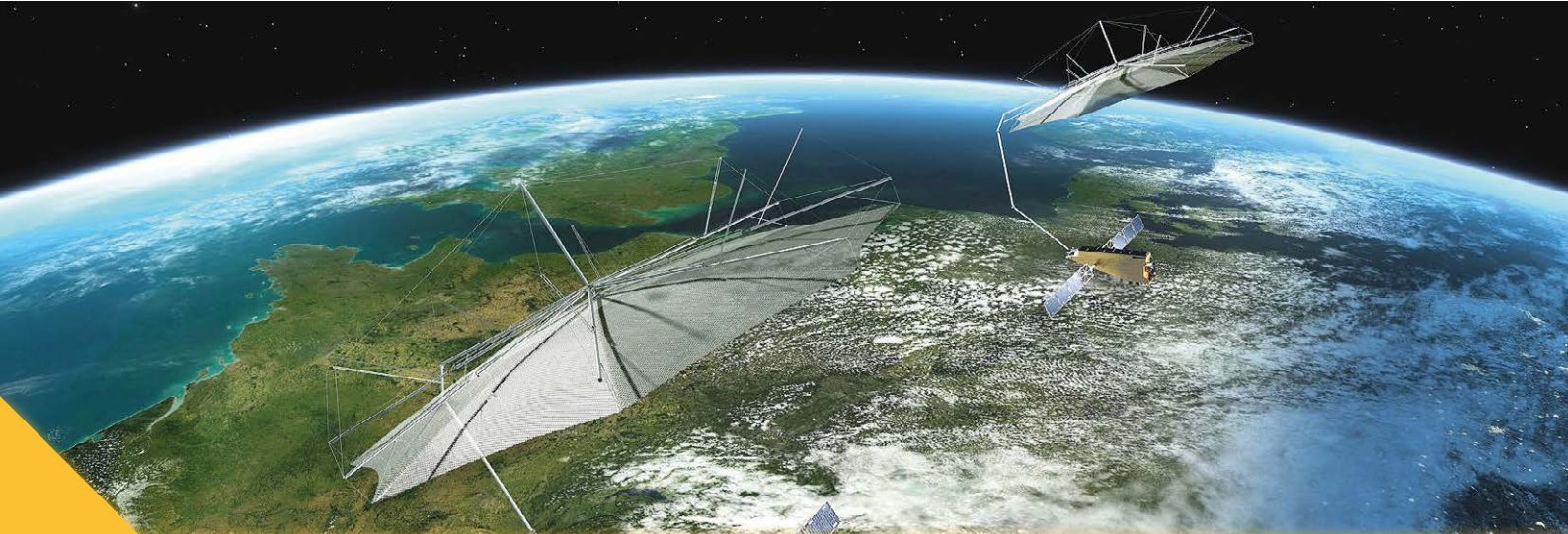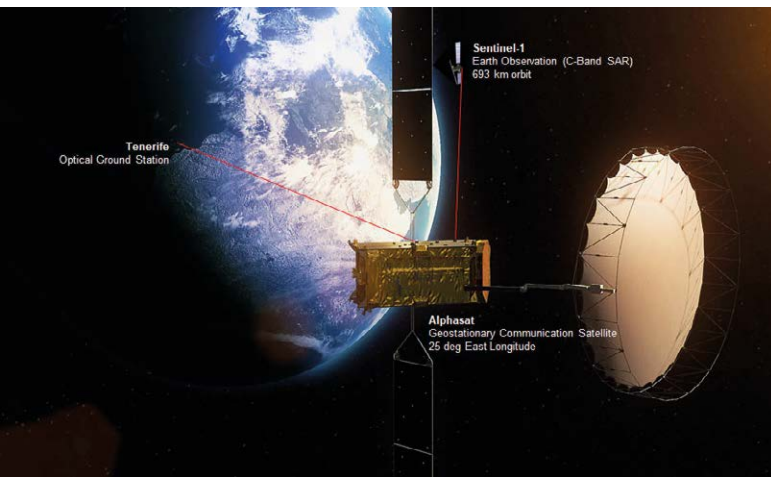# Flight Dynamics Services

DLR

Title: Artist's view of the Tandem-L formation flying mission

Flight Dynamics Services

The GSOC Flight Dynamics Services (FDS) group supports German and foreign space agencies, industry and academia in the preparation and operation of satellite missions. FDS sustains a variety of missions and provides services such as mission analysis, trajectory design, maneuver planning, orbit and attitude determination and analysis, conjunction assessment and mitigation, as well as operations support.

Our flight dynamics team has a very strong background and precious experience in astrodynamics, guidance, navigation and control, mission analysis, software and systems engineering, and project management. The FDS engineers diligently design, engineer, develop, maintain, improve, and adapt systems and interfaces to ensure that all mission requirements are met.

Laser-links from geostationary Alphasat to optical ground-station and LEO satellite

Point of Contact

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Mission Preparation

We provide the following services to support your mission preparation activities:

- **Feasibility Studies**, e.g. Definition and evaluation of orbit or formation control concepts; Assessment of flight dynamics requirements; Contribution to mission and operations concepts.
- **Mission Analysis,** e.g. First contact (influence of injection errors); Launch windows; Reference orbit optimization; Target orbit acquisition and positioning strategies for conventional and low-thrust propulsion; Orbit maintenance and reconfiguration incl. GEO station-keeping and re-location, constellation and formation control; Collision risk; Attitude analysis; Life expectancy; Re-entry; Orbital events (eclipses, ground-station visibility, sensor events etc.).
- **Software and Systems Engineering:** Application of flight-proven tools and enhancement or new-development of systems and interfaces to ensure meeting your requirements.
- **Cross-Validation** to support the validation of your flight dynamics functionalities.
- **Training and Simulation**, e.g. Lectures and training in usage of FDS software; Support of offline and real-time simulations.
- **Pre-Launch Products,** e.g. Support of training and simulation campaigns; Interface tests; Launch and LEOP planning activities.

Operations Support

We provide services during all mission phases, from launch till disposal:

- **Orbit Determination,** e.g. from tracking-data or Global Navigation Satellite System (GNSS) navigation data; cm-precise orbit determination and mm-precise relative navigation based on GNSS raw observations; Calibration of orbit maneuvers
- **In-flight AOCS and GNSS characterization,** e.g. GNSS receiver performance evaluation; Analysis of Attitude Control System (ACS) sensor data (observation errors, correction of mounting matrices, etc.).
- **Provision of Products for Science/Customers,** e.g. Precise orbit and attitude ephemeris data.
- **Operations Support Products,** e.g. Orbit and attitude predictions incl. precise maneuver modelling; Prediction of orbit-related events (shadow, elevation, sensor events, etc.) for mission operations, mission planning and ground-stations (prediction of the satellite position for tracking antennas, visibilities, sun interference, etc.); Commands for on-board AOCS support (orbit propagator, attitude profiles, variable model parameters, etc.).
- **Orbit Maneuver Planning,** e.g. Optimization of maneuvers for transfer to Geostationary Orbit (GEO) with chemical or electrical propulsion; GEO Station-Keeping and Re-location; Low- and Medium Earth Orbit (LEO and MEO) target orbit acquisition and maintenance; Repeat ground-track control with tight control requirements; Formation and constellation control; Re-orbiting and deorbiting
- **Attitude Operations,** e.g. Precise satellite attitude determination; Computation of attitude profiles for satellite commanding; Visibility conditions for optical communication (satellite-satellite, satellite-ground).
- **Collision Avoidance,** e.g. Analysis of critical close approaches (satellites or space debris); Planning and assessment of Collision Avoidance Maneuvers (CAM).
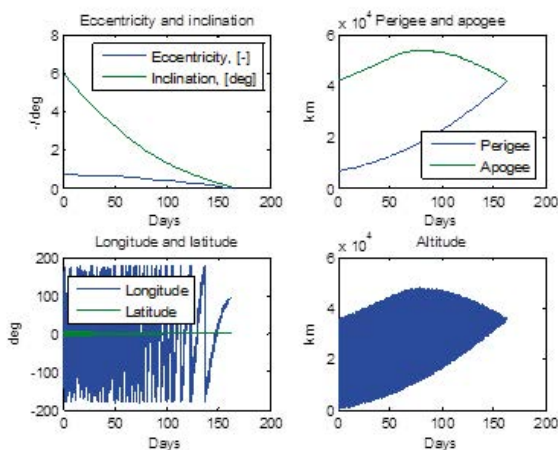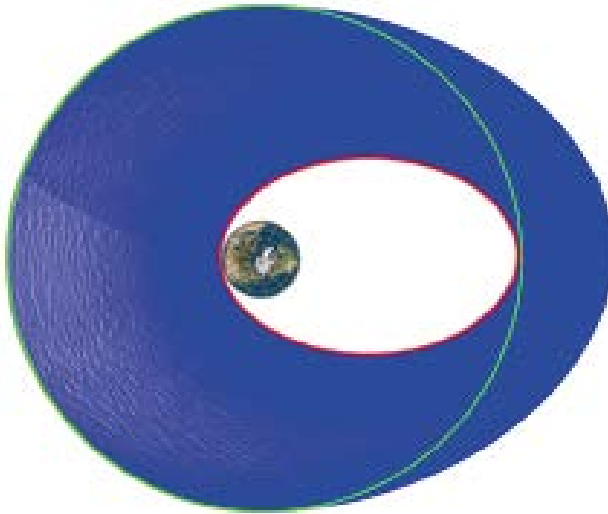
GTO-GEO low-thrust transfer trajectory and evolution of some orbital parameters during the transfer period.
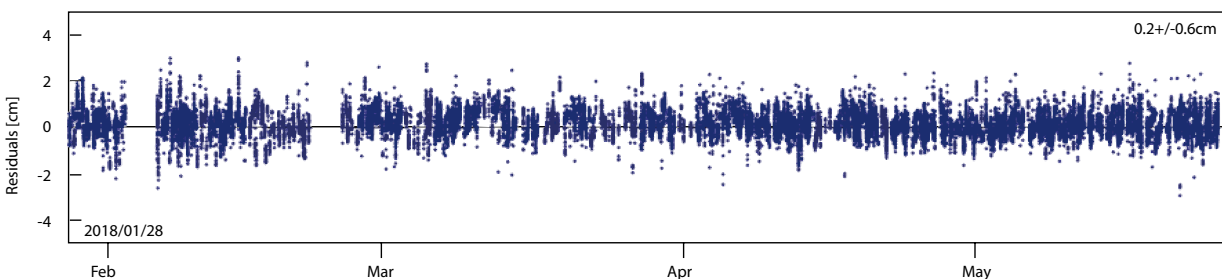
GSOC precise orbit determination for Sentinel-3A: laser ranging residuals proof mm-level position accuracy.

Publisher

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