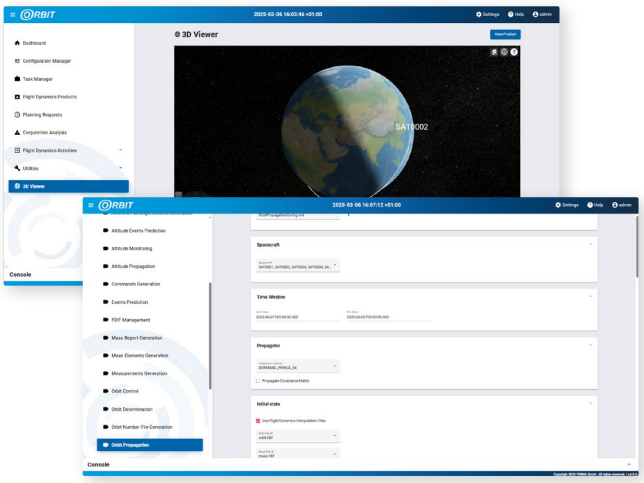
ORBIT

FLIGHT DYNAMICS SYSTEM

THE TERMA ORBIT PRODUCT PROVIDES SUPPORT TO FLIGHT DYNAMICS OPERATIONS FOR A WIDE RANGE OF MISSIONS, FROM LEO TO GEO SATELLITES. IT IS DESIGNED TO SUPPORT MULTIPLE SPACECRAFT AND AUTOMATED OPERATIONS SCENARIOS. IT IS BASED ON THE TERMA FLIGHT DYNAMICS LIBRARY, EXTENSION OF OREKIT.



Environment Files Ingestion & Update

This component allows updating several files provided by external agencies and used to accurately model the Earth physical properties.

Automatic updates: Update the files automatically at desired scheduled times.

ORBIT Determination

The Orbit Determination component provides estimations of the spacecraft orbit and model parameters.

Tracking Data Ingestion & Pre-processing: Ingest tracking data in several formats (e.g. GPS Rinex, CCSDS TDM, Cortex) and uses algorithms to reduce, smooth and filter them.

Measurement models: Model and simulate various measurements (e.g. two-way range and range-rate, Azimuth/Elevation and Right-ascension/Declination angle pairs, GPS pseudo-range).

Estimation: Estimate via Batch Least-Squares the orbital state as well as several dynamical and measurements model parameters (e.g. Cd, Cr, maneuver calibration factors, station biases, etc.)

ORBIT Propagation

The Orbit Propagation component computes the evolution of the spacecraft state forward and backward in time.

Force Models: Earth geopotential, Earth atmospheric drag, solar radiation pressure, luni-solar perturbations, ocean and solid tides). Maneuvers: Impulsive and finite maneuvers.

Covariance Propagation: Propagate the covariance matrix using variational equations.

Attitude laws: Several attitude laws are supported (e.g. Sun-pointing, nadir pointing, inertial pointing, etc.).

Event Predition

The Event Prediction component calculates several orbital and attitude events.

Orbital events: Ascending and descending node crossing times, apogee and perigee crossing times, umbra and penumbra crossing times for Earth and Moon eclipses, ground stations AOS/LOS, South Atlantic Anomaly crossing times, altitude crossing times and geographic region crossing times.

Attitude Events: Sun, Earth and Moon visibilities for sensors with conical and pyramidal FOV.

Intersatellite Events: Predict inter satellite links and visibilities among constellation satellites events.

Optical payload events: Computation of optical sensor footprints on the Earth's surface for a given Field of View shape or Field of Regard, as well as the visibility time windows of Areas of Interest (AOI), considering solar local time constraints and predicting the attitude offset from the nominal one to acquire the AOI.

Attitude Support

The Attitude Support component provides tools to execute various operations:

Attitude determination: Reconstruct the spacecraft attitude from telemetry data.

Attitude prediction & slew maneuvers: Predict the evolution of the spacecraft orientation and angular velocity and compute slew maneuvers profiles.

Reference ORBIT Definition

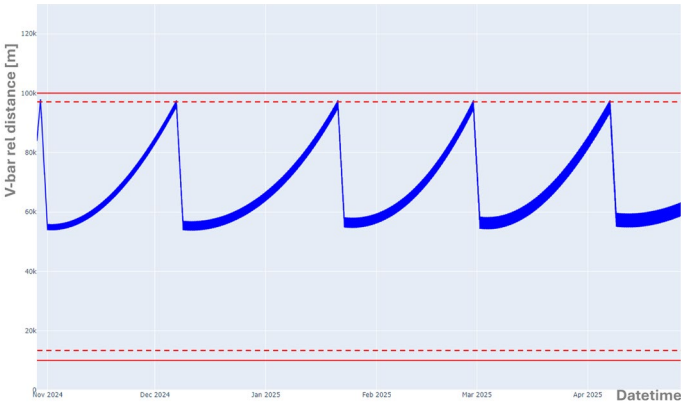
The Reference Orbit Definition component generates the desired target orbit.

Target Orbits: Several target orbits can be defined (e.g. Sun-synchronous orbits, orbit with repeating ground track, constant local time at ascending/ descending node).

ORBIT Control

The Orbit Control component calculates and optimize the maneuvers required to maintain the spacecraft on the reference orbit or inside the station-keeping box.

Maneuver Optimization: Several algorithms are supported depending on the reference orbit to optimize the maneuver execution.



Formation Flying

Monitor, acquire, and control the flight formation of multiple satellites using different strategies and numerical optimization to initiate and maintain the formation within a given control band.

Propellant Bookkeeping

The Propellant Bookkeeping component estimates the remaining propellant mass in the spacecraft tanks from the downloaded telemetry.

Estimation Methods: Several bookkeeping methods are supported (e.g. PVT with ideal and real gas model, pulse-counting).

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Conjunction Analysis

The Conjunction Analysis component provides tools to predict hazardous conjunctions and compute avoidance maneuvers.

Conjunction Analysis: Several algorithms are supported to determine the Time of Closest Approach (TCA) and the Probability of Collision (POC).

Collision Avoidance Maneuver: Maneuvers to ensure maximum miss distance or the minimum collision probability are supported.

Management and visualization of generated fd products

This component provides tools to manage and visualize the generated FD products (e.g. orbit files, mass file).

Internal database: Fully integrated database to store and retrieve FD products.

File formats: XML and ASCII for file report. PNG and EPS for data plots.

3D view of OPM: 3d view of the products OPM generated, displaying the determined orbits of the constellation.

TLE Management

The TLE Management component provides support in dealing with Two Line Elements (TLE) format.

TLE Ingestion: Ingest TLE from the NORAD database and the generate the corresponding orbit file.

TLE Generation: Generate TLE from a given orbit file.

Antenna Pointing Elements Generation

This component provides tools to generate tracking data information in various formats (e.g. ESA STDM, NASA IIRV).

Command Generation

The Command Generation component provides tailored tools to generate command parameters.

Orbital commands: Maneuver commands and On-board Orbit Propagator inputs.

Attitude commands: Attitude law via Chebyshev polynomials.

Transformation Utilities

Services to perform typical conversations useful for operations.

Reference frame transformation: convert cartesian coordinates between IERS frames.

Time format: transform date times in different formats as Julian epochs, ISO UTC and others.

Interfaces

GUI	Configurable, multi-user, web based.
REST APIs	Full support to REST APIs.
NATS Server	The system is designed to connect to a NATS server and operate based on event-driven automation.
External Files	TLE (Two-line element sets), CCSDS OEM (Orbital Ephemeris Message), SP3 (National Geodetic Survey), SPK (SPICE Ephemeris Format), CCSDS TDM (Tracking Data Message), CCSDS CDM (Conjunction Data Message).

Software Platform

Java, based on Orekit (www.orekit.org) from www.cs.fr and Terma FD framework. IPR owned by Terma, no export restrictions.

ORBIT is a live product that adapts to market needs.

Upcoming Features

- Low thrust maneuvers: low thrust stations keeping, orbit raising, GTO to GEO, etc.
- 3d view enhancements: covariances ellipsoids upon the orbit, events visualization, sensors FOV, pertinent references frames, etc.
- Formation flying controlled by differential drag.
- Full cloud deployment.
- Further automation features for Flight Dynamics procedures.

Initial releases of ORBIT are available. More information on:
http://tgss.terma.com

If you have any questions, please contact our team,
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