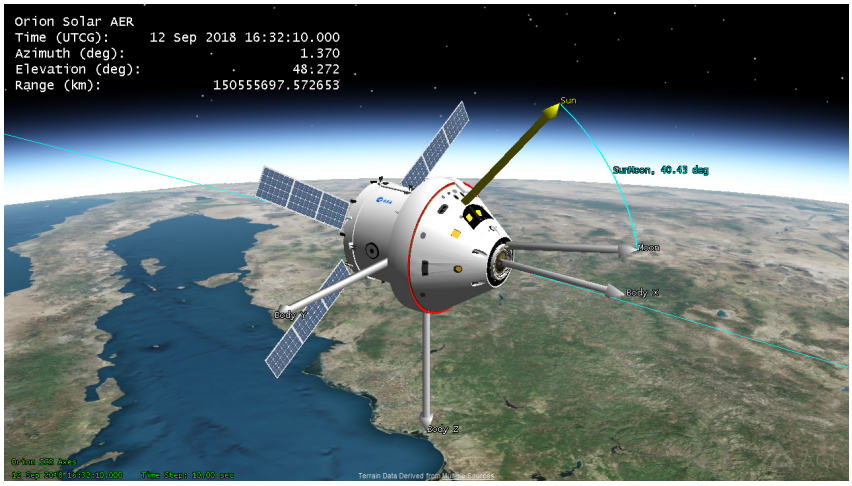
Ansys

MISSION

STK Premium (Space)

Advanced analytical tools and higher fidelity modeling in the space domain.

STK Premium (Space) adds advanced modeling of space-based platform and payload systems to STK Pro, including advanced orbit design and maneuver planning for satellite and spacecraft missions. STK Premium also adds analytical tools to improve your understanding of system performance.



Core Functionalities

Analytical capabilities include:

- Automated trade study design and analysis tools built on ModelCenter's optimization algorithms
- Electro-optical infrared (EOIR) sensor performance and image prediction
- High resolution global terrain, imagery, and map data
- Parallel computing capability increased to 16 local cores
- Analysis of live or simulated real-time data feeds, including interoperability with VR-Link Toolkit

Space-based systems modeling capabilities include:

- High-fidelity orbit propagation
- Deep space trajectory design
- Rendezvous and proximity operations (RPO)
- Conjunction analysis
- Orbit maneuver planning
- Attitude modeling
- Power generation, storage, and consumption modeling
- Satellite constellation design
- Launch window analysis
- Space environment effects

Sample Use Cases

- **Space systems design**. Model across the engineering life cycle, from concept development to validation of operational mission requirements, using high fidelity orbit and subsystem modeling capabilities.
- **Trajectory planning**. Design spacecraft trajectories from LEO to deep space, including advanced maneuver planning. Define orientations to optimize quality-image capture and downlink opportunities. Build large satellite constellations.
- **Space operations**. Understand the probability of conjunctions. Assess the true nature of RPO events.
- **Trade studies**. Perform automated trade studies and solve complex problems with advanced optimization algorithms.
- **Real time data integration**. Bring live flight data into STK for visualization and direct analysis of exercises or tests.
- **Electro-optical and infrared sensor systems**. Model the detection, tracking, and imaging performance of electro-optical and infrared sensors to support concept development, design, field testing, and operations. Simulate accurate sample data for the development of image analysis and evaluation techniques, algorithms, and tools.
- **Multidomain concept of operations**. Plan space, air, and terrestrial assets in a single mission environment.

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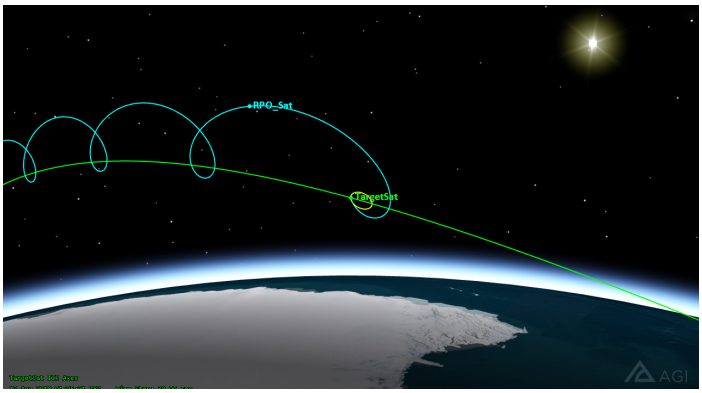
Space-Based Systems Modeling Capabilities

Astrogator

Used in support of missions ranging from LEO to GEO, from the Sun to Arrokoth, STK's *Astrogator* capability provides everything mission planners need to develop, optimize, and validate flight-ready trajectory solutions. The combination of GUI-driven workflows and 3D visualization makes creating and understanding complex missions simple. You can easily integrate custom engine models, force models, and propagation variables that are fit to your exact mission specifications. In addition, *Astrogator* reveals mission-critical insights that can decrease overall program costs.



Sample Use Cases

- Create and analyze high-fidelity spacecraft trajectories in any regime, including LEO, GEO, GTO, HEO, Lunar/cislunar, libration points, and deep space.
- Model impulsive or finite spacecraft maneuvers.
- Support early phase design and planning, trade studies, proposals, or internal research.
- Collaborate with other subsystem teams to analyze mission impacts and iterate new trajectories quickly.
- Conduct force model or aggregate launch analysis.
- Support ongoing spacecraft operations with maneuver planning or trajectory refinement.
- Integrate *Astrogator* into your flight dynamics system.
- Derive intelligence from realistic simulations of third-party spacecraft, including advanced maneuvers such as rendezvous and proximity operations, station keeping, or formation flying.

Key Value Points

- Includes industry-standard models and optimization engines to solve both common and unique astrodynamics problems.
- Produces repeatable, accurate results suitable for operational space missions.
- Enables you to create customized and automated workflows tailored to your needs.
- Comprehensive reporting and analysis tools make deriving insights as easy as creating a trajectory. Because it is directly integrated with STK, you have immediate access to a multidomain modeling and analysis environment — something that is unavailable with most dedicated trajectory design software products.
- Amazing visualization capabilities enable you to communicate with team members and decision makers using precise data and engaging images and animations.

Core Capabilities

- **Segmented trajectory design**. *Astrogator* uses a series of segments to define the complete trajectory and generate the final ephemeris. Examples of individual segments include Initial State, Launch, Follow, Maneuver, Propagate, Target Sequence, etc.
- **Maneuver simulation**. Capabilities include maneuver pointing and thrusting strategies that you can execute in an impulsive or finite sense, as well as a mechanism for optimizing the pointing of finite maneuvers.
- **High-fidelity force models**. Includes accurate force models that you can customize to tailor propagations to your mission requirements.
- **Advanced search and optimization**. A collection of search profiles — differential corrector and SNOPT and IPOPT optimizers — helps you quickly and accurately discover the best trajectories to achieve your mission goals.
- **User scripting**. Includes built-in scripting for individual sequences and a high-level API to orchestrate entire simulations. Internal scripting supports JScript, VBScript, or MATLAB (the API supports additional languages).
- **Highly customizable variables**. You can define your own engine models, propagators, central bodies, fuel tank characteristics, calculations, constraints, stopping conditions, and more.
- **Conditional responses**. Subroutines within automatic sequences enable conditional responses based on user-defined criteria.
- **Thorough reporting and graphing**. Includes multiple data products and views, including maneuver summaries, hundreds of built-in calculation objects, execution logs, and user-defined variable accounting.

SatPro

STK's *SatPro* capability enables higher fidelity satellite systems modeling and analysis. The propagators included in *SatPro* can incorporate numerical integration and differential equations of motion, compute ephemeris for months and years, and integrate specialized propagation methods. *SatPro* also enhances attitude analysis for designers and operators with attitude spheres, attitude coverage, and tailored profiles and constraints. Finally, *SatPro* provides you with a collection of satellite engineering tools that model a satellite's surface area, mass, solar panel configuration, and more.

Sample Use Cases

- Propagate orbits based on HPOP, LOP, or SP3 propagation.
- Compute a satellite's covariance.
- Simulate attitude states with custom torque models and momentum biases.
- Evaluate solar panel performance.
- Determine the life span of a satellite's orbit.
- Visualize changes in attitude over time, including vector-based sensor pointing.
- Generate a Walker constellation model.

Space Environment Effects Tool

STK's *Space Environment and Effects Tool (SEET)* capability adds space environment variables to your orbit modeling and analysis. *SEET* provides comprehensive modeling of the near-Earth space environment and its expected impacts on a space vehicle. *SEET* calculates spacecraft exposure to ionizing particles, thermal radiation, and space debris throughout the orbit. This level of analysis is critical because higher levels of debris and energetic natural phenomena (such as solar flare activity) are increasing the environmental risks to spacecraft.

Sample Use Cases

- Compute the expected temperature of your satellite.
- Determine the optimal amount of satellite radiation shielding, appropriate for its orbit, without unnecessary weight.
- Determine precise windows to shut down instrumentation while in the South Atlantic Anomaly.

Conjunction Analysis Tool

STK's *Conjunction Analysis* capability includes four collision-threat analysis tools to detect and assess potential collisions in space:

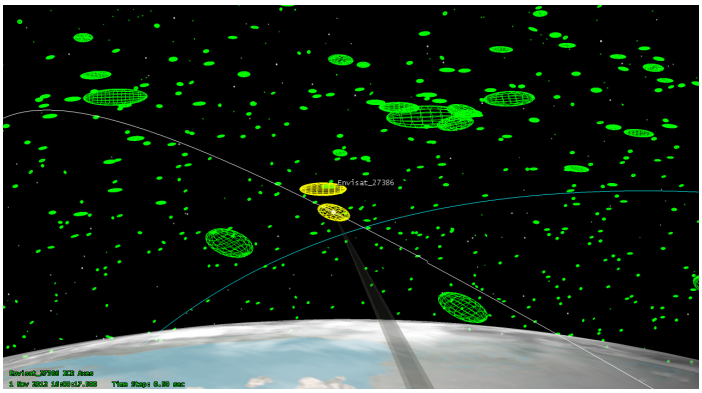
- The **Close Approach** tool detects conjunction events for a single primary satellite with any set of space objects defined by a TLE file.
- The **Advanced CAT** tool detects conjunctions for a set of primary objects against a set of secondary objects, where proximity is measured as the distance between threat volumes.
- The **Launch Window Analysis** tool determines the blackout times in a launch time window, wherein a conjunction with a secondary object would occur.
- The **LaserCAT** tool determines the blackout times within a firing time window of a ground-based laser.

Sample Use Cases

- Detect close approaches to a satellite of interest.
- Compute threat volumes for groups of objects.
- Assess the potential for an unintended illumination of a satellite.
- Evaluate a launch window.

Key Value Points

- Prefiltering of orbit elements provides unprecedented computation speed without reducing fidelity.
- Includes precise 3D visualization of error volumes.
- Uses the NORAD TLE database of more than 15,000 objects.
- High-fidelity integrated ephemeris supported for both primary and secondary objects.
- Computes probability metrics, appropriate for both short and long encounters.
- Supports scripted automation of data updates, computations, and reporting.



Advanced Analytical Capabilities

Analyzer and Optimizer

STK's *Analyzer* capability integrates the engineering analysis capabilities of ModelCenter with STK. Explore the design space of your systems with parametric studies, carpet plots, Design of Experiments (DOE) tests, Monte Carlo-based probabilistic analysis, and optimization algorithms.

STK's *Optimizer* capability is a collection of optimization algorithms that you can use within *Analyzer*, including gradient based optimizers, genetic algorithms, multiobjective algorithms, and other heuristic search methods.

Sample Use Cases

- Optimize maneuvers to minimize fuel usage.
- Maximize an asset's collection time over an area of interest.
- Understand how launch errors could affect the orbit of your satellite and its mission.
- Determine how the number of orbit planes and satellites in a constellation will affect coverage.
- Maximize signal-to-noise ratio with optimal antenna properties.

Key Value Points

- Plots are interactive and customizable.
- An algorithm wizard makes it easy to choose the algorithms that will work best for a problem.
- Computations can be scaled with parallel computing.
- Enables you to perform analyses easily, without programming or scripting.
- Capable of solutions that would be infeasible with a brute force approach.

Terrain, Imagery, and Maps

STK's *Terrain, Imagery, and Maps (TIM)* datasets provide a locally hosted (offline) alternative to streaming datasets such as Microsoft Bing's imagery services. *TIM* datasets contain STK high resolution mapping data for the entire globe.

Datasets included

- Shuttle Radar Topography Mission (SRTM) 4.1
- National Elevation Dataset (NED)
- EarthSat NaturalVu
- Relational World Data Bank (RWDB II)

Key Value Points

- Provides offline availability of high-resolution terrain, imagery, and maps
- Enables you to accomplish faster analysis of terrain-masking for line-of-sight and sensor intersections on terrain.

Image from Terrain, Imagery, and Maps

Real-Time Tracking Technology (RT3) and Distributed Simulation (DSim)

STK's *RT3* capability ingests live and simulated vehicle track data feeds into STK for visualization and analysis and provides tools to filter tracks, define events and alerts, and archive live data for playback. It also includes a software development kit (SDK) to customize *RT3* or integrate it with third-party applications.

STK's *DSim* capability expands *RT3* to include distributed simulation data feeds using an IEEE-compliant interface that connects *RT3* with VR-Link Toolkit by VT MÄK.

Sample Use Cases

- Monitor a live test or exercise directly within STK.
- Automatically populate a scenario with a group of objects and their routes.
- Evaluate thousands of entities using STK's multitrack objects.
- Quickly filter through large datasets to make operationally viable decisions.
- Specify event criteria using conditional logic on position and associated data and get notified when events occur.
- Automate standard responses by assigning actions to event definitions.
- Create DIS and HLA compatible data feeds from STK.

Included Data Feed Readers

- Link 16
- DIS and HLA
- STANAG 4609 - NATO Digital Motion Imagery Standard
- STANAG 4607 - NATO Ground Moving Target Indicator Format
- NMEA (National Marine Electronics Association)
- NRTI (Near Real Time Interface)
- TENA (Test and Training Enabling Architecture)
- COT (Cursor on Target)
- ESRI Tracking Server

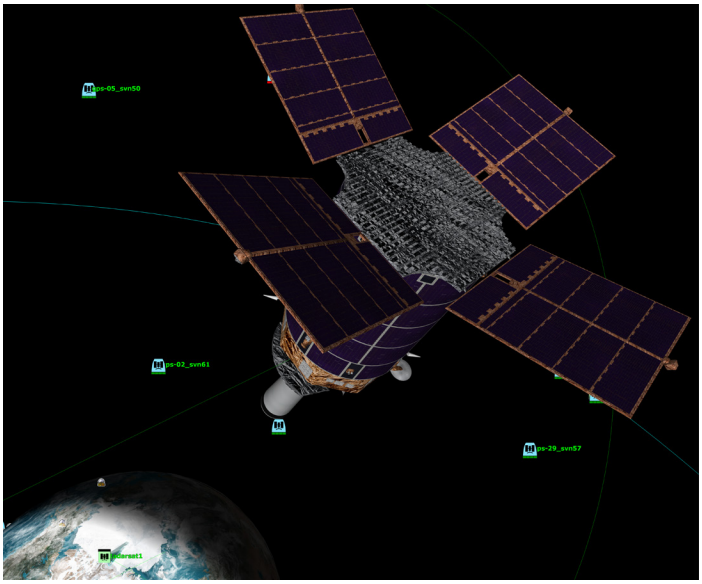
Parallel Computing

As the level of detail required for a calculation grows, so does the amount of time and memory needed to compute it. STK's *Parallel Computing* capability accelerates computations by enabling STK to distribute its most resource intense tasks across multiple computing cores. STK Premium includes the ability to scale using up to 16 local cores, with additional cores, server, cluster, and cloud options available with additional licensing.

Parallel Computing also includes Software Development Kits (SDK) for .NET, Java, and Python. These SDKs make it easy to parallelize the execution of custom models and algorithms.

Key Value Points

- Reduces design time and maximizes fidelity.
- The number of cores is configurable, ensuring control over reused worker processes.
- Automatically turns on and off for all supported computations.
- The Integrated Job Monitor tracks status and progress of parallel jobs as they execute.

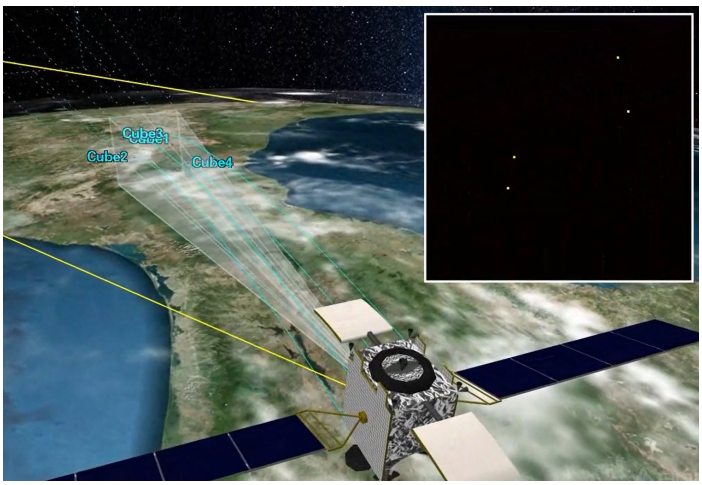


EOIR

STK's *EOIR* capability models detection, tracking, and imaging performance of electro-optical and infrared sensors. Its radiometric sensor model goes beyond simple geometry to consider the full, time-dynamic physics-based interactions of sensor, target, and environment. *EOIR* is faster and more accessible than complex, stand-alone sensor models.

Sample Use Cases

- Support the design, development, and operation of imaging systems.
- Simulate accurate sample data and truth-values for the development of image analysis and evaluation techniques, algorithms, and tools.
- Rapidly develop prototypes for proposals and presentations that are validated against program mission requirements.



Core Capabilities

- **Target modeling**. Model optical and thermal properties of aircraft, satellites, and missiles by specifying shape, dimensions, surface material, and surface temperature.
- **Synthetic scenes**. Synthesize sensor scenes with 27 optical materials and thermal models of planets, stars, solar radiance, and missiles.
- **Multisensor architecture analysis**. Create up to 12 independently specified and steered sensors.
- **EOIR sensors**. Use up to 36 bands per sensor to simulate a multiband sensor or different settings of a system. Define spatial, spectral, optical, and radiometric properties on a per-band basis.
- **Atmospheric models**. Use a simple atmospheric model to calculate transmission, scatter, and thermal path radiance or increase fidelity with the included MODTRAN-based atmospheric model — one of the highest fidelity, community standard atmospheric models available.
- **Clouds**. Configure the thin layer cloud model with multiple time-dynamic layers and cloud characteristics, such as percent cloud cover, temperature, emissivity, and radiance.
- **Earth surface**. Calculate reflectance, emissivity, and temperature texture using the included low to moderate spatial resolution global spectral material map of Earth, broken into the 17 IGBP Global Land Cover types.
- **Stars**. Leverage STK's database of more than two million high quality star records to model precise position and spectral irradiance.
- **Celestial bodies**. Include thermal and optical properties of Earth, the Moon, the Sun and other planets, including diurnal, latitudinal, and seasonal variations.
- **Customization**. Create your own custom models, materials, target signatures, and thermal profiles.
- **Export capabilities**. Export sensor output images for use in external image processing algorithms or sensor modeling tools.