Senplanner

SST SENSOR PLANNING AND TASKING SOFTWARE

GMV's ***Senplanner*** COTS software is a software application for **planning and tasking observations** of a given network of tracking and surveillance SST and SDA sensors, including telescopes (both on-ground and on-board), radars, satellite laser ranging stations and passive ranging sensors, in order to maintain and characterize an objects catalogue. The software allows the generation and submission of the necessary inputs for **execution of observations by SST sensors** based on the orbital information of the objects for tracking activities and the strategies for survey activities.

In short, ***Senplanner*** is able to perform **automatically** the following operations:

- **Tasking optimization** of **tracking sensors** (telescopes, radars, laser ranging stations and passive ranging sensors), including calibration tasks
- **Survey strategy optimization** of **survey telescopes**
- **Object visibility windows** computation of **survey and tracking sensors**

Visibility windows needed for the generation of tracking and survey plans are computed in all cases considering all SST sensors **observability and detectability constraints** of the sensor and objects, including:

- Elevation cut-off and elevation mask
- Field-of-view
- Limiting detection magnitude and RCS
- Illumination condition of objects
- Illumination condition of sensors
- Range limit as a function of RCS
- Moon, Sun and galactic plane effect
- Planned and contractual unavailability time intervals

For **optical, radar, laser and passive ranging tracking activities**, ***Senplanner*** optimizes the **tracking plan** of the network of sensors following a heuristic method selecting the tracking slots per sensor and object optimizing:

- Distribution of slots of a given object (in a night for the telescopes)
- Prioritisation of important objects
- Minimization of sensor movement (only for telescopes)

For **optical survey activities**, ***Senplanner*** optimizes the **survey strategy** of optical survey telescopes in terms of right ascension and declination band to survey maximizing:

- Expected number of objects observed, according to the area of the space where most objects are orbiting (see image below)
- Effective time spent by the sensor in leak-proof strategy
- Apparent magnitude of the objects observed through the phase-angle of the observations

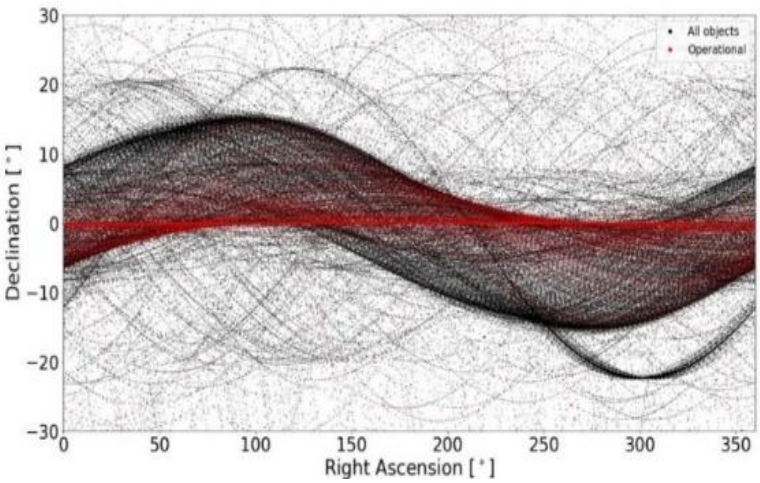

Figure 1: GEO objects and declination band used by *Senplanner* to optimize the declination band used for survey operations

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In terms of **processing experience**, ***Senplanner*** has been used in the following operational experience:

- Daily sensor planning of radar and telescope sensor network of Spanish SST system, Greek SST System, and Romanian SST system
- Dedicated optical tracking and survey campaigns with Polish sensors for provision of optical data and orbit determination services to Eumetsat.
- Custom GMV optical campaigns with telescope and radar data providers

As end user products, ***Senplanner*** generates the following products:

- For **tracking activities**,
    - **Tracking planned schedule**, indicating the object to be tracked by each sensor in each available time slot

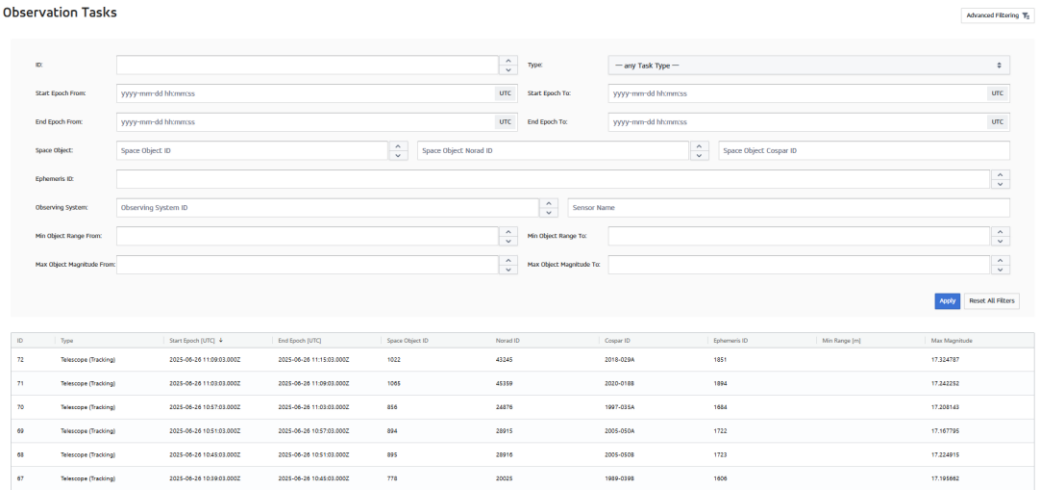

Figure 2: Example of planned tracking activities generated by ***Senplanner***

    - **Summary of planned schedule**, indicating the number of slots commanded per sensor, time slot duration per sensor, total commanded time per sensor and number of objects commanded per sensor
    - **Ephemeris information** in various formats (OEM, CPF, SCM, sensor pointing file, etc) of the objects included in the tracking plan
    - **Sensor azimuth-elevation evolution,** as a 2D interactive plot

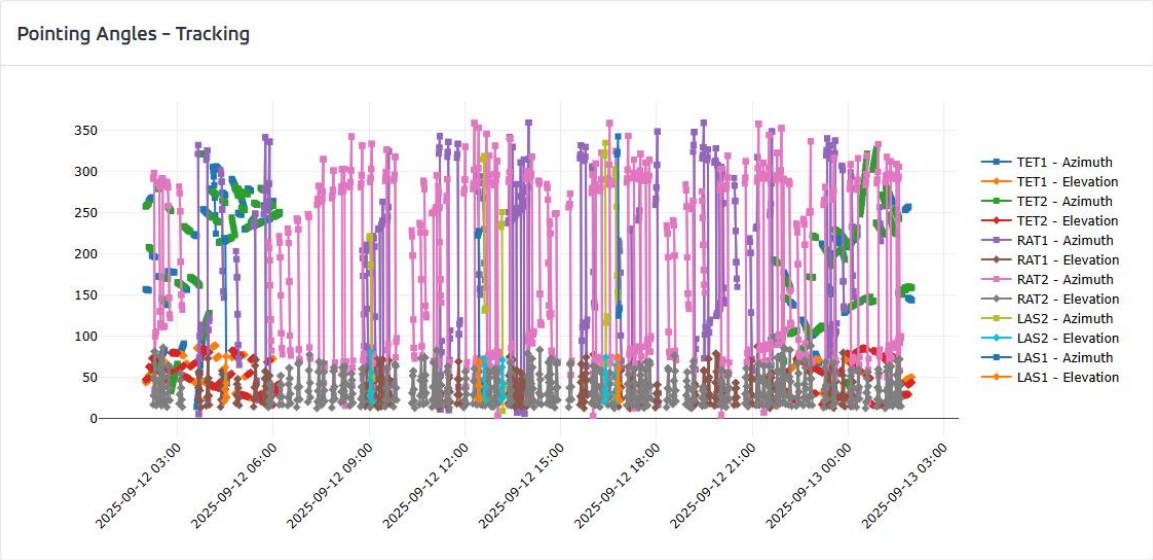

Figure 3: Example of azimuth-elevation evolution of the sensor generated by ***Senplanner***

- **Gantt chart**, as a graphical representation of the tracking plan for the whole

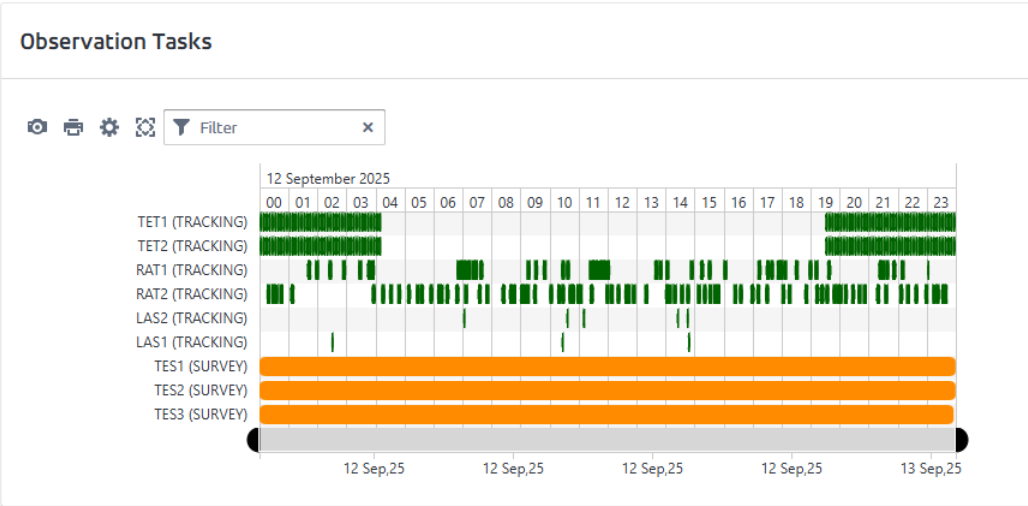

Figure 4: Example of Gantt-chart with planned tracking activities generated by ***Senplanner***

- **Tracking tasks**, as a 3D animated visualization

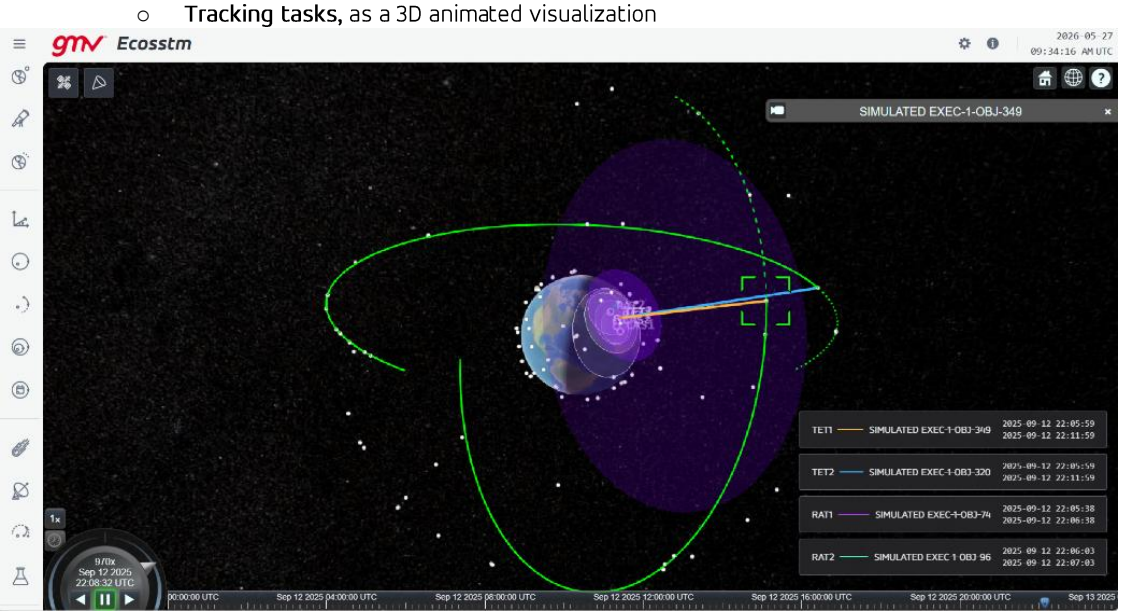

Figure 5: Example of 3D visualization of planned tracking activities generated by ***Senplanner***

- For **optical survey activities**, the following products are generated
  - **Survey strategy pointing file** of each sensor, indicating the declination and right ascension values as a function of time
  - **Dynamic graphical visualization** of the survey strategy, showing the survey strategy followed by the sensor together with all constraints and optionally the objects being observed

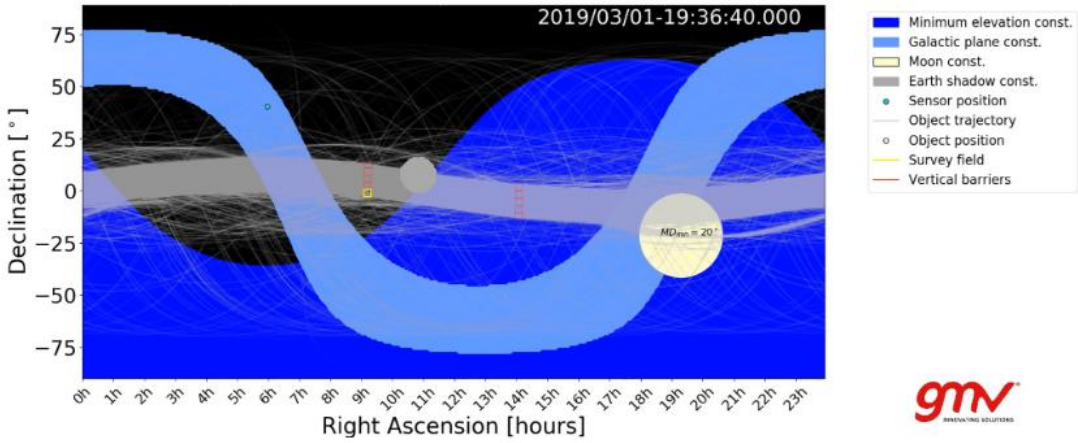

Figure 6: Screenshot of video generated by ***Senplanner*** for the optimized survey strategy of a telescope with two survey barriers

- **Azimuth-elevation coverage plots**, indicating the azimuth-elevation area covered by the sensor during the survey activities of a given night

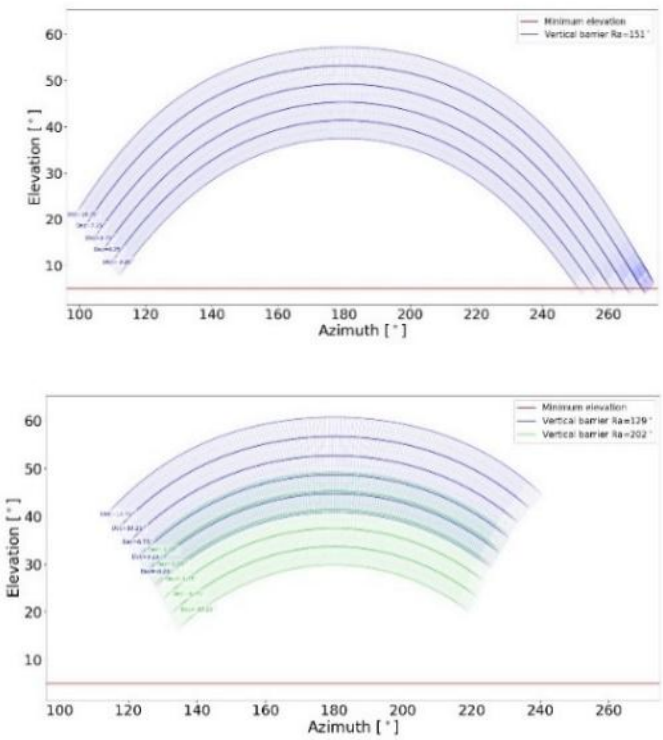

Figure 7: Example of plots with azimuth-elevation coverage for a survey strategy with one and two barriers generated by ***Senplanner***