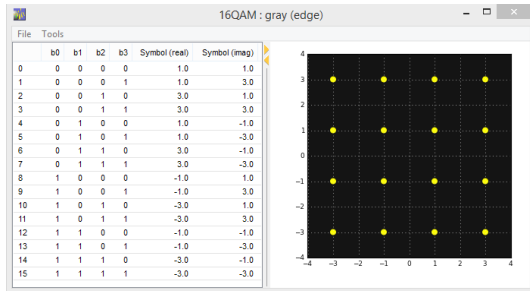
- symbol or bit output with hard or soft decision,
- phase ambiguity, spectrum inversion and mapping.



Output data are saved in a file.

MAPPING

This tool allows the operator to define its own mappings for PSK, APSK, QAM constellations.



These mappings are saved in files and are usable within the demodulation tool.

DATABASES

HyperMon includes several databases:

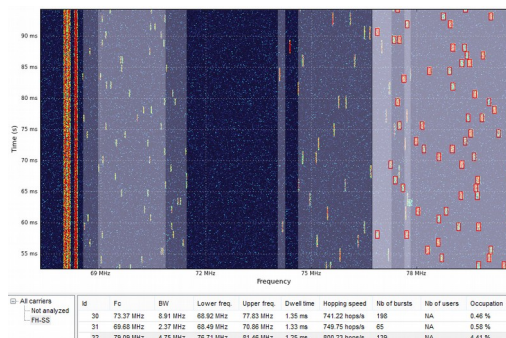
- Satellites base: It contains all known geosynchronous and geostationary telecommunication satellites. Ephemeris, uplink and downlink coverages, transponders... are part of the data describing each entry in this base.
- Ground stations base: It contains the ground stations declared and described by the operator: geographical position, antenna (size, polarization...), pointed satellite...
- Carriers base: The results of carrier detection and characterization are stored in this base: interception ground station, pointed satellite, frequency, modulation, constellation... These recordings are to be used as references for future comparisons.

The operator can add, modify or delete the entries of these databases.

OPTIONS

FHSS

The **FHSS** is dedicated to the detection and identification of slow frequency hopping networks (i.e. hopping rate lower than symbol rate) ; this action is available in both radio (VUHF radio networks) and satellite (advanced satellite) contexts.



The goal is to spot FHSS networks (even overlapping ones) and to separate them from other signals (SC, TDMA...).

Each burst is automatically bounded in the time/frequency plan and can then be extracted and analyzed.

MODEM CONTROL

The **Modem control** option allows to program a hardware modem directly from **HyperMon**.

Compatible modems are:

- CDM625 (Comtech) (Ethernet link)
- AMT73 (Advantech) (RS232 link)

If the carrier parameters identified during analysis stage are compatible with the capabilities of a modem declared in **HyperMon**, they can be automatically transmitted to this modem; thus the operator saves time while programming the modem which is a quite tedious task.

Information of lock and link quality as estimated by the modem are displayed in **HyperMon**.

SOFTWARE

HyperMon consists of an installation file and a hardware security key (dongle).

The compatible operating systems are:

- MS Windows (64 bits)
(Vista, 7 and 8.1 versions)
- Linux (64 bits)
(RedHat / CentOS, Fedora, Debian, Suse distributions).

The hardware prerequisites are:

- Intel (recommended) or AMD PC processor (SSE2 compatible).
- Memory: 4 Go (minimum) (8Go or more recommended).
- USB 2.0 (minimum) port for security dongle.
- Hard disk: 1 Go (program only, additional space required for recorded signals besides).

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