FROM SIMULATION TO REALITY: CATALOGUING OF OBJECTS FROM GROUND-BASED OPTICAL OBSERVATIONS

Raúl Domínguez González
Nuria Guijarro López
Jaime Nómen Torres
Miguel Hurtado Romero
Noelia Sánchez Ortiz

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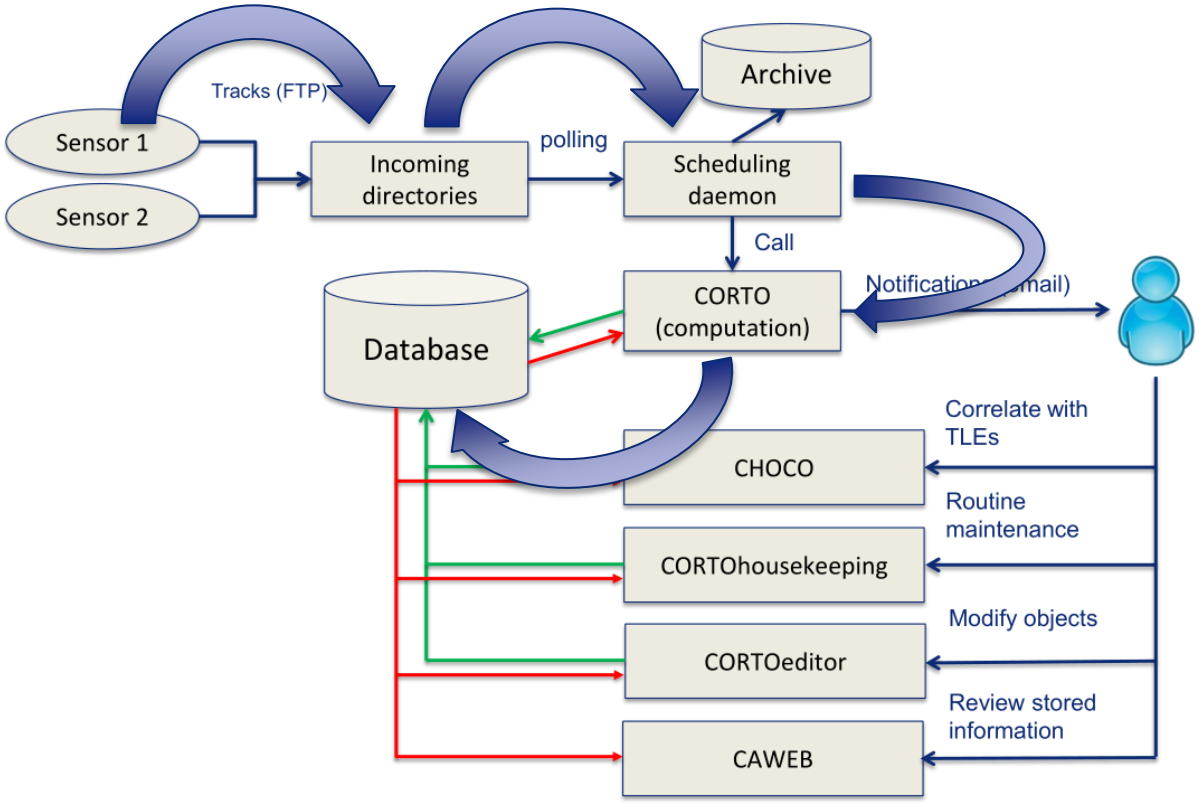
Description

Origins and evolution

- CORTO (CORrelation TOol) was originally devised for building a catalogue of Earth-Orbiting objects from scratch.
- It was originally used for a surveillance campaign, and further developed and tested with simulated data, building on the expertise of the Deimos team
- During 2014, it got updated to support the development of a full SST system
  - The data storage was updated to an external postgresql database
  - Added an scheduler and a web user interface to support the routine operations on the catalogue
  - Interfaces for subsidiary services were added
- It is an evolving tool. We can adapt the tool to the operational procedures, as some needs arise.
- It will be used to process the data from the new Deimos observatory

Description

Structure

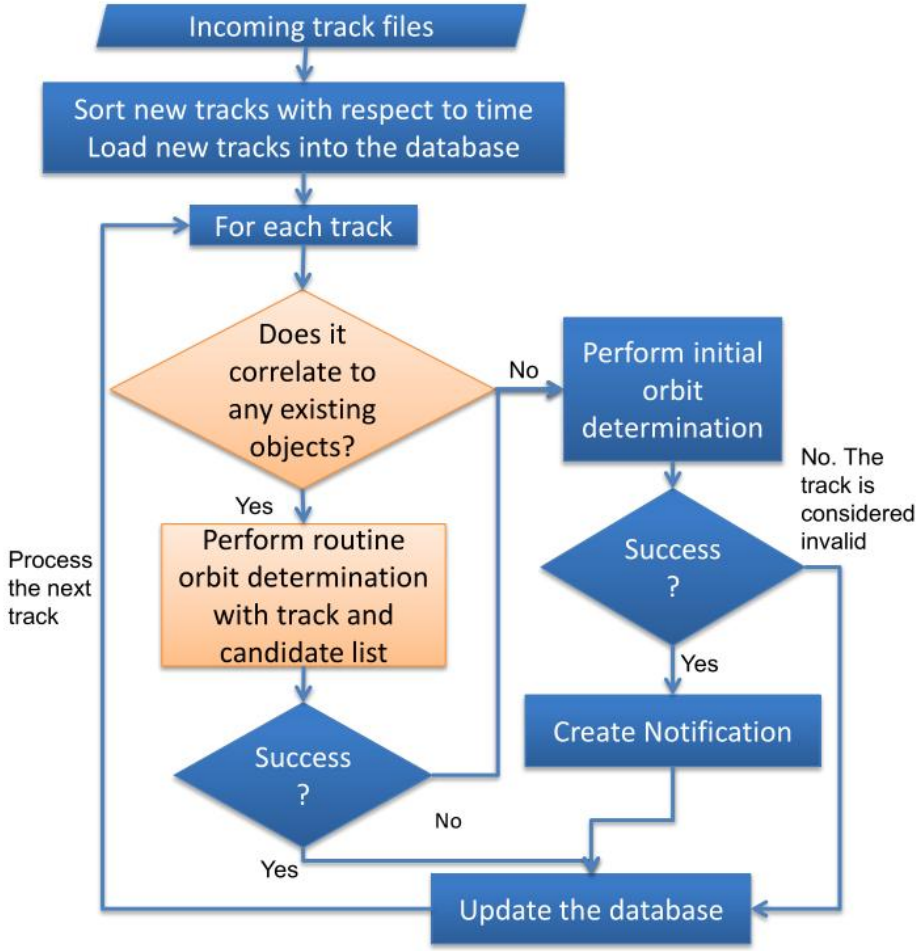


- Tracks are created by the sensors
- Sensors push the tracks into the incoming directories
- The tracks are scheduled for processing
- CORTO processes them and updates the database
- The operator supervises and performs additional actions

Database structure

- The database stores a number of objects.
- Each object has associated a list of status updates, that can be:
  - An update of its orbital information by means of a track (on which an orbital determination is performed)
  - An user-inserted manoeuvre
- Each status update is traced to the track or manoeuvre that triggered it
- Each object in the catalogue is given a CORTO id (a sequential integer number)
- Objects can be optionally linked with an object in the NORAD catalogue (by means of a NORAD id)

Main algorithms

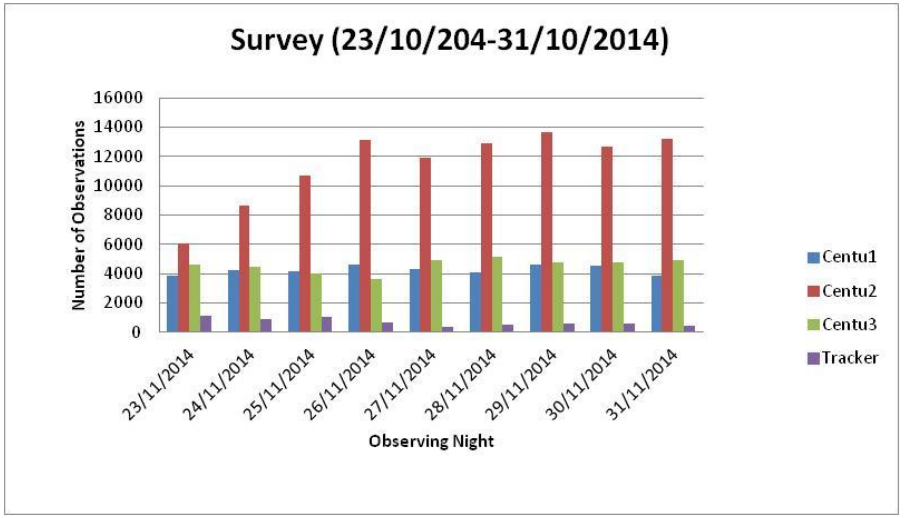


- Correlation is measurements based (expected and actual measurements are compared)
- The initial orbit determination is an enhanced double-R iteration (for angles-only cases) and Gibbs-Herrick Gibbs for angles and range cases
- The routine orbit determination is an SRIF. It is applied to the tracks one by one

Campaign

Setup

- Data from a survey campaign carried out in October 2014 was processed by CORTO.
- The campaign comprised four telescopes (three surveillance telescopes and a tracking one), performing a surveillance aimed at the GEO ring. All the sensors were located at the same position in southern Spain

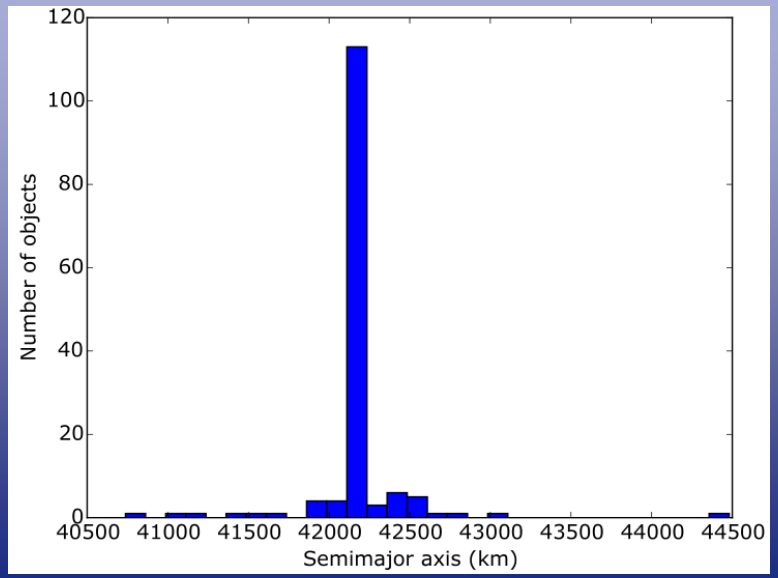


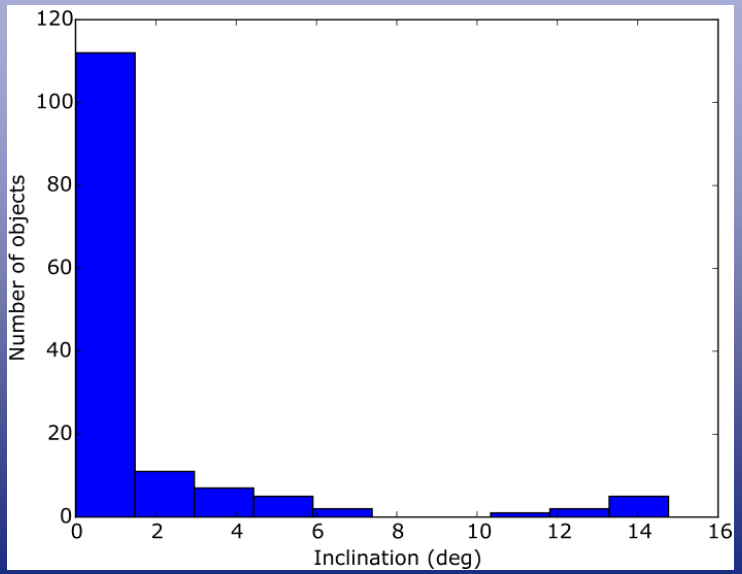
Campaign

Results

Number of created objects	1660
Number of deleted objects	517
Total number of tracks	39676

Objects with more than 50 associated tracks:

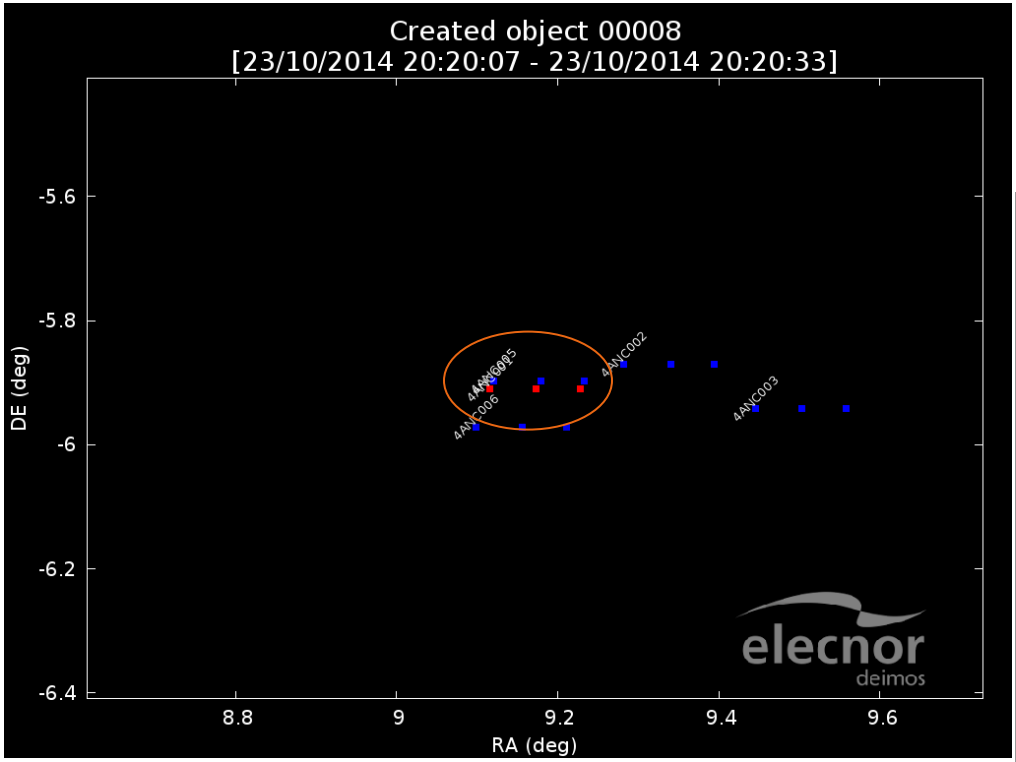


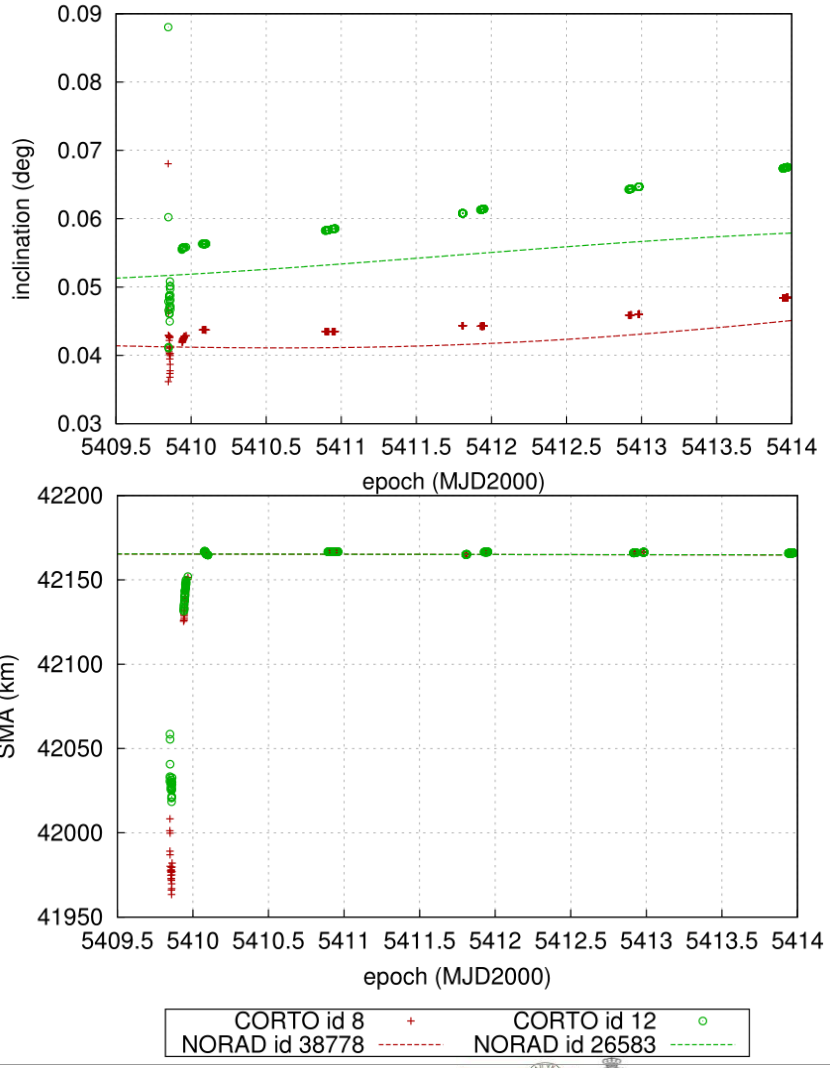


Campaign

ASTRA 2C and ASTRA 2F

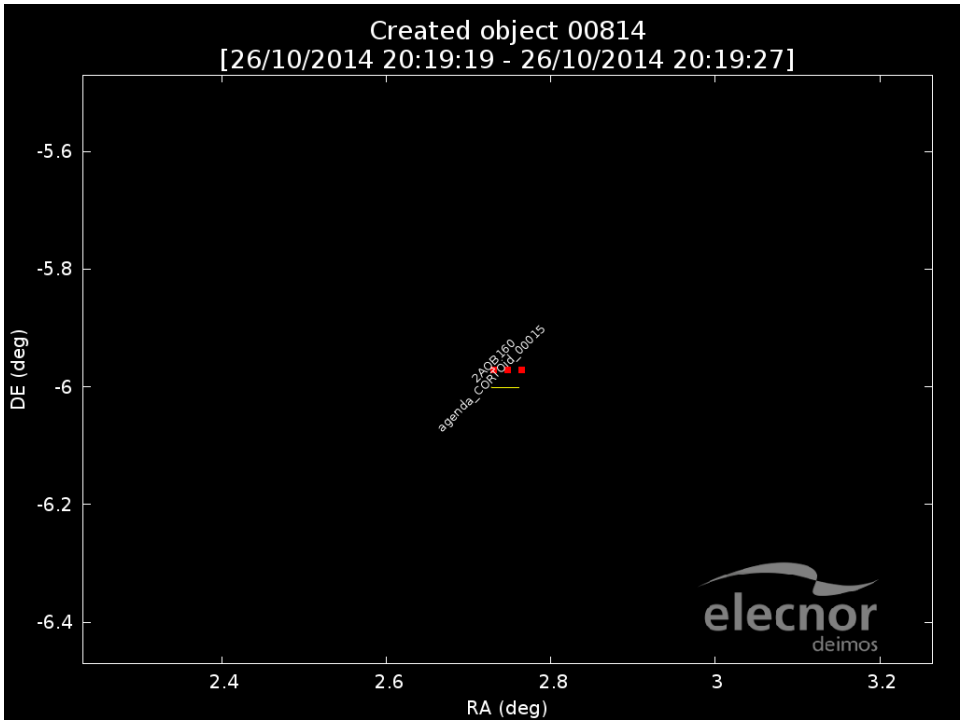
This cluster was observed, we were able to follow the two objects

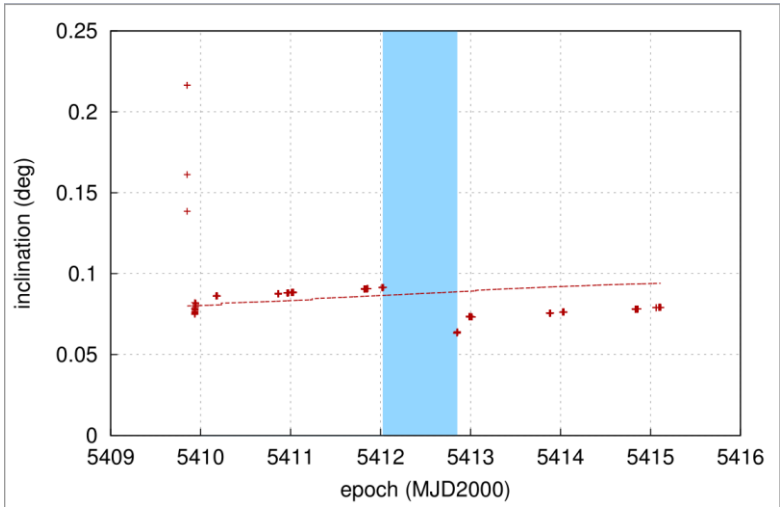




ARABSAT 5C (manouevre?)

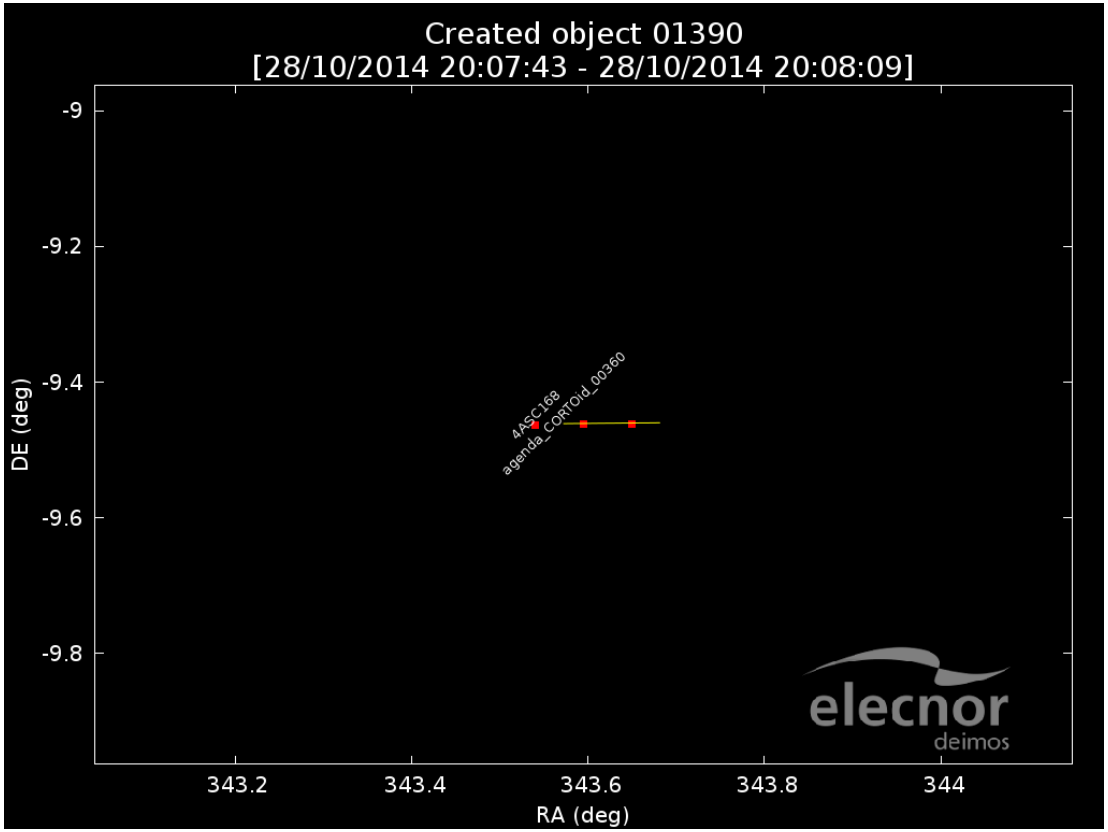
According to our observations, this object might have performed a manoeuvre





Campaign

METEOSAT constellation



MSG-1 performed an East-West station keeping manouevre on 28 Oct 2014 05:13 UTC
The effect of the manoeuvre can be clearly seen on the next observation of that object.
The manoeuvre affects the accuracy of the catalogued orbit

	Pos. accuracy (km)	Vel .accuracy (km/s)
MSG1 (CORTO)	35.12	$2.3 \cdot 10^{-3}$
MSG1 (TLE)	33.82	$2.6 \cdot 10^{-3}$
MSG2 (CORTO)	0.46	$2.9 \cdot 10^{-5}$
MSG2 (TLE)	4.82	$2.5 \cdot 10^{-4}$
MSG3 (CORTO)	0.60	$4.9 \cdot 10^{-5}$
MSG3 (TLE)	4.68	$8.4 \cdot 10^{-4}$

Conclusions

- The maintenance of the catalogue is driven not only by the processing software, but also by the capabilities of the sensors network. The software and operational procedures should adapt to the particularities of the network
- The software is independent from the TLE catalogue. Although NORAD TLEs are an invaluable source of information, using them is optional.
- The future works will involve:
  - Improving the software capabilities. Support new kinds of sensors, improve the algorithms.
  - Improving the operational procedures. Define workflows for the operators depending on the capabilities of each particular sensors network.
  - Adding additional modules for tasking the sensors, for adaptive survey planning, and for detection of fragmentation events.

Thank you

www.deimos-space.com