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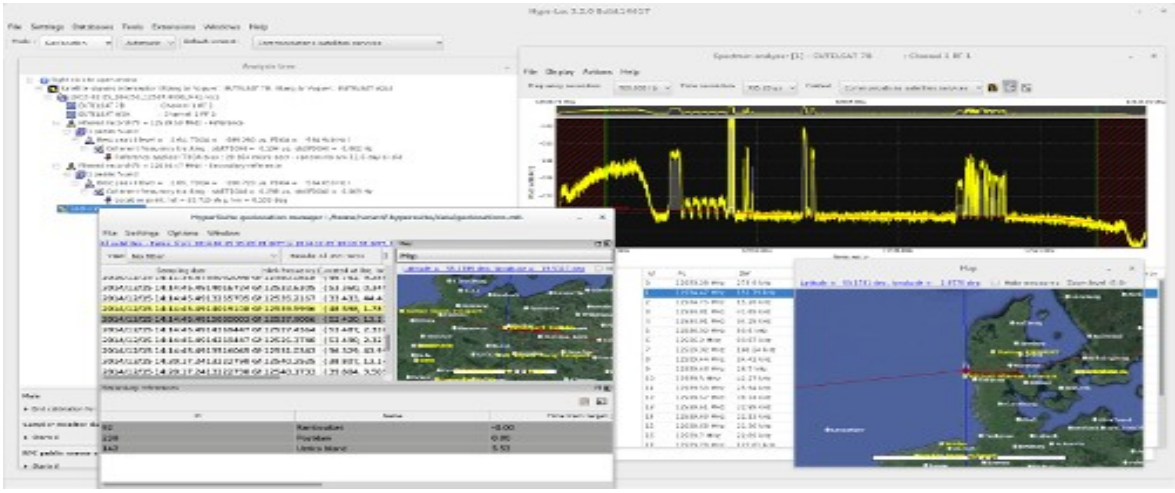
HyperLoc 3.2

Geolocation of Communication Satellite Carriers



The last decades have seen a tremendous growth of the number of active communication satellites in all areas in the world as well as their users and the emergence of the VSAT systems. Consequently, the number of cases of illegal transponder use, active disruption of transmissions or satellite interference is constantly growing and impacts on the cost of civilian satellite communications.
On the military or intelligence side, it is now important to locate transmitters in any satellite, friendly or not.
HyperLoc gives powerful answers to these problems allowing the localization of transmitters in L to Ka bands, for satellite communication carriers or interference.

Global features

HyperLoc is a full-software solution, based on hyperbolic techniques using TDOA (Time Difference Of Arrival) and FDOA (Frequency Difference Of Arrival) estimates, and involving two or more adjacent satellites. It allows signal selection and corresponding transmitter geo-location within minutes.

The location accuracy ranges from a few km to a few tens of km, depending on operating conditions.

HyperLoc gives answers to the following needs:

- transmitters geo-location for satellites working in the L, C, X, Ku and Ka frequency bands,
- real-time or off-line processing: all the geo-location process is done using signals recorded from a digital sampler,
- automatic or manual processing allowing geo-location of the more difficult cases (carriers with SNR up to -70dB on mirror satellite, bursted carriers, “double-talk”),
- crossing measures allowing TDOA - TDOA, FDOA - FDOA or FDOA - differed FDOA localizations,
- accurate localizations, up to 1 km, thanks to all bias compensation (on board LO, phase noise, satellites orbits) with our original algorithms (multi-references or co-orbit),
- localization of all kind of carrier (narrow or wide band, analog or digital carriers, jammers and noise).

HyperLoc guides the operator for the geo-location process using many data visualizations. It uses a database which describes all known geo-stationnary satellites.

Description

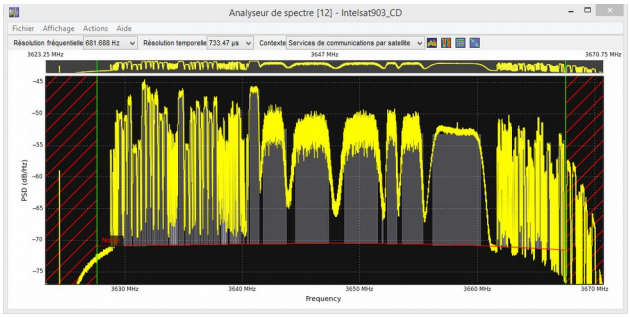
Signals

HyperLoc works with sampled signals.

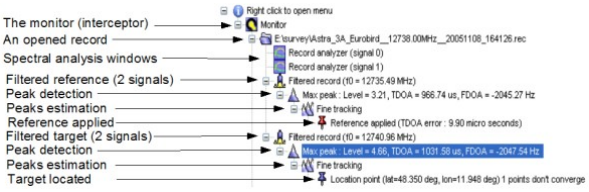
These samples could be read from a file or directly from a compatible sampler stream.

Analysis Tree

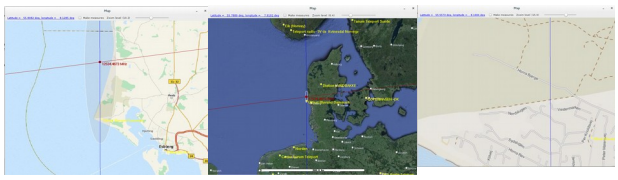
HyperLoc reads data, displays corresponding spectrum and detects carriers: this detection is automatic (i.e. without any action from the operator) and instantaneous (even when the spectrum is occupied by one hundred carriers).



The “reference” and “target” carriers are pointed, filtered and processed step by step in an automatic mode inside the “analysis tree”. This analysis tree allows to re-process targets (manual mode) when the automatic mode fails (for the most difficult cases).



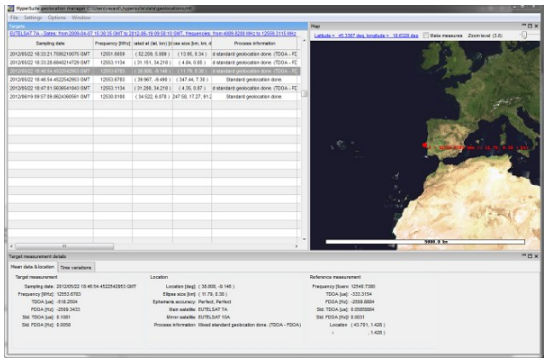
The found location of the carrier can be displayed with a mapping tool integrated inside **HyperLoc**. This mapping tool uses images allowing to display high accurate details (street). This tool can also be configured to use Google Earth satellite images.



Target manager

When a carrier has been localized, it is recorded inside an integrated tool called “Target Manager”. This target manager allows to re-process target or crossing measures:

- re-localization of targets without re-processing data (for example, when new satellite orbits are available),
- localization of a carrier using measures obtained at several times of the day. This allows TDOA – TDOA or FDOA – differed FDOA localization,
- computing a best estimation of a target position by crossing ellipses obtained with several measures (mixed ellipse).



In addition, the target manager allows to locate targets by choosing secondary references as input parameters for multi-references or co-orbit algorithms.

Databases

HyperLoc comes along with its own databases:

- a satellite database that contains all known geo-synchronous and geo-stationnary telecommunication satellites currently declared. For each entry, it provides the orbits, the coverage in up-link and down-link, the transponder matrix, etc...
- a transmitter (targets & references) database.

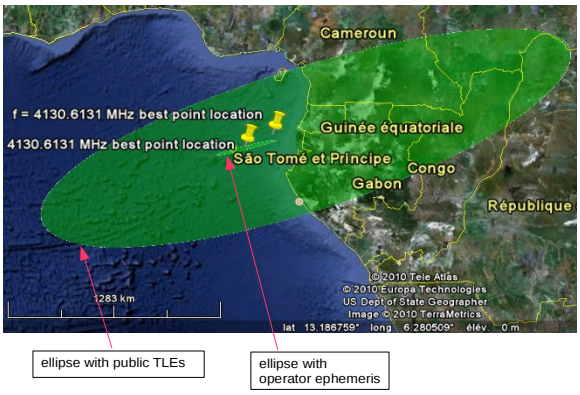
Of course, the user is allowed to create new items in these databases or to modify already existing items.

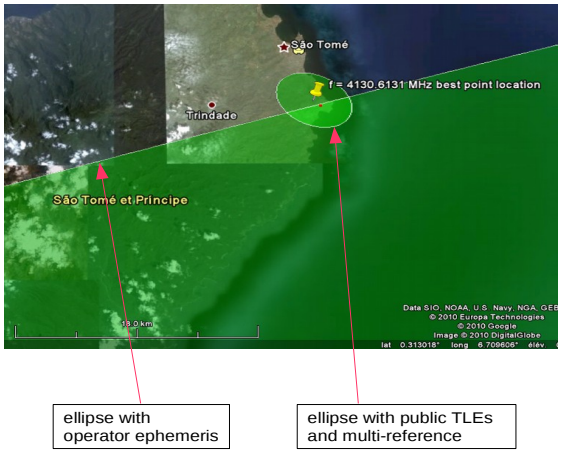
Performances

When only public orbits (NORAD) are available for the satellites of interest, their quality does not allow accurate locations. Generally speaking, the corresponding ellipses can have a great axis which can be as large as several hundreds (sometimes several thousands) of kilometers.

In this case, using some known location carriers (secondary references), multi-references or co-orbit algorithms allows to give very accurate target carrier locations.

The two following figures show an example where public orbits, operator orbits and public orbits with multi-references are used.





HyperLoc is then able to locate any carrier with an accuracy depending on the satellites inclination and the kind of orbits used:

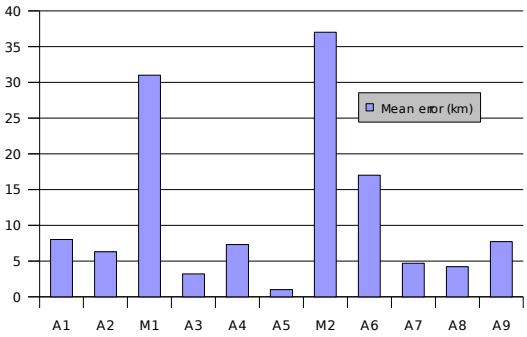
Case	Typical location accuracy
Inclined satellite, perfect orbits	1 km
Normal inclination satellite, perfect orbits	15 km
Inclined satellite, public orbits	10 km
Normal inclination satellite, public orbits	30 km

Geo-localization example

This example concerns the localization of 11 targets in Africa / Middle-East operating in C band transponder.

HyperLoc has located the 11 targets with no failures. The targets carrier bandwidths range from 64 kHz to 1 MHz. Public orbits (NORAD) are used and the multi-references algorithm is used for bias compensation.

We show the error distance in the bar-graph just below. Nine targets in Africa (A1-A9) show errors less than 10 km, and 2 targets in middle-east show errors around 30 km.



Operating system

HyperLoc 3.x works on MS Windows XP, Vista, 7, 8 64bits and Linux (RedHat / CentOs, OpenSuse, Debian, Fedora) operating systems.

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