

Detailed Ansys STK Capabilities

		<i>Pro</i>	<i>Premium (Air)</i>	<i>Premium (Space)</i>	<i>Enterprise</i>
Systems Tool Kit (STK)	2	✓	✓	✓	✓
STK Communications	5	✓	✓	✓	✓
STK Radar	7	✓	✓	✓	✓
STK Terrain Integrated Rough Earth Model (TIREM)	9	✓	✓	✓	✓
STK Urban Propagation	11	✓	✓	✓	✓
STK Analysis Workbench	12	✓	✓	✓	✓
STK Coverage	14	✓	✓	✓	✓
STK Integration	16	✓	✓	✓	✓
STK Engine	18	✓	✓	✓	✓
STK Parallel Computing	20	✓	✓	✓	✓
STK Analyzer	21		✓	✓	✓
STK EOIR	23		✓	✓	✓
STK Real-Time Tracking Technology (RT3)	26		✓	✓	✓
STK Distributed Simulation (DSim)	27		✓	✓	✓
STK Aviator	29		✓		✓
STK Astrogator	32			✓	✓
STK SatPro	34			✓	✓
STK Space Environment and Effects Tool (SEET)	36			✓	✓
STK Conjunction Analysis Tool (CAT)	38			✓	✓
Geospatial Content Server	40				✓
TETK	42				✓
Behavior Execution Engine	44				✓

Systems Tool Kit (STK)

A physics-based environment for digital mission engineering.

With STK, you can measure the performance of your system and component models in the context of a complete mission:

- Select, build, or import vehicle and sensor models and combine them to accurately represent existing and proposed systems.
- Simulate the entire system in action at any location and at any time to gain a clear understanding of the system behavior and its mission performance.

STK also supports collaboration with distributed, multidisciplinary teams across all operational domains and life cycle phases:

- Save, load, and share scenarios and dynamic data from the STK Data Federate.
- Access hosted terrain, imagery, and other heterogeneous 3D data from the STK Geospatial Content Server (GCS).
- Access scenarios on the SDF from a cloud-based version of STK.

/ Accurate Environment

Accurate Earth representation. WGS84, MSL and Earth motion (pole wander, nutation, sidereal time).

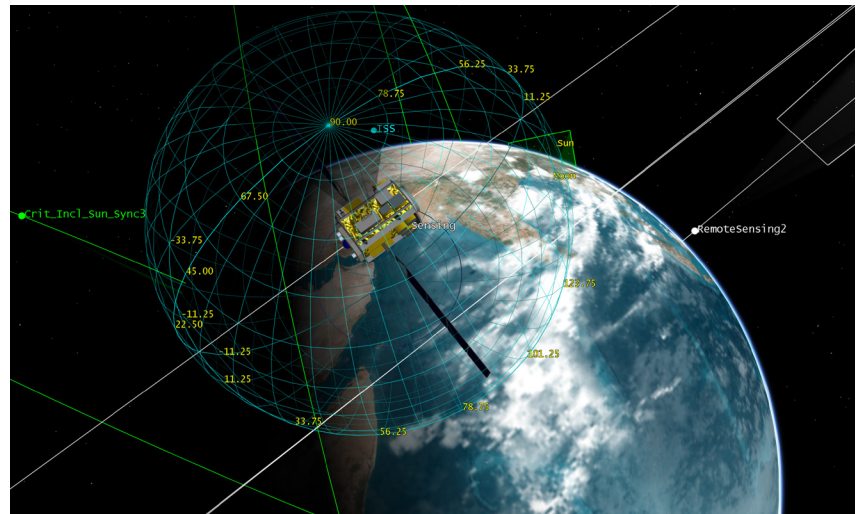
Streaming terrain. Stream worldwide terrain for both analysis and visualization from the STK GCS.

Streaming or local imagery. Bing Maps, ArcGIS, WMS, .bmp, .jpg, .jp2, .tif and .nitf.

Import, analyze, and export GIS data. Import and export KML and shapefiles.

Digital terrain data. Load all standard types of data to more accurately model and visualize altitude variations, line-of-site restrictions and sensor footprint intersection.

3D Tiles. Optimally stream massive 3D datasets, such as entire cities, CAD models down to the rivets, or centimeter-level terrain, into a 3D Graphics window.



/ Objects

Ground types. Facility, target, places, area target, line target.

Vehicles types. Aircraft, ground vehicle, ship, launch vehicle, missile, satellite, and multi-track object.

Vehicle routes. Great arc (with terrain following), ballistic, two-body, HPOP, J2, J4 SGP4, GPS, LOP, 11-Parameter, SPICE, and External (data file).

Import standard objects. Standard object databases that contain thousands of satellites, facilities, ground station networks, aircraft, cities, and sensors are available online and locally.

Import user data. Vehicle data in any format can be imported into STK.

Vehicle attitude profiles. Nadir alignment with ECF or ECI velocity constraint, ECF velocity alignment with nadir or radial constraint, ECI velocity alignment with nadir constraint, GPS External attitude, Coordinated Turn External, User-defined Attitude profiles, Fixed in Axes, and Aligned and Constrained.

/ Sensors

Sensors are used to define Fields of View and Fields of Regard on objects.

Sensor Types. Simple Conic, Complex Conic, Half Power, Rectangular, and Synthetic Aperture Radar (SAR).

Sensor Pointing. Along Vector, customer External, Fixed, radars, push broom sensors and other instruments that spin, scan or sweep over time.), Grazing Altitude, Fixed In Axes, 3D Targeted (track other objects.), Spinning (for Model)

Sensor AzEl Mask. Defines an azimuth-elevation mask for the sensor. Terrain calculated or file defined.

/ Constraints

You can impose constraints to add fidelity to an STK object.

Basic. Imposes standard access constraints on an object. Constraints are Altitude, Azimuth angle, Elevation Angle, Line of Sight, Field of View, Range, Azimuth Rate, Elevation Rate, Range Rate, Angular rate, Propagation Delay, Terrain Mask, 3D Tiles Mask, Facility Az-El Mask, and Sensor Az-El Mask.

Sun. Imposes constraints based on the position of the Sun and Moon. Constraints are Line of Sight, Lighting, Sun Elevation Angle, Sun Ground Elevation Angle, Lunar Elevation Angle, Line of Sight Sun Exclusion Angle, Line of Sight Lunar Exclusion Angle, Boresight Sun Exclusion Angle, Boresight Lunar Exclusion Angle, Sun Specular Point Exclusion, Solar/Lunar Obstruction, Field of View Specular Point Exclusion, and Additional Central Body Obstruction.

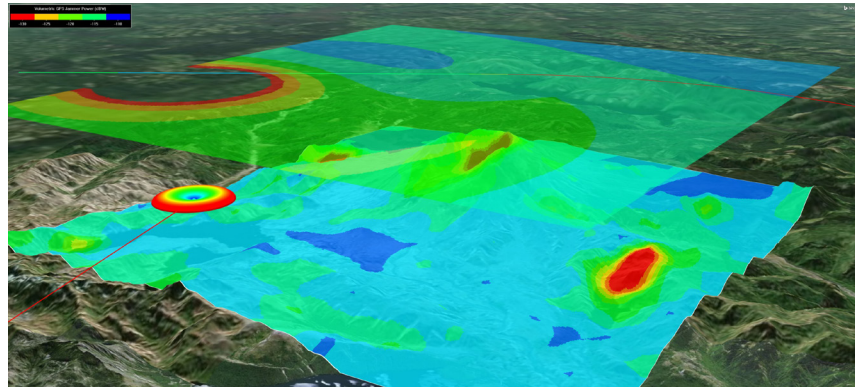
Temporal. Imposes time-based constraints on an object.

Vector. Constrains access computations with respect to any valid vector or angle.

Zone. Defines areas where access is or is not allowed using inclusion and exclusion zones.

Resolution constraints for sensors. Limit access based on sensor characteristics and the quality of the inview.

Geostationary Belt Exclusion Angle. Constrains access to an object when it falls within the specified angle. This constraint is useful when calculating access from a facility, place, or target to a LEO satellite.



Height Above Horizon. Constrains access based on the minimum and/or maximum height of the facility, place, or target above the horizon.

Terrain Grazing Angle. Constrains access based on the minimum and/or maximum angle between the relative position vector and the local terrain.

Object Exclusion Angle. Used to select and remove objects that are to be excluded from access computations if they are at the indicated angle from the original object.

Elevation Rise-Set Angle. Used to specify different elevation angle limits for the rise-stage and setting-stage of a satellite.

Access constraint plugins. Provide a method for adding customized constraints directly into visibility computations.

Targeting constraints. Define the relationship between an object and the target of that object.

Space-related advanced constraints. Impose a variety of vehicle-specific constraints.

/ Reports and Graphs

Create reports and graphics from STK's data providers. There are thousands of data providers, including:

Sensor Boresight Grazing LLA and Boresight Grazing LLR data providers report information on the point along the sensor boresight direction with the lowest detic altitude. The point is computed in the sensor's central body fixed coordinate system.

Sensor Access Refraction reports information on the effects of refraction on elevation angle, range, and propagation delay.

Azimuth Elevation Mask data provider reports the obscuration mask data for a sensor or facility.

/ Utilities and Tools

You can use the following to fine-tune your analysis and enhance your visualization.

Access tool. Determines the times one object can “access,” or see, another object.

Data tools and utilities. Used to manage, update, and export data.

Import and Export tools. Used to import your data into STK and export STK data, such as ephemeris, attitude, sensor pointing, KML and display times.

Object-specific tools. Used to manipulate and display the data related to individual objects. These tools include calculating vehicle or sensor swath, or generating a Walker constellation.

Share Analysis. Convert your STK 3D scenarios to VDF files that can be viewed in the free STK Viewer.

Deck Access. Computes access to a set of objects, not currently defined in the STK scenario, from a single object in the scenario. Deck access operations are useful when you have a large number of objects that no longer need to be in the STK scenario but for which you would like visibility information. Using deck access can greatly reduce load and save time for such scenarios and minimize graphical clutter.

Area tool. Calculates the area of a model from a given view direction, over a given time interval, such as an orbit period.

Obscuration tool. Determines when a sensor’s field of view is obscured by one or more objects.

Imagery and terrain converter. Converts any image, including terrain data, into a format that can be displayed in the 3D window.

Calculation tool. Produces various time-dependent quantities that include both installed and user definable scalars, conditions, and parameter sets.

Vector geometry tool. Defines location, pointing, and orientation in 3D space, using both installed and user definable points, vectors, angles, axes, and coordinate systems.

/ Visualization

Time-dynamic 3D globe. Annotations, object lines, lighting, stars, vectors and overlays.

Time-dynamic 2D map. Equidistant cylindrical, Mercator, orthographic and azimuthal equidistant.

Timeline view. Time components, access intervals and ephemeris intervals.

Advanced 3-D model options. Import from CAD, COLLADA, articulations and scaling.

3D model database. Hundreds of models (glTF, glb, dae, and mdl).

Advanced viewing controls. View from or to any STK object, change field of view and more.

Virtual Reality headsets. Most models are natively supported with STK.

Advanced analysis display options. You can apply constraints to the graphical display of a Sensor’s field of view, display a facility’s azimuth-elevation mask, and use 2525B symbology.

/ Extend STK’s Capabilities

Automate tasks, extend analysis, and customize workflows using the fully documented, open API.

Interface with STK using Connect and the Object Model.

Extend the computational capabilities of STK using Analysis Workbench.

Customize STK using UI Plugins.

Speed up Coverage, Deck Access, Chains, Volumetrics, and Analyzer trade study computations using STK Parallel Computing.



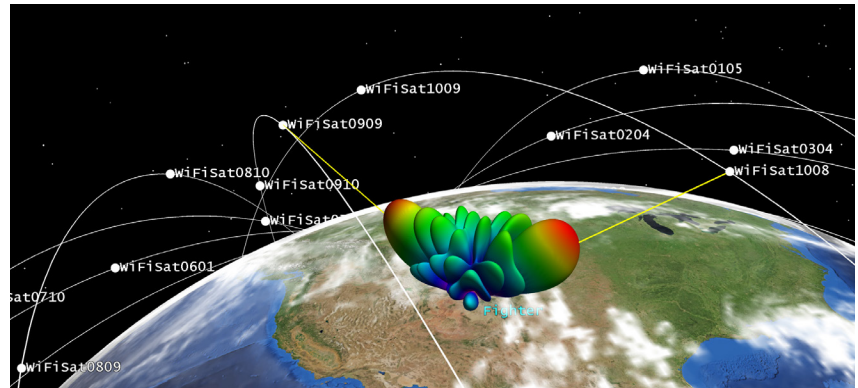
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STK Communications

Model and analyze real-world dynamic RF and optical communications.

Provides high fidelity modeling and analysis that includes:

- Detailed link budget reports and graphs
- Signal performance contours
- Visualization of dynamic system performance
- Detailed rain models, atmospheric losses, and RF interference sources
- Ability to plug in custom models or interference sources
- All system models easily editable from the components browser



/ System modeling

Provides the ability to model the physical components of each node in any communications system.

- Eight STK receiver types: Simple, Cable, Medium, Complex, Multibeam, Laser, RF plugin, and Laser plugin
- Eight transmitter types: Simple, Cable, Medium, Complex, Multibeam, Plugin, Laser, and GPS Satellite
- Three re-transmitter models: Simple, Medium, and Complex
- Over 60 Antenna types, including multi-beam and phased array
- Support of many external antenna gain pattern data files, including Complex ANSYS *.ffd antenna file and Complex *.uan antenna file formats
- Over 20 power spectrum filter models for a transmitter or receiver
- Wideband and narrowband jammer modulators, third-party modulators, external file modulators, and script plugin modulators
- Multiple demodulators, including a user-defined demodulator

/ Multibeam antennas

- Each beam is an independent antenna with its own frequency, RF power level, polarization state, gain and characteristic type.
- Each beam's boresight directions can also be independently oriented.
- Aggregate or individual beam contours displayed in 2D and 3D.
- Variable beam selection criteria.
- Different beam selection criteria, such as maximum gain or minimum boresight angle, or plugin script.

/ Phased array antennas

- Multiple array configurations: Circular, Hexagon, Linear, Polygon, and external data.
- Define number of elements, grid type and spacing.
- Disable/enable individual elements.
- Specify beam direction and Null steering to other STK objects from a data file or script.
- Adaption algorithms include Min. Variance Distortionless Response (MVDR) and user-specific weights from a data file or script.

/ Modeling the RF environment

A full range of propagation environment models is provided.

- Empirical rain models: Crane 1982, Crane 1985, and ITU-R P.618, as well as user-definable outage percentage and rain rate.
- Atmospheric absorption models: ITU-R P.676 and Simple Satcom. ITU-R P.1814 for laser receivers.
- Urban and terrestrial models: Two-Ray and STK Urban Propagation extension.
- Clouds and fog models: ITU-R P.840 recommended for attenuation due to clouds and fog
- Tropospheric scintillation model: ITU-R P.618 model with option to compute deep fade
- Ionospheric fading loss ITU-R P.531
- Custom loss plugin models
- Object specific losses such as local surface atmosphere and system temperature
- Terrain Integrated Rough Earth Model (TIREM)

/ Terrain Integrated Rough Earth Model (TIREM)

TIREM adds fidelity to the calculation and dynamic modeling of point-to-point, line-of-sight effects for link performance in Communications, by taking into account the effect of irregular terrain, sea water, and non-line-of-sight effects. The maximum height for these models is 30km.

/ Constraining RF phenomenon

Communications links can be constrained in a variety of ways on a transmitter or receiver.

- Frequency range, received isotropic power level, power flux density, link EIRP, Doppler shift, carrier-to-noise density ratio, power at receiver input, true carrier-to-noise ratio, bit error rate, link margin, bit energy to noise power density ratio
- Relative angle between the transmitter's plane of polarization and the receiver's plane of polarization
- Dynamically computed ratio of the link budget receiver gain value (G) along the link vector and the total receiver noise temperature (T)
- User plugin

/ Analyzing comm systems

The full power of STK reporting and graphing is available to present analyses of communications links.

Link margin specification and calculations:

- The Link Information report for a Receiver includes the Link Margin Type (BER, RIP, C/N, etc.), Link Margin threshold value, and the computed Link Margin.
- Filter report results based on the Link Margin calculation.
- **Interference analysis**
- Performs network and target interference analysis as well as target interference analysis.
- Quickly calculates the impact of the interference network into communication links and presents the results as time-ordered data and statistical summaries using probability density functions (PDFs) and cumulative density functions (CDFs).
- Enables you to investigate the $C/(N+I)$, C/I , DT/T and power flux density.

- Quickly accomplish interference analysis for a specific link (e.g., ground station to a target) by leveraging the STK Satellite Database.
- Combined with a user-supplied RFI database file, you can quickly identify which satellite may cause or be susceptible to RF interference from a ground station.

/ Visualize and animate your analysis

Highlights the Communications components, such as interferers, during the STK animation period on both the 2D map and 3D globe.

/ Fully integrated with STK analysis tools

STK Analysis Workbench tools. Extend the fundamental computational capabilities of *Communications* by using the Time, Vector Geometry, and Calculation Tools.

Coverage and Volumetric analysis. Evaluate spatial conditions and calculations across a number of grid points. (Requires Coverage and Analysis Workbench licenses.)

Coverage or SatPro. Display jamming/ interference contours on 3D coverage grids or on the 3D attitude sphere. You can also investigate the $C/(N+I)$, C/I , DT/T and power flux density.

/ Integration with third party tools

Connect and Object Model. Automate and interface custom software using the Connect engineering-level interface or the finer grain MS Com-compliant Object model interface.

MATLAB. Generate link budget data between a transmitter and a receiver that is suitable for the STK MATLAB interface.

QualNet interface. Combines network performance evaluation from QualNet with the platform mobility models, wireless link calculations and mission visualization environment of STK.



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STK Radar

Provide thorough modeling and analysis of radar systems.

The STK Radar capability simulates radar system performance in Synthetic Aperture Radar (SAR) or Search/Track modes. With *Radar*, you can model Monostatic, Bistatic, and Multifunction radars in the context of your mission to account for the participation of every asset. Assess the impacts of a wide variety of conditions and interference on your radar system. Evaluate the results with reports, graphs, and 2D and 3D visualization.

/ Use cases

- Analyze dynamic radar performance.
- Model RF environments.
- Analyze system-level interference.
- Examine long distances to determine latencies from deep space.
- Model Sun, Earth, cosmic and other environmental impacts on both signal attenuation and radar receiver temperatures.
- Simulate benign and denied communications environments.
- Decide optimal placement of system assets.

/ Radar types and modes

Model types. Monostatic Radar, Bistatic Receiver Radar, Bistatic Transmitter Radar, and Multifunction Radar.

Operational modes. Search/Track Radar, Synthetic Aperture Radar (SAR), and Radar Advanced Environment (RAE).

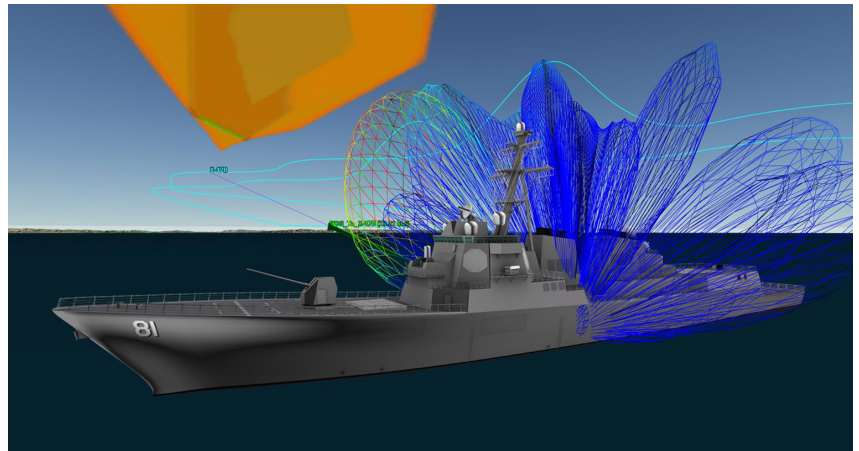
Multifunction radar. Models multiple radar beams and supports:

- Simultaneous handling of tasks by multiple beams, such as scanning search zones or tracking targets as directed by a user-specified schedule.
- Dynamic waveform switching for each of the active beams. Each beam selects and uses an appropriate waveform based on a target's range from the radar system.

/ Radar components

Radar Receiver

- Model orthogonal RF polarized channel
- Model receiver specs



- Radio frequency filter
- Single or dual polarization channels
- System noise temperature
- Radar Sensitivity Time Control (STC) attenuation
- Additional gains and losses
- Constant false alarm rate (CFAR) algorithm
- Cell-Averaging (CA-CFAR) and Ordered Statistics (OS-CFAR) algorithms for CFAR and Probability of Detection (PDet) computations
- User plugins for adding custom CFAR and PDet algorithms

Radar Transmitter

- Model orthogonal RF polarized signal
- Model transmitter specs
- Radio frequency filter
- Single or dual polarization channels
- Additional gains and losses

Antenna

- 60+ antenna models are easily accessible and editable using the Component Browser
- Antenna model types include Bessel, Cosecant, Cosine, Dipole, GPS, Gaussian, Helix, Hemisphere, ITU, Isotropic, Parabolic, Pencil Beam, Phased Array, Rectangular Beam, Simple Optical, Sinc, Square Horn, Uniform Aperture, and user-defined

/ Bistatic transmitters

Both Monostatic and Bistatic Transmitter Radar systems can be used as the Bistatic Transmitter for the Bistatic Receiver Radar system.

/ Jammers

Radar enables you to identify RF transmitters and other radars as jammers and assess their impact on the performance of a radar system. Signal spectrum power spectral Density (PSD) of these jamming sources can be computed across radar receiver bandwidth for high fidelity analysis.

/ Clutter

The clutter geometry algorithm determines the location of each clutter point relative to the radar, and displays it as a single clutter point on the target or displays clutter over a smooth or oblate Earth. A Clutter Geometry Model plugin is also available.

Custom clutter models may be added by a user to enhance clutter computations

/ Radar cross section

Radar enables you to specify an important property of a potential radar target: its radar cross section (RCS). RCS can be a constant value, an aspect dependent real or complex valued matrix. It can also be an aspect dependent complex scattering block matrix. The Bistatic radar model supports bistatic RCS for a target. Bistatic RCS can be of types listed above.

A plugin RCS module option for user specified RCS computations allows addition of dynamic or adaptive RCS algorithms.

/ Radar constraints

- Search/Track, Search/Track with Jamming, Search/Track OrthoPol, and Search/Track OrthoPol Jamming
- SAR, SAR with Jamming, SAR OrthoPol
- Bistatic, Noise, Sun, Temporal, Zones, Targeting, Vector, and plugins
- New RF-based Access constraints applicable to Multifunction radars



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/ Model atmospheric refraction using three models

- Effective Earth Radius
- ITU-R P.834
- Satellite Control Facility (SCF)

/ RF Propagation models

A full range of environment models is provided:

- **Rain models.** Crane 1982, Crane 1985 and ITU-R P.618, as well as user-definable outage percentage and rain rate
- **Atmospheric absorption models.** Atmospheric absorption models — ITU-R P.676-9 and Simple Satcom. ITU-R P1814 for laser receivers.
- **Clouds and fog models.** ITU-R P.840 recommended for attenuation due to clouds and fog
- **Tropospheric scintillation model.** ITU-R P.618 model with option to compute deep fade
- **Ionospheric fading model** ITU-R P.531 for space based radars or targets. Uses the International Reference Ionosphere (IRI-2016) based algorithms and ionospheric electron and ion content data updates
- **Custom loss plugin models,** such as launch vehicle plume attenuation and aspect dependent antenna radome attenuation
- **Object specific losses** such as local surface atmosphere and system temperature

/ Terrain Integrated Rough Earth (TIREM) model

TIREM adds fidelity to the calculation and dynamic modeling of point-to-point, line-of-sight effects for link performance, by taking into account the effect of irregular terrain, sea water, and non-line-of-sight effects. The maximum height for these models is 30 km.

/ Reports and graphs

A wide variety of radar data providers are available for generating custom reports and graphs

/ Radar Advanced Environment (RAE) extension for Radar

Extends the capabilities of Radar by introducing ground reflectivity as a contributing factor in dynamic radar assessments.

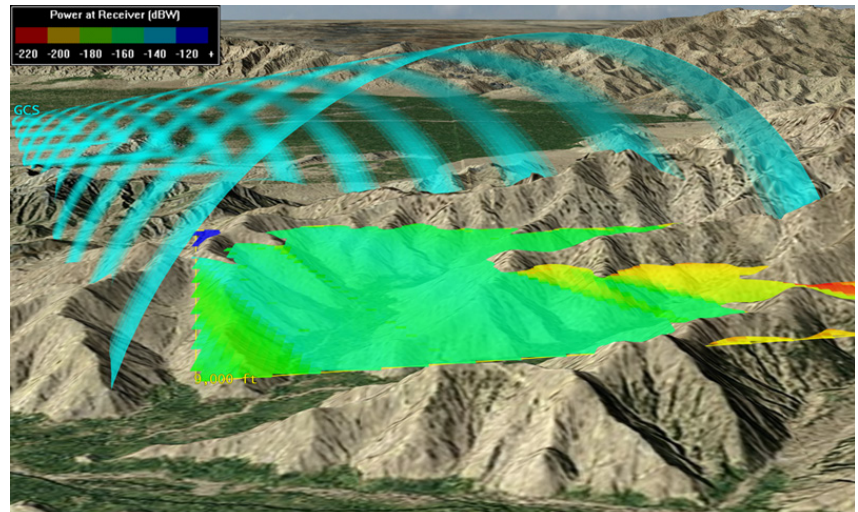
STK Terrain Integrated Rough Earth Model (TIREM)

Calculate RF propagation loss over irregular terrain, from 1MHz to 20 GHz.

Communication and radar analysts can calculate and dynamically model point-to-point line-of-sight effects for link performance in STK. However, in some cases there is the need to consider the effect of irregular terrain, seawater, and non-line-of-sight effects. The TIREM capability for Communications and Radar lets you perform such analysis and modeling by adding fidelity to radio frequency (RF) calculations.

In addition to propagation loss over irregular terrain, TIREM models near-field considerations, power density and field strength equation. TIREM examines the elevation profiles, and, based on the geometry, selects the optimum model for the calculations. It can also select appropriate modes of propagation for paths based on the geometry of the profile — such as multiple knife-edge diffraction and troposcatter, two physical phenomena that extend the signals propagation into the BLOS (beyond line-of-sight).

TIREM has been fully integrated into STK, enabling propagation loss calculations from within Communications and Radar. It



incorporates the government-standard terrestrial propagation algorithm directly into the STK RF environment — allowing users to perform analyses among dynamic nodes as part of an overall system simulation. This capability can be enhanced through visualization in 2D or 3D by performing access or coverage analyses over areas of terrain.

TIREM path loss guidelines

Frequency	Line of sight			Beyond line of sight		
	Sea	Sea/land	Land	Sea	Sea/land	Land
1 to 16 MHz	Smooth-earth loss	Weighting by sea/land distance	Smooth-earth or reflection loss	Smooth-earth diffraction or troposcatter loss	Weighting by sea/land distance	Smooth-earth or troposcatter loss
16 to 20 MHz			Interpolation from 16 to 20 MHz			Interpolation from 16 to 20 MHz
20 MHz to 10 GHz			Reflection loss			Smooth-earth diffraction, rough-earth diffraction, or troposcatter loss
10 to 20 GHz	Loss as calculated above plus atmospheric absorption					

/ Median propagation loss

Median propagation loss is calculated using free-space spreading, reflection, diffraction, surface-wave, tropospheric-scatter, and atmospheric absorption. These various techniques help predict median propagation loss from 1 MHz to 20 GHz to solve many communications analysis problems.

/ Propagation loss along a path of irregular terrain

TIREM calculates the propagation loss along a path over irregular terrain, providing additional fidelity for current RF calculations over terrain. This enables space and terrestrial-based users of STK to leverage the full functionality of Communications and Radar with the best analytical tools possible.

/ Automated selection of modes of propagation

Based on the geometry of the profile, TIREM selects all appropriate modes of propagation for paths with endpoints that are either within line-of-sight (LOS) or beyond line-of-sight (BLOS).

/ Enhanced modeling

TIREM models the phenomena that have the largest impact on terrestrial communications:

- **Multiple knife-edge diffraction.** Physical phenomena that extends the signal's propagation into the BLOS zone.
- **Troposcatter.** Another of the physical phenomena that extend the propagated signal into the BLOS zone. In this case, the electromagnetic signal is reflected off of the Earth's troposphere. TIREM models troposcatter as a function of frequency and other environmental and equipment factors.

/ Calculation considerations

TIREM offers more precise calculations via:

- Atmospheric absorption for frequencies above 10 GHz.
- Long-term power fading can be considered for climatic conditions representing most parts of the world.
- Modeling variability as a result of the standard deviation of the model from measured data can also be considered.



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STK Urban Propagation

Fast, site-specific, path loss predictions for communication links in urban environments.

The capability offers an unmatched combination of fidelity and speed, as compared to empirical and full-physics based alternatives, across a broader range of frequencies and link geometries. These attributes make it ideal for defense and intelligence applications involving trade studies, time-based scenarios and coverage analysis.

/ Higher fidelity results

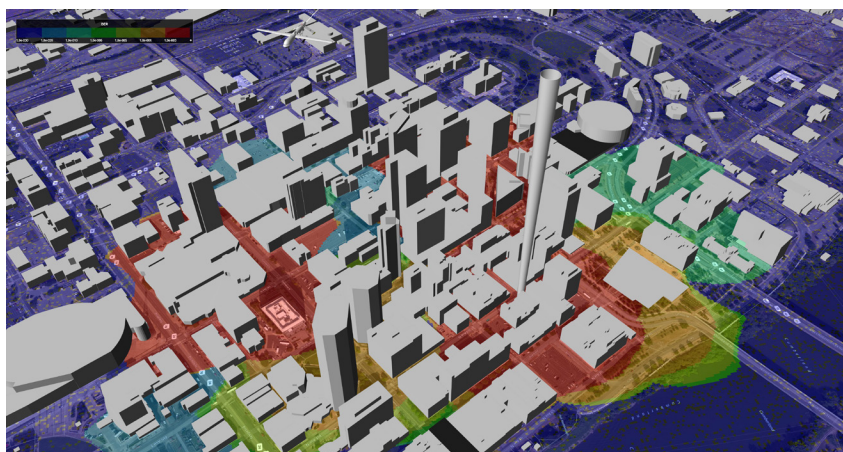
The Urban Propagation capability uses site-specific building geometry for correspondingly higher fidelity results than empirical models (e.g., Hata, COST-Hata) that ignore local obstructions. Building geometry is supplied via shapefiles — a popular vector data format supported by almost all geospatial software products and urban data suppliers.

/ Triple-path geodesic model

Employing the well-established Uniform Theory of Diffraction, a triple-path geodesic model computes three dominant paths from the transmitter to the receiver. Received powers are summed to estimate total signal strength at the receiver.

/ Very fast computation time

Using Remcom's rapid ray tracing techniques and efficient diffraction methods, aggregate computation times can be over two orders of magnitude faster than full-physics models employing Finite Difference Time Domain (FDTD) methods. This makes the Urban Propagation capability a perfect fit for trade studies, time-based scenarios and large area coverage analysis.



/ Better fit for defense and intelligence

Most empirical models were developed for cellular telephone applications and impose limitations on antenna heights, ranges and frequencies that are too restrictive for defense and intelligence problems. The Urban Propagation capability has no limitations on antenna heights, supports ranges up to 10 km and is valid at 100 MHz and higher frequencies.

/ Comparable fidelity to full-physics models

Results compare very favorably with the much longer running full-physics models. Comparative data is available.

/ Powered by Real-Time propagation algorithms

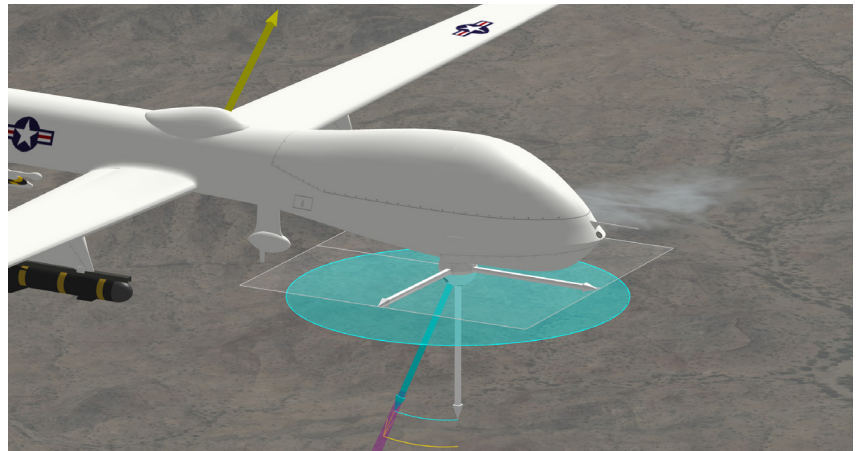
The Urban Propagation capability is powered by Remcom's Wireless InSite® Real-Time propagation algorithms. Remcom has been a pioneer in the field of electromagnetic simulation since 1994 serving multiple Department of Defense and commercial customers.

STK Analysis Workbench

Streamline, organize, and extend the fundamental computational capabilities of STK.

The Analysis Workbench capability contains these application-wide tools:

- **Time Tool.** Creates components that produce instances or intervals of time.
- **Vector Geometry Tool.** Creates components that define location, pointing, and orientation in 3D space.
- **Calculation Tool.** Creates components that produce various time-dependent quantities.
- **Spatial Analysis Tool.** Creates calculations and conditions that depend on locations in 3D space which are, in turn, provided by user-definable volume grids.



/ Creating components

- Select from a large number of installed components or create custom components that meet your needs.
- Create custom computational flows by using the results produced by some components as inputs for other components.

/ Access components

A set of components is automatically created for all access objects.

/ Time Tool components

Time Tool components deal with time related quantities and include the following types.

- **Time Instant.** Defines components that produce a single moment in time.
- **Interval.** Defines components that produce a single interval of time.
- **Interval List.** Defines components that produce an ordered list of time intervals.
- **Collection of Interval Lists.** Defines components that produce a collection of related interval lists.
- **Time Array.** Defines components that produce intervals of time within which there are ordered arrays of times. The times may or may not be evenly spaced.

/ Vector Geometry Tool (VGT) components

VGT components deal with time-varying placement and/or orientation in 3D space and include the following types:

- **Vector.** Defines direction in 3D space as well as magnitude.
- **Axes.** Defines orientation and rotational motion of a triad of mutually orthogonal unit vectors in three-dimensional space.
- **Points.** Defines location and translation motion in three-dimensional space.
- **Coordinate System.** Defines location and translation motion of the origin and orientation and rotational motion of a triad of mutually orthogonal unit vectors in three-dimensional space.
- **Angle.** Defines angular separation between two vectors or planes.
- **Plane.** Defines location and translation motion of the origin and orientation and rotational motion of a two-dimensional plane in three-dimensional space.

/ Calculation Tool components

Calculation Tool components produce time-varying computational results which can be transformed and analyzed further, and include the following types.

- **Scalar.** Defines components that produce scalar time-varying calculations.
- **Condition.** Defines a scalar calculation, which is considered to be satisfied when it is positive and not satisfied when it is negative.

- **Parameter Sets.** Defines a set of related scalar calculations. They can be organized into multiple nested parameter sets but each parameter set contains related calculations that typically represent various aspects or parameterizations of one common phenomenon.

/ Spatial Analysis tool

Includes the following component types:

- **Spatial Calculation.** A calculation that depends on both time and location.
- **Spatial Condition.** A scalar condition that depends on both time and location.
- **Volume Grid.** A collection of enumerated points placed in 3D space, using steps taken in each coordinate and using various coordinate types.

/ Fully integrated

Report and graphs. Any of the installed or user-created components can be used in reports and graphs.

- Combining spatial calculations and volume grids in volumetric objects generates report and graph calculations over time and across grid points.
- All components from Time and Calculation Tools have on-the-spot, right-click, reporting options that enable you to generate reports and graphs using all of the relevant information from the selected component without first having to create a new style.

Timeline View. Time components can be added to the Timeline View which provides another way to display and operate on time components. They can be added via the Timeline View menus or dragged and dropped into the Timeline View from the Analysis Workbench window.

Create data files. You can create external files of Analysis Workbench components that can be imported into STK.

Visualize 2D and 3D time-dynamic data. Any of the installed or user-created components can be used to visualize 2D and 3D time-dynamic data.

Connect and Object Model. Components can be accessed via the STK Connect interface, the STK Object Model interface, and the STK scripting interface which supports Perl, VB Script and MATLAB.



Learn more
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STK Coverage

Analyze surface coverage by a collection of assets.

The STK Coverage capability uses the following variables to determine the quality of system performance for a chosen analysis interval:

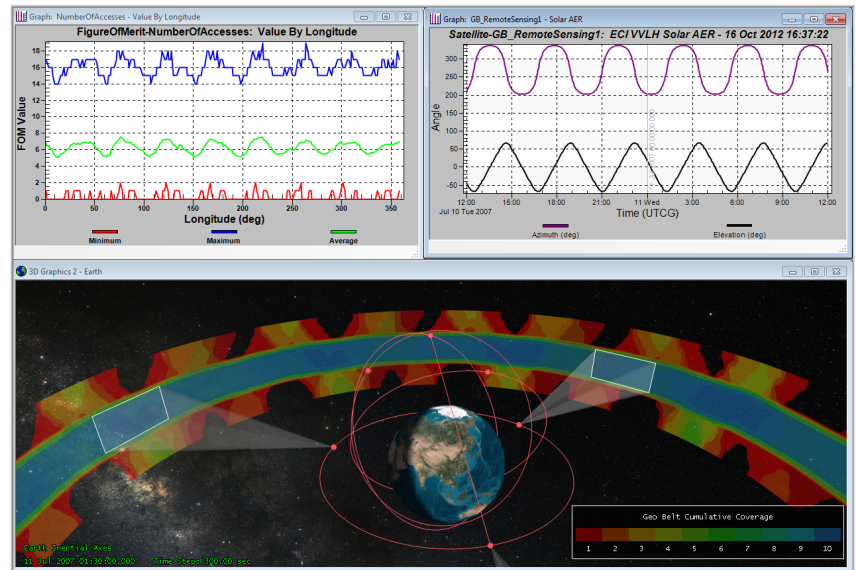
- **Coverage definition grid.** The set of points used for sampling within the areas of interest is called the coverage grid. Coverage computes FOM satisfaction based on the access accessibility to these points.
- **Coverage assets.** The selection of vehicles, sensors, or ground stations that define your coverage analysis system.
- **Figure of merit (FOM).** The quality or type of coverage that measures system performance.

Coverage computes FOM satisfaction based on the access from the coverage assets to each of the coverage definition grid points. In addition to reports and graphs, the system performance for any FOM is visually displayed as color-coded performance areas that can be displayed as cumulative results over the analysis period or dynamic instantaneous results at each time step.

/ Coverage definition

A coverage definition, which is also called an area of interest, can be defined as: a contiguous area such as a country, the globe, or a user-defined boundary; or a collection of areas — such as two states and a lake.

- **Pre-defined grid definitions.** Global, latitude bounds, lat/lon bounds, user-selected region, user-defined boundary, latitude line, and longitude line
- **Point granularity (sampling).** Grid definitions are point sampled based on a specified granularity or imported from a file that customizes the location of the point sample
- **Point altitude options.** The coverage grid can be located on the surface of the ellipsoid or defined as follows: altitude above MSL, altitude above terrain, altitude above WGS84, depth below MSL, altitude above ellipsoid, depth below ellipsoid, and radius.
- **Grid constraints.** Reference constraint class, use object instance, use actual objects on the grid points, and line of sight obstruction surface.



/ Customize assets

Any vehicle, sensor, facility, chain, or constellation may be an asset with constraints used in access determination. STK objects may be used as assets in any combination.

/ Figures of Merit (FOM)

A set of pre-defined metrics to measure your coverage performance.

- **Simple coverage.** Measures a point is covered.
- **N asset coverage.** Measures the number of assets available simultaneously during coverage.
- **Coverage time.** Measures the amount of time during which grid points are covered, either in total time, time per day, or as a percentage.
- **Revisit time.** Measures the duration of intervals during which coverage is not provided.
- **Access duration.** Measures the duration of individual coverage intervals.
- **Number of accesses.** Measures the number of independent accesses of points.
- **Number of gaps.** Measures the number of gaps in coverage of points.
- **Access separation.** Measures if a point has coverage from multiple assets within a user-defined time tolerance.

- **Time average gap.** Measures the average length of the coverage gap found if sampled randomly.
- **Response time.** Measures the time between a request for coverage at the point and the time at which the coverage is achieved. Options are mean, min/max, or nth-percentile values.
- **Access constraint.** Measures the value of a user-selected visibility constraint such as elevation angle or slant range, or probability of detection using TIREM.
- **Dilution of precision.** Measures the relative level of uncertainty of a navigation solution due to the relative geometry of the transmitter locations (i.e., Geometric, Position, Horizontal, Vertical, and Time).
- **Navigation accuracy.** Measures the uncertainty of a navigation solution based on one-way range measurements from a set of transmitters. Most often, the transmitters are those onboard GPS satellites.
- **System response time.** Measures the elapsed time from a request for coverage until collection assets are commanded, the collection occurs and the downlink of collected data is complete.
- **System age of data.** Measures the time elapsed since a Coverage grid point has been seen where simulated collection of grid points is subject to the same sequence of Command-Collect-Downlink events as are used in the System Response Time.
- **Age of data.** Measures the time since the end of the last coverage interval.
- **Cumulative N asset.** Determines the number of unique assets providing coverage to grid points.
- **Scalar calculation.** Creates a FOM using the Calculation tool.

/ Coverage satisfaction

Satisfaction is a comparison operator that establishes “if” or “when” a FOM is “satisfied.” The Satisfaction criteria identify the relationship between the FOM value and the user-specified threshold value (i.e., at least, equal to, at most, greater than, less than). This lets you quickly answer questions of coverage.

/ Attitude Coverage

Attitude Coverage combines features of Attitude and Coverage to enable you to analyze coverage in various directions over time, using several attitude-dependent figures of merit.

/ Coverage tools

Grid Inspector tool. Enables you to focus closely on a region or point within a coverage grid, furthering your analysis efforts.

Single object coverage. Evaluates the dynamic coverage to a single object instead of a continuous area – for example coverage along a flight path, an orbit, or a truck route.

/ Volumetric analysis

Volumetric analysis combines the Spatial Analysis tool with the capabilities of Coverage's Volumetric object by evaluating user-defined volumes that are displayed as interpolated values across grids points in the 3D window. 3D grids can be defined in any coordinate system, relative to Earth or any STK object.

/ Coverage definition reports and graphs

Coverage reports and graphs provide the ability to dissect your overall performance. All data computed during the analysis is available to inspect at the asset-specific level or system level. Percent contributions, gaps, and time to cover values can all be analyzed.

/ Figure of Merit reports and graphs

Provides analysis of minimum, maximum, and average values over the coverage grid as well as percent satisfied results over the analysis period.

/ 2D and 3D coverage visualization

STK Coverage results can be displayed statically (an accumulation of figure of merit satisfaction over the analysis interval) or during animation (instantaneous satisfaction of the figure of merit for that particular time step).

Each grid point is color-coded based on the user-defined color selection or color ramp along with a defined number of contours or levels. To generate the smoothest looking contours, you can optionally choose to interpolate between grid points.

/ Automation or third-party application access to STK Coverage

Coverage can be accessed via the STK Connect interface, the STK Object Model interface, and the STK scripting interface which supports Perl, VB Script, or MATLAB.

STK Integration

Automate and integrate STK with other applications to extend its capabilities.

Using the STK Integration capability, you can automate repetitive tasks and integrate with other applications, such as MATLAB.

/ Automate

- Use Connect and the STK Object Model to build tools that control STK functionality from inside or outside the application.
- Use a command line or batch file to send Connect commands to STK.

/ Connect

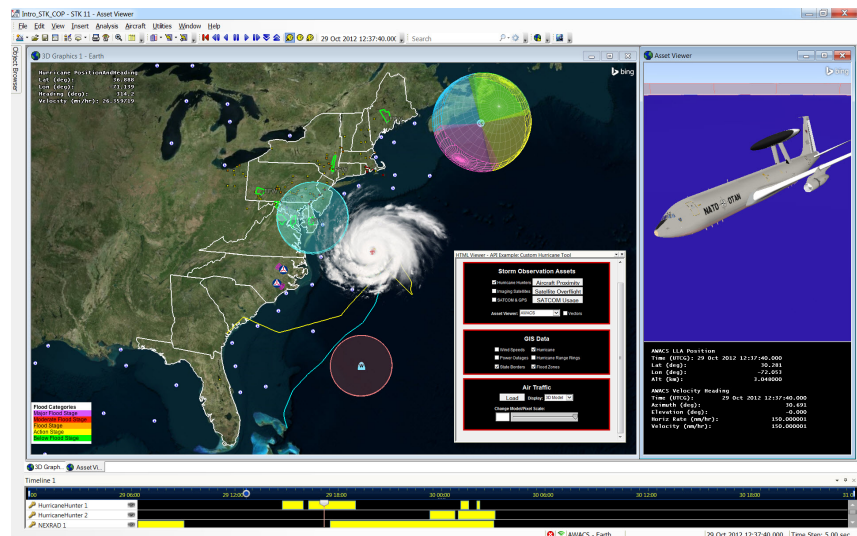
Connect provides a simple string-based language to communicate with STK in a client-server environment.

- Easily allow applications to communicate with STK using a library shipped with STK.
- Generate optional diagnostic messages.
- Modify the standard messaging or use a custom messaging format for compatibility with third-party applications.

/ STK Object Model

The STK Object Model is an object-oriented programming interface to STK, built on Microsoft COM technology that can be used in conjunction with Connect. The STK Object Model contains these COM libraries:

- **STK Object.** Includes ability to create and manipulate all STK object properties as well as compute and report all analysis options such as access and coverage.
- **STK X.** Provides ability to embed STK analysis and visualization into any application.
- **STK Util.** Contains objects and enumerations shared by the STK X and STK Objects type libraries.
- **STK Graphics Primitives.** Contains ability to control 3D globe visualization by manipulating graphics constructs such as globe overlays, primitives, screen overlays, display conditions, pick callbacks, and camera controls.



- **STK ESRI Display.** Use to integrate ESRI map documents and GIS functionality into custom STK X and STK Engine applications.
- **STK VGT (Analysis Workbench).** Use to construct and manipulate geometry, time, volume, and calculation components.
- **STK Astrogator.** Supports Astrogator technology.
- **STK Aviator.** Use the rich Aviator API to automatically configure a mission and generate routes.

/ Available environments

The STK Object Model is built on COM technology and can be used in environments supporting standard COM automation including:

- .NET (Visual Basic, C#, etc.)
- Java
- C++
- Python
- PowerPoint, Excel, Access
- Scripting languages supporting COM late binding

/ MATLAB

- Leverage the two-way communications pathway between STK software and MATLAB.
- Open a TCP/IP socket to STK from within the MATLAB workspace.
- Use more than 150 native MATLAB-formatted commands to model orbital, ballistic, and great arc trajectories and perform the analytical functions of STK.
- Parse STK data, including dynamic position, velocity and attitude data, back into the MATLAB workspace for further mathematical analysis.
- Create and manipulate objects in STK via Connect commands, and then use the data providers for MATLAB to optimize any single or combination of parameters.

/ Real-time GIS display and analysis

Integration and ArcGIS. Used with the ArcGIS Tracking Analyst, you can receive, process, analyze, and display real-time data, such as that received from the Global Positioning System (GPS).

Integration with the ArcGIS bundle. Enables you to:

- Conduct temporal and spatial GIS analyses in real-time.
- Visualize data in both STK and ArcGIS.
- Understand the association moving objects, such as military vehicles, aircraft, satellite sensors and ships, have within the GIS environment.



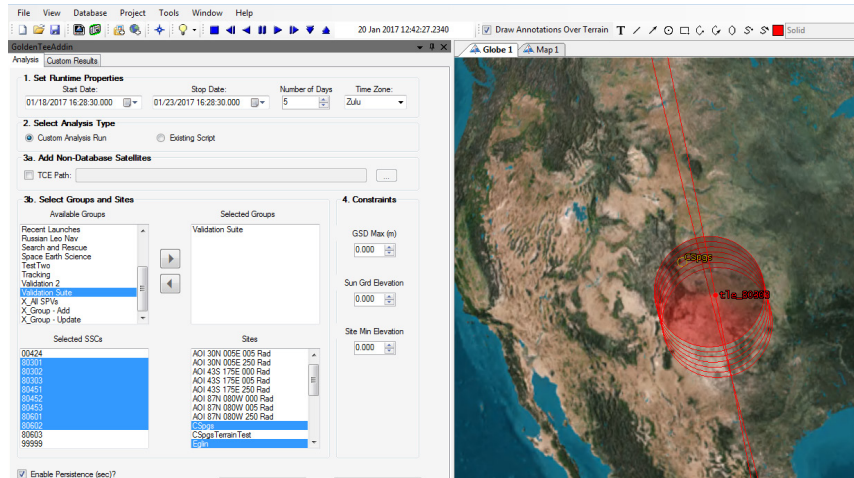
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STK Engine

Adds STK's proven technology to your applications and speeds up your automation scripts.

STK Engine provides an Application Programming Interface (API) for adding STK's analytical and visualization capabilities to existing applications or to build new custom applications. Integrators and engineers alike can build applications that:

- Create and manage high-level objects (satellites, aircraft, and facilities).
- Propagate and orient vehicles, including automatically configuring an Aviator aircraft and mission, and generating routes
- Analyze relationships between objects.
- Visualize objects in 2D and 3D.
- Import industry standard imagery and terrain formats.
- Animate in real or simulated time.
- Include any of the other computations and visualizations available in STK.



/ Flexible development environment

STK Engine is a collection of high performance native libraries that are exposed to .NET, Java, C/C++ and scripting languages (Python, MATLAB). Additionally, the 2D and 3D views can be embedded in any program that supports ActiveX controls—including Word, Outlook, Excel and PowerPoint – to generate powerful automation tools.

/ Multi-platform support

STK Engine is available for both Microsoft Windows and Linux. On Windows, the system requirements are identical to STK Desktop. STK Engine for Linux is officially supported on Ubuntu, CentOS and Red Hat Enterprise Linux, and currently only offers the Java API.

/ Extend your STK Engine analysis

Extend the analytical depth of your STK Engine application with the same functionality available with STK. Developers have the option to add communications link analysis, radar analysis, trajectory design, dynamic coverage, attitude analysis, and conjunction analysis to their deployed application.

/ STK Engine software development kit

The software development kit includes documentation and tutorials that step you through example applications in a variety of programming and scripting languages to help jumpstart development efforts. Once the application is complete, STK Engine includes deployment packages for building an installer to widely distribute the application. For .NET, Ansys also provides a Custom Application Framework that speeds development time by providing an add-in structure that allows for custom workflows along with standard functionality common to many STK Engine applications.

/ Event registration and notification

Customized user interactions with the graphics window and analytical feedback can be linked to mouse events, keyboard events, and drag-and-drop events to optimize mission-specific workflows.

/ NoGraphics

For use cases where visualization is not needed (for instance computation on a server or a compute node), the STK Engine in NoGraphics mode provides additional performance and footprint improvements.

/ Scripting

STK Engine shares some of the same APIs as STK Desktop (Object Model, Connect). So scripts developed against STK Desktop can easily be tweaked to also run against Engine. This can provide significant performance gains for repetitive workflows where the UI and graphics are not needed.

/ STK Parallel Computing

The STK Parallel Computing Server includes tools and instructions for improving the performance of large scale computations by allowing them to be scaled vertically across multiple cores and horizontally on compute clusters. Key features include the ability to parallelize and monitor jobs in a distributed environment thereby maximizing the use of available resources for efficient resolutions to complex analysis problems.



Learn more
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STK Parallel Computing

Scale calculations across multiple workstation cores to increase computational performance for resource-intensive applications of STK.

As the level of detail required for a calculation grows, so does the amount of time and memory needed to compute. STK Parallel Computing Server provides the development and runtime environment to distribute large-scale jobs, using multiple computing resources to process more at once. The server can be shared amongst multiple users.

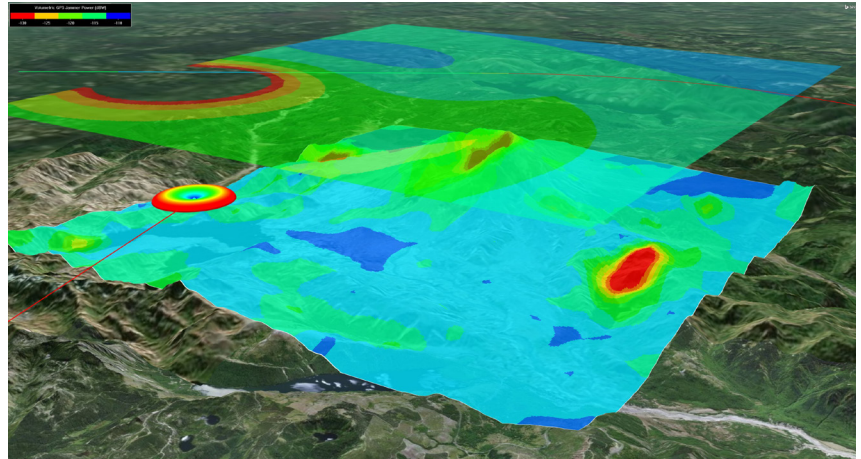
/ STK Parallel Computing Server Core Capabilities

STK Parallel Computing Server provides all of the infrastructure needed to assemble multi-core computing resources, receive and execute jobs in parallel, and administrate the system. This includes:

- A **Coordinator** that receives jobs and handles the distribution of their tasks, based on configurable priorities, for parallel execution amongst the Agents.
- An **Agent** that runs on each compute node and is responsible for executing the tasks that the Coordinator assigns to it.
- The **Portal**, a website that provides task queue management and real-time monitoring capabilities for the Coordinator machine and all connected Agents.

The STK Parallel Computing Server infrastructure and client APIs provide the following capabilities:

- Automatic deployment of .NET, Python, or Java code
- Execution of jobs in isolated processes
- Cross-machine communication and security
- Return of the results to the client
- Thorough error handling
- Fine grain worker selection
- Flexible scheduling algorithms
- Cancellation support
- Progress reporting
- System monitoring and logging
- Computing resource management
- User management



/ Integration with STK and ODTK

Parallel Computing Server works with STK to scale up Coverage, Deck Access, Chains, Volumetrics, and Analyzer trade study computations, using more resources than are available locally on the machine running STK. You can use the provided STK Parallel Computing Desktop API to benefit from the same STK infrastructure to parallelize your own computations.

The provided Parallel Computing Server SDKs can also be used with other STK development libraries, such as STK Components, STK Engine, and ODTK to distribute workflows, including large scale orbit determination, conjunction analysis, and other custom computations.

/ STK Parallel Computing Server Software Development Kit

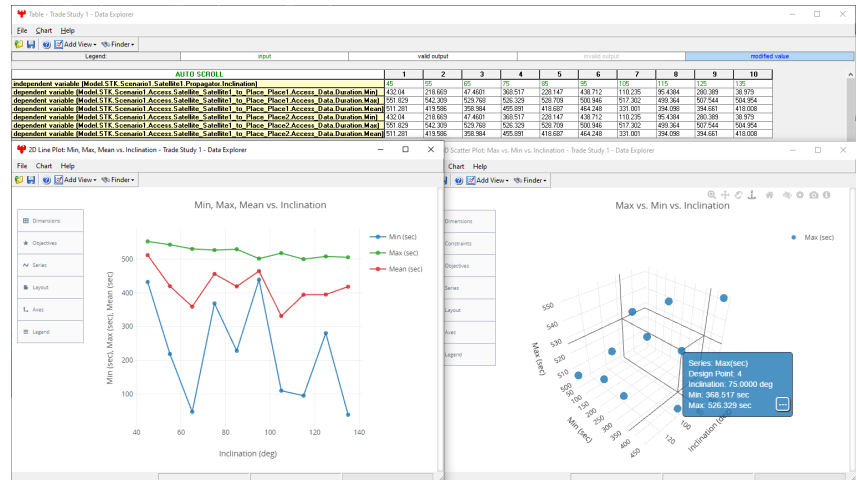
In addition to the out of the box, no programming involved STK integration, Software Development Kits (SDKs) are available for .NET, Java, and Python. These SDKs make it easy to parallelize the execution of custom models and algorithms. The SDKs are fully documented and include tutorials, tools, and instructions to help you get the most out of the API and runtime environment.

STK Analyzer

Automate and analyze STK trade studies to better understand the design of your system.

Analyzer is a fully integrated STK capability that:

- Blends engineering analysis capabilities of ModelCenter with STK.
- Enables you to perform analyses in STK easily without involving programming or scripting.
- Introduces trade study and post-processing capabilities.
- Can be used with all STK scenarios, including those with STK *Astrogator* satellites.
- Fully supports *Mutlfunction Radar* (MFR) objects in *Analyzer* studies.
- Supports many *Aviator* features in *Analyzer* studies.
- Computes trade studies in parallel with the STK Parallel Computing Server.



/ Analyzer analysis tools

- **Parametric study.** Varies one item over a range to study the effects on various figures of merit defining performance.
- **Carpet plot.** Varies two items over ranges to study the resultant behavior of another parameter.
- **Design of experiments.** Varies multiple parameters creating a table of runs using various design type algorithms to study the effects on various parameters.
- **Probabilistic analysis.** Runs studies in Monte Carlo fashion. Output data can be analyzed and presented in histogram fashion.
- **Optimizer.** A separate extension that provides additional optimization algorithms to Analyzer.

/ Gradient-based optimizer

Local search for optima in problems with smooth, continuously varying objective and constraint functions.

/ Optimizer

The Optimizer extension for STK *Analyzer* extends *Analyzer*'s parametric analysis capabilities:

- Adds three different optimization algorithms to the four existing parametric analyses offered with *Analyzer*.
- Features two design tools for further trade space exploration and parametric analysis insight.

/ Adaptive Surrogate optimizer

Part of Boeing's Design Explorer software, the Adaptive Surrogate Optimizer solves complex problems characterized by long-running analyses.

- Intelligently uses non-physics-based mathematical models (Kriging models) to reduce the number of required scenario executions.
- As a global search algorithm, it is not likely to get stuck in local optima.
- Performs well in noisy design spaces and is robust in the face of scenario failures.

/ Darwin Genetic optimizer

Darwin Genetic algorithms are ideally suited for design problems with discretely valued design variables (e.g., integer variables).

Because they do not require objective or constraint gradient information, genetic algorithms effectively search discontinuous and “noisy” design spaces.

/ Variable Influence profiler

The Variable Influence profiler enables you to gain a better understanding of variable relationships and overall design trends.

- Performs sensitivity analysis on a scenario.
- Encourages a more effective design problem formation and location.
- Provides more accurate optimization results.
- Generates variable importance plots that illustrate the relative impact of selected parameters on a scenario.
- Generates main and interaction effects plots that significantly reduces the complexity of the design task.

/ Prediction profiler

Interactively explores the design space, enabling you to.

- Efficiently predict output variable values for any combination of input variables.
- Visualize slices of the resulting n -dimensional design space (including the effects of constraints).
- Manually explore and search the design space for good designs.

This tool can be used to locate good designs, find good starting points for a more formal optimization algorithm, or visualize the design space around an optimum point generated by an optimization algorithm.



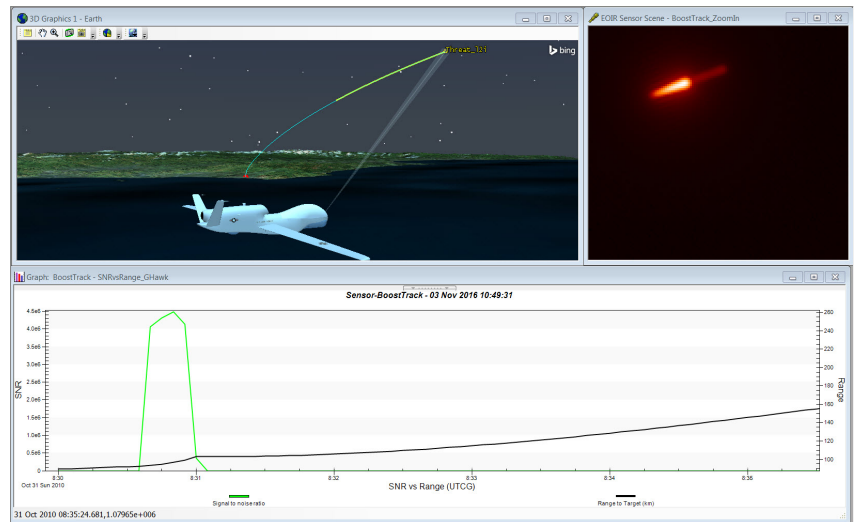
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STK EOIR

Model detection, tracking, and imaging performance of electro-optical and infrared sensors.

STK EOIR provides the following benefits:

- Radiometric sensor model that goes beyond simple geometry. STK EOIR considers the physics-based interactions of sensor, target, and environment providing accuracy and fidelity that are anchored against operational sensor measurements.
- Faster and more accessible than complex, stand-alone sensor models. The low complexity of the model speeds analysis and provides usability for both general systems engineers and sensor design and image analysis experts.
- Comprehensive mission analysis. STK's broad mission modeling environment considers EOIR performance in conjunction with sensor platform and target dynamics, communications, and other mission architecture elements to assess integrated performance across a variety of digital mission scenarios.



/ EOIR sensors

STK EOIR supports up to 36 bands per sensor. Bands share a common location and line of sight, but otherwise can have different parameters. You can use bands to simulate a multiband sensor or different settings of a system. You can define spatial, spectral, optical, and radiometric properties on a per-band basis, including:

- Angular field of view extents
- Focal plane height and width in pixels
- Detector pitch or spacing
- Lower and upper band edges
- System spectral response function or individual optical transmission and detector quantum efficiency spectral response functions
- Band integration time, sensitivity (NEI, NER) and dynamic range (SEI, SER)
- Optical parameters such as effective focal length, entrance pupil diameter, and F-Number
- Diffraction wavelength
- Longitudinal defocus
- Image quality (aberration level of none, negligible, mild or moderate, an RMS wavefront error, or a PSF/MTF input file)
- Line of sight jitter

Included in STK Premium (Space), STK Premium (Air), STK Enterprise

/ Sensor performance

Report radiometric performance for point sources and extended objects through STK reports, graphs and dynamic displays. Metrics include target radiance/irradiance, background radiance/irradiance, scene photon signal-to-noise ratio (SNR), noise equivalent irradiance (NEI) and noise equivalent radiance (NER).

/ Multi-sensor architecture analysis

Model mission architectures with up to twelve independently specified and steered sensors distributed across satellite, aircraft, missile, or ground platforms.

/ Synthetic sensor scene

The scene represents the analog world by digitally sampling the “modeled universe” at four times the sensor’s detectors spatial frequency (16 spatial samples per sensor pixel) and over the passband at the wavelengths defined by the sensor model.

The scene models 27 optical materials, central bodies, stars, satellites, aircraft, missiles, and thermal models of planets, stars, solar radiance, and missile plumes. You can also include custom materials as well as static or time-dynamic temperature profiles.

/ Atmosphere models

Simple atmosphere model. Calculates transmission, scatter, and thermal path radiance at the wavelengths corresponding to the Spectral Band Edges, and at a spectral resolution specified by the user-defined number of intervals.

MODTRAN-based atmospheric model. One of the highest fidelity, community standard atmospheric models available for EOIR simulation. This model approximates MODTRAN results for the same surface conditions that are modeled by the Simple atmosphere model.

/ Clouds

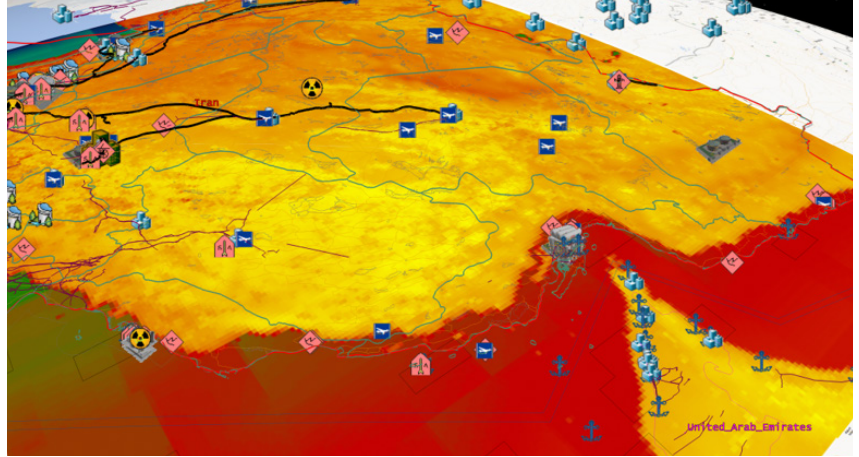
STK EOIR uses a thin layer cloud model that is accessible through Connect or the GUI. The cloud model is extremely flexible with inputs for multiple time-dynamic layers and cloud characteristics, such as percent cloud cover, temperature, emissivity, and radiance. The model allows for integration with a community standard cloud modeling file, which you can display in the 3D Graphics window.

/ Target modeling

Model optical and thermal properties of aircraft, satellites, and missiles by specifying shape, dimensions, surface material, and surface temperature. Missile targets can be multi-staged with independent stage properties and a solid black body plume model (temperature and emissivity). Furthermore, custom 3D geometry and spectral materials can be loaded to simulate various other target types applicable for your EOIR mission, and hundreds of relevant low polygon count 3D models are included.

/ Surface materials

- Aluminum MLI
- Black thermal control paint
- Burnished aluminum
- Gold MLI
- Gray body
- Silver MLI
- Solar panel
- White thermal control paint
- Load your own custom material reflectance or emissivity spectra



/ Earth surface material

STK EOIR has a low to moderate spatial resolution global spectral material map of the earth broken into the 17 International Geosphere Biosphere Program (IGBP) Global Land Cover types plus Tundra. You can also override a portion or all of the map with your own custom reflectance, emissivity, and temperature texture maps with arbitrary spatial resolution.

/ Accurate star field

Leverage STK's database of over two million high quality star records from the Hipparcos and Tycho II catalogs to model precise position and spectral irradiance based on apparent motion, temperature, and magnitude.

/ Celestial bodies

Include thermal and optical properties of the Earth, Moon, Sun and planets. Thermal models include diurnal, latitudinal, and seasonal variations. Optical surface properties maps are included for the Earth, Moon and Mars at 0.93 km, 2.5 km, and 0.47 km resolutions, respectively. The Earth includes an atmospheric model with four aerosol settings.

/ Use custom models, materials, target signatures, and thermal profiles

- **Custom 3D Models.** Load custom, lowpoly (around 1,000 polygon count) 3D models as EOIR targets.
- **Custom Materials.** Load custom materials for EOIR targets. Compatible with the freely available NASA maintained ASTER USGS material with over 2,400 spectral samples.
- **Point Source Target Signature.** Load your own custom Target Signature File (.tsf) that defines the EOIR properties of the target signature that can vary with time, angle, and wavelength.
- **Custom Thermal Profiles.** Create time-temperature thermal profiles with external tools, manually, or with thermal calculation tools such as STK SEET's passive thermal model to have targets exhibit time-dynamic surface temperatures.

/ EOIR sensor constraints

EOIR constraints set a signal-to-noise ratio (SNR) on an EOIR sensor.

/ Export sensor images

Export sensor output images as bitmaps for video creation or ASCII raw data files for use in external image processing algorithms or sensor modeling tools in MATLAB, MathCAD, etc.



Learn more
[ansys.com](https://www.ansys.com)

STK Real-Time Tracking Technology (RT3)

Display and analyze data feeds in STK and custom applications built with STK Engine technology.

The RT3 capability works with live and simulated data feeds by providing integrated tools to filter tracks, define events and alerts, and archive live data for playback.

/ Situational displays

Out of the box integration with STK 2D and 3D visualization capabilities can quickly turn a stream of bits into an interactive display that incorporates terrain, imagery, maps, and other geospatial data.

/ Interpret and monitor data

Set up and dynamically reconfigure displays to suit immediate needs and provide background processing to draw attention to important events.

/ Off-the-shelf analysis

Make better decisions with off-the-shelf analysis. The RT3 capability supports operations planning and decision-making by exposing archived data to offline STK analysis such as line-of-sight access, range to target, sensor coverage, communications link budgets, radar performance, and more.

/ Multiple simultaneous data feeds

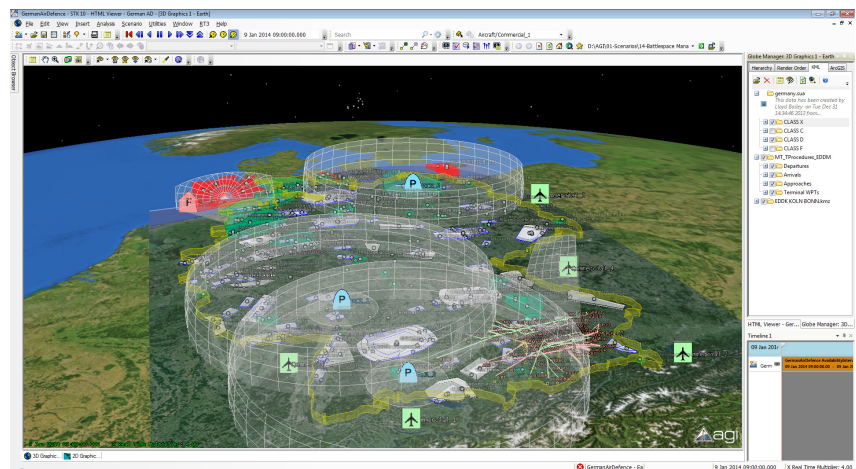
Create a consolidated display of all the data you need even when it comes from multiple independent sources in different formats.

/ Display filters

Monitor large volumes of data more effectively with automated event detection. Specify event criteria using conditional logic on position and associated data, get notified when events occur, and review logs to check for past events.

/ Events and alerts

Interpret your data better by managing what gets displayed and how it appears. Use dynamically reconfigurable filters on



position and associated data to hide or display certain data and specify colors, symbology, and other graphical properties.

/ Assign actions

Automate standard responses by assigning actions to event definitions. Actions can include playing an audio clip, sending an email, running a report, or executing STK functionality.

/ Archiving and playback

Support activities such as offline analysis, event reconstruction, and training by recording incoming data feeds, and replaying any portion when needed.

/ Available data feed readers

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

STK Distributed Simulation (DSim)

Integrate modeling and simulation tools with STK's high-fidelity modeling capabilities.

Powered by RT3 within STK and leveraging VT MÄK's VR-Link toolkit, DSim provides the ability to port M&S data feeds into STK for analysis including:

- Line-of-sight access between objects
- Communications links
- Sensor coverage with terrain, weather, lighting, and body obscuration constraints
- Navigation accuracy and jammer modeling
- Enhanced situational awareness of thousands of object tracks

/ DIS and HLA-compliant

DSim is a complete off-the-shelf solution that can import and export both DIS and HLA data from any modeling and simulation (M&S) environment into and out of STK. By leveraging MÄK Technologies' VR-Link through DSim, you can evaluate thousands of entities using STK's multi-track objects (MTOs), as well as develop custom plugins for added flexibility and customization.

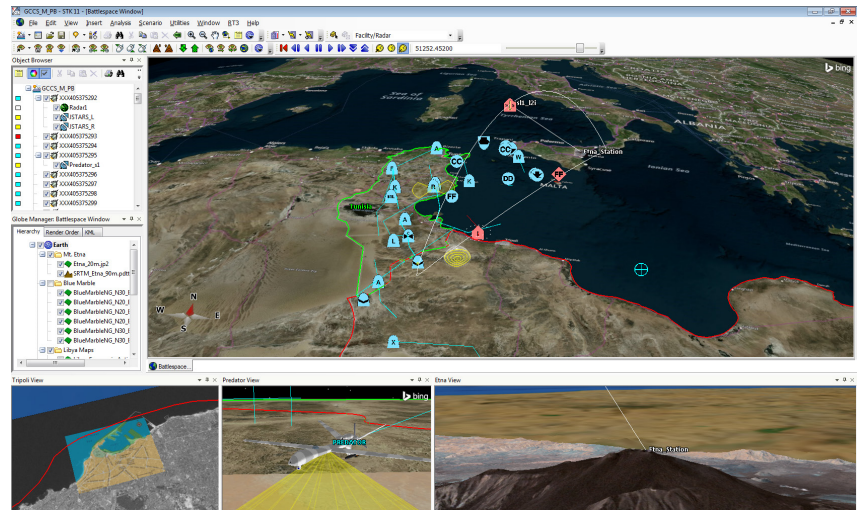
/ Space-based models

Generate DIS and HLA compliant space-based platforms, such as:

- GPS satellites for navigation and targeting
- Communications satellites for long-range UAV command and control
- High-altitude sensor platforms that provide persistent surveillance during a mission

/ Analysis of M&S models

Increase the fidelity of your M&S environment by calculating sensor coverage and incorporating a wide range of line-of-sight constraints, such as terrain, relative grazing angles, altitude, solar angles, and exclusion zones to determine when vehicles, sensors, ground sites, and other assets are in view of each other.



/ Display filters

By using dynamically reconfigurable filters (based on position and associated data), you can manage the display of objects and alter their representation through color, symbology, and other attributes.

/ Events and alerts

Monitor large volumes of data effectively with automated event detection.

- Specify event criteria using conditional logic on position and associated data.
- Get notified when events occur.
- Review logs to check for past events.
- Automate standard responses by assigning actions to event definitions.
- Actions can include but are not limited to playing an audio clip, sending an email, running a report, or executing STK functionality.

/ 2D and 3D visualization

DSim generates immediate 2D and 3D visualization of objects generated by DIS and HLA-compliant tools. These visualizations enhance situational awareness for M&S entities by displaying simulated data and analytical components in one interactive common operating environment.

/ Open architecture for customization

Further tailor your M&S environment to:

- Process incoming data (e.g., track correlation).
- Implement custom data feed interfaces cores/compute clusters using the Scalability Extension.



Learn more
ansys.com

STK Aviator

Model real-world flight, especially at hypersonic velocities and altitudes.

STK Aviator performs complex, highly accurate, time-based mission analysis for aircraft operations. It is built on the concept of an aircraft's mission, as opposed to a mere point-to-point route. An aircraft using STK Aviator as its propagator can carry out operations that are more complex than a transit between two points (e.g., holding in a pattern).

/ Aircraft models

An aircraft model defines the physical characteristics of the aircraft and the modes of flight that define how the aircraft flies in any given situation.

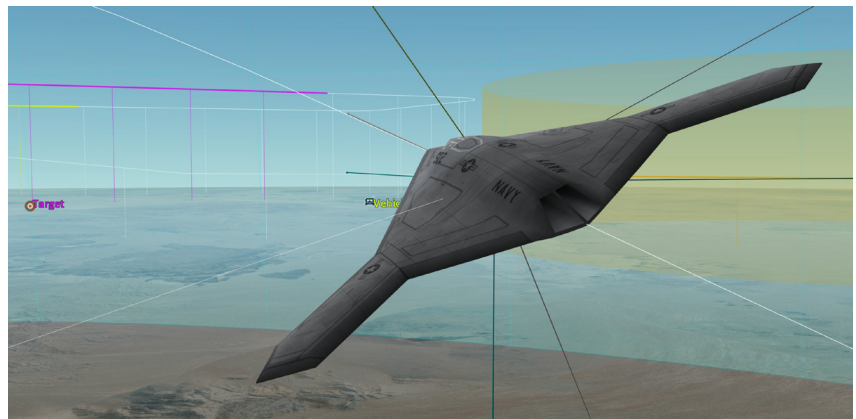
/ Configuration

- **Basic.** Used to define empty parameters of the aircraft, and displays the total values, based on the stations and fuel tanks defined for it.
- **Stations.** Used to define internal fuel tanks, stations, and external fuel tanks that are attached to the stations.
- **Fuel.** Displays all fuel tanks defined for the aircraft, in their consumption order.

/ Performance models

Over 15 performance models are used to define the behavior of the aircraft in flight. By specifying performance models to use with each phase of the mission, you can vary the manner in which the aircraft performs based on the priorities of the mission. Performance models include:

- Basic and advanced acceleration
- Basic, advanced, and sequenced climb
- Basic and advanced cruise
- Basic, advanced, and sequenced descent
- Basic and advanced landing
- Terrain follow
- Vertical take off and landing (VTOL)



/ Phases

Phases are the basic logical unit of a mission, and serve as containers for the procedures that define the aircraft's actions. You can select a specific set of performance models to use with each phase, allowing you to perform one mission with multiple performance characteristics.

/ Sites

Each procedure is associated with a site. The site defines the location and the nature of the position at which the procedure takes place — e.g., a runway, a waypoint, another aircraft — and also determines what procedure types are available for selection. There are over 15 types of sites, including:

- Airport, Navaid, runway, VTOL point, and waypoint from the Aviator catalog
- STK objects, including area target, waypoint, static object, and vehicle
- Relative to previous procedure, relative to stationary STK object
- Reference state
- Super procedure

/ Mission profile

The mission profile can display a variety of data describing the mission. The default profile displays the aircraft's altitude relative to its downrange distance, but the graph can be customized to display any Flight Profile data provider with respect to time or downrange distance.

/ Flight procedures

At a specified waypoint, you can specify a flight procedure from a set of over 25 flexible, pre-defined options, such as:

- Arc enroute, arc point to point
- Area target search
- Basic maneuver, basic point to point
- Holding: circular, Holding: figure-8, Holding: racetrack
- Hover, hover translate
- Landing, takeoff
- Parallel flight line, terrain following
- Transition to forward flight, transition to hover
- Vertical landing, vertical takeoff

/ Basic maneuvers

A basic maneuver procedure is a single action undertaken by the aircraft, in contrast to most procedures in STK Aviator, which represent a series of actions that together comprise a common flying procedure. There are over 15 types of basic maneuvers, such as:

- Aileron roll, barrel roll
- Autopilot: horizontal plane, Autopilot: vertical plane, Glide: Vertical Plane
- Loop, pull, rolling pull
- Simple turn, smooth turn
- Smooth accel
- Straight ahead, weave
- Cruise profile
- Profile Segment: Bezier or push/pull

/ 3D route editing

You can build routes and add, move, and alter waypoints within the 3D environment. The entire mission, including waypoints and procedures, can be clicked out in a matter of seconds. Holding pattern parameters such as length and width can be edited by simply clicking and dragging the 3D control points.

/ Catalogs

STK Aviator provides a catalog for the loading and saving of aircraft, airports, nav aids, runways, VTOL points, and waypoints. Each of these elements of a mission has an associated catalog in STK. You can add, modify, and delete items from the catalogs to make it easier to use the same elements for multiple missions and procedures. In addition, you can import catalogs of compatible data, such as DAFIF and ARINC424 data, and access them for use in defining these elements.

/ Wind and Atmosphere Model tool

The Wind and Atmosphere Model tool enables you to simulate wind and atmospheric conditions for the scenario, a mission, a specific procedure, or a group of multi-selected procedures.

- Wind models in STK Aviator can change the ground speed, flight path angle, and altitude rate of an aircraft and can produce a difference between the heading and course of an aircraft (also known as a crab angle).
- Atmosphere models in STK Aviator define air density, which affects the behavior of all performance models.

/ Refuel/Dump tool

The Refuel/Dump tool simulates adding or removing fuel in flight during the associated procedure.

/ Advanced Fixed Wing tool

The Advanced Fixed Wing tool is used to define a highly precise set of physical properties for the aircraft that you are modeling. These physical properties can then serve as the basis for a set of advanced performance models. Properties include:

- Aircraft Geometry
- Aerodynamics
- Powerplant
- Structural and Human Factors Limits

/ Hypersonic/thermodynamic propulsion models

These high-end, complex, propulsion models incorporate an extensible fuel model system that handles the thermodynamic properties of air and fuel mixtures. All of the models incorporate variable, specific, heat thermodynamics. The fuel models are all plugins, so you can employ your own models by providing additional plugins.

- **Dual Spool Turbojet.** You can specify various maximum values for temperatures and pressure ratios along with component efficiencies to model the effect of those parameters on thrust and fuel burn.
- **Dual Spool Turbofan.** You can specify standard parameters, including the bypass ratio, to understand how advances in technology affect thrust and fuel burn across the flight envelope.
- **Sub/Super/Hypersonic Powerplant.** Combines the operating concepts of turbines, ramjets and scramjet modes.

/ Search patterns

Define search patterns using the Flight Line and Parallel Flight Line procedures or the Area Target Search procedure.

/ Automate tasks with the STK Aviator API

STK Aviator has a rich API via the STK Object Model. You can use the API to automatically configure a mission and generate routes, as well as access the Aviator Catalog to automatically configure aircraft and other catalog items.

/ STK Aviator Pro

STK Aviator Pro extends the modeling capabilities of STK Aviator by providing a selection of real guidance strategies for the Basic Maneuver procedure. These strategies are executed without future knowledge of the target object's route, so that the aircraft reacts in simulated real-time to the target object's maneuvering.

- **Intercept.** The aircraft attempts a forward quarter intercept on a moving object, guided to a constant target aspect or lateral separation.
- **Relative Bearing.** The aircraft flies to a constant relative bearing to a stationary or moving object.
- **Stationkeeping.** The aircraft orbits a point relative to a stationary or moving object.
- **Rendezvous/Formation.** While operating in the wind frame, the aircraft uses multi-mode guidance to maintain formation with a cooperative aircraft.

/ STK Aviator Prop Nav

STK Aviator Prop Nav adds ITAR hypersonic and weapons models to Aviator Pro.

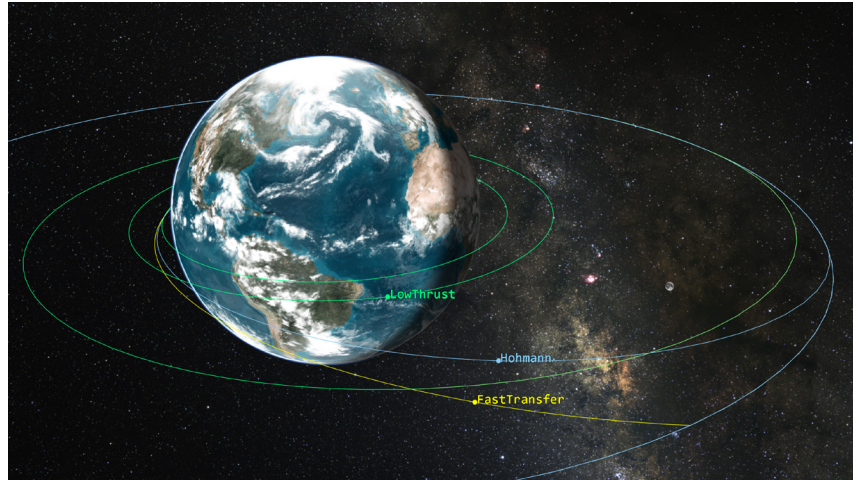


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STK Astrogator

Add advanced spacecraft trajectory modeling and maneuver planning capabilities to STK.

Used for over two decades by space professionals, Astrogator provides everything mission planners need to develop, optimize, and validate flight-ready trajectory solutions and reveal mission-critical insights that can decrease overall program costs. 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. Astrogator has been used on missions ranging from LEO to GEO, from the Sun to Arrokoth, and many places in between.



/ Use Cases

- Create and analyze high-fidelity spacecraft trajectories in any regime, including:
 - LEO, GEO, GTO, HEO
 - Lunar/cislunar
 - Libration points
 - 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

- Solves both common and unique astrodynamics problems with industry-standard models and optimization engines.
- Produces repeatable, accurate results suitable for operational space missions.
- Enables you to create customized and automated workflows tailored to your needs.

- Includes reporting and analysis capabilities that make deriving insights as easy as creating the trajectory.
- Because it is directly integrated with STK, you have immediate access to a full all-domain 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 total 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 can be executed 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, SNOPT, and IPOPT optimizer — helps you quickly and accurately discover the best trajectories to achieve your mission goals.

- **User scripting.** Includes built-in scripting for individual sequences, as well as 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, various execution logs, and user-defined variable accounting.

/ Technical Details

/ Orbit propagation

- Includes several numerical integration schemes, including a Runge-Kutta-Fehlberg 7/8 scheme, a Gauss-Jackson integrator, and more.
- Includes numerous standard atmospheric density models to support orbital drag modeling for propagation at relevant altitudes, including Jacchia-, MSIS-, and DTM-based models; also includes a user plugin point for density models.
- Includes non-Earth atmospheric density models, such as Mars-GRAM.
- Includes several solar radiation pressure models including Bar-Sever, N-Plate, and spherical models, as well as a plugin point for user models. Also included are options for thermal pressure and albedo modeling.
- Includes high-fidelity geopotential gravity modeling that accounts for tides with configurable degree and order options.
- Third-body effects are available for numerous bodies and planetary systems.
- Includes lower-fidelity models for initial design and analysis, including two-body gravity and a native implementation of the circular restricted three-body model.

/ Maneuver modeling

- Offers mechanisms for automatically transitioning between impulsive and finite maneuver models.
- An optimal finite maneuver provides an interface and tool set to numerically optimize the thrust-pointing angle along a finite maneuver using orthogonal collocation.
- Implements a modular, separated pointing and thrusting system for maneuver modeling that enables combinations of pointing strategies with multiple engine models.
- Engine models can be used as single units or combined as a thruster set to support complex thrusting geometries consistent with mounting and constraints.
- Pointing and thrusting strategies include multiple options as well as user plugin points to support unique spacecraft configurations.



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STK SatPro

Provides in-depth space tools for designing and operating satellite systems.

SatPro adds the following functionality to STK:

- Additional high fidelity orbit propagators
- Multiple attitude enhancements
- Satellite-specific engineering tools

/ Additional orbit propagators

High Precision Orbit Propagator (HPOP). HPOP uses numerical integration of the differential equations of motions to generate ephemeris. Several different force modeling effects can be included in the analysis.

- Central body gravity
- Solar radiation pressure
- Drag / atmospheric density
- Third body gravity
- Covariance
- Integrators: RK 4, RKF 7(8), RKV 8(9), Bulirsch Stoer, and Gauss Jackson

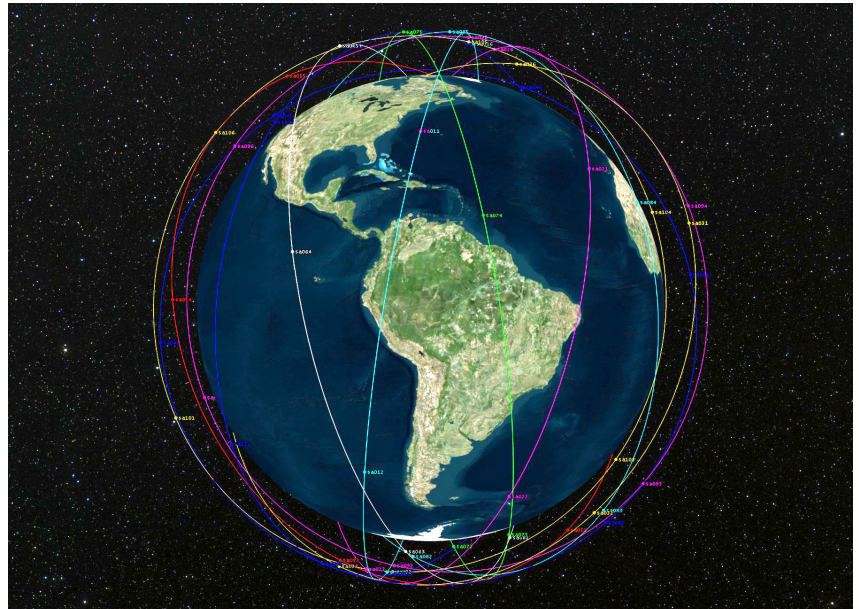
Long-term Orbit Predictor (LOP). LOP provides an accurate prediction of the motion of a satellite's orbit over many months or years. The LOP propagator uses the same orbital elements as the Two-Body, J2, and J4 propagators.

SP3 Propagator. This propagator reads .sp3 files of type 'a' and 'c' and enables use of multiple files in sequence. These files are used to provide precise GPS orbits from the National Geodetic Survey (NGS).

/ Attitude profiles

/ Additional attitude profiles

- Nadir alignment with ECF velocity constraint, Nadir alignment with orbit normal constraint, Nadir alignment with Sun constraint,
- ECF velocity alignment with radial constraint, ECF velocity alignment with nadir constraint
- Coordinated turn
- ECI velocity alignment with nadir constraint, ECI velocity alignment with Sun constraint



- Sun alignment with nadir constraint, Sun alignment with ecliptic normal constraint, Sun alignment with ECI Z axis constraint, Sun alignment with occultation normal constraint, Sun alignment with Z in orbit plane
- XPOP inertial attitude
- Yaw to nadir
- Inertially fixed
- Spinning, spin about nadir, Precessing spin, spin aligned
- Fixed time slew, variable time slew

/ Targeted attitude segments

Used to override the basic attitude profile for a satellite, missile, or launch vehicle and have a selected axis (its Z axis by default) point in the direction of one or more targets, subject to applicable access constraints.

/ Multi-segment attitude profiles

Used to set up complex sequences of varying attitude profiles over time.

/ Real time attitude data

With an STK Integration license and live data, you can create an attitude profile using near-real time flight data.

/ External attitude files

Used to import an external attitude file that will override any target pointing or basic attitude profile during the imported file's time period.

/ Attitude analysis

SatPro provides dynamic attitude modeling and simulation using several tools and calculation components:

- **3D Attitude graphics window.** Provides an easy way to visualize the attitude of a vehicle and changes in its attitude over time. It includes the attitude sphere, and vector-based sensor pointing visual aids
- **Attitude coverage.** Used to analyze coverage in various directions over time, using several attitude-dependent figures of merit. Requires a Coverage license.

/ Attitude Simulator

The Attitude Simulator provides the ability to incorporate the following when generating attitude trajectories:

- Custom torque models (e.g., gravity gradient, aerodynamic, etc.)
- Custom momentum biases
- Use of customized control laws (including static and dynamic feedback, dynamic compensators, etc.)

The tool numerically integrates an attitude state (represented by a quaternion) and its body angular velocity components as well as other optional variables.

Attitude Simulator plugin scripts may supply these variables and generally perform custom computations during numerical integration.

/ Satellite engineering tools

Generate TLE tool. Generates a two-line element set for the selected satellite using either the trajectory sampling method or single point method.

B-Plane template tool. The B-Plane template tool is used to create templates that define the configuration of B-Planes that can be displayed in the 3D Graphics window. Elements that can be displayed are:

- B-Plane
- B vector
- T-R axes
- Theta
- Asymptote
- S Vector
- Reference vector

Lifetime tool. The Lifetime tool estimates the amount of time a satellite can be expected to remain in orbit before atmospheric drag and other perturbations cause it to decay. Calculation options include:

- Drag coefficient
- Solar radiation pressure coefficient
- Drag area
- Area exposed to Sun
- Mass
- Atmospheric density
- Solar flux file
- Solar flux sigma level
- Advanced options to adjust computation performance

Solar Panel tool. The Solar Panel tool is used to model the exposure of solar panels over a given time interval. The resulting data can be used to determine the varying availability of electrical power for operations.

Model Area tool. The Area tool is used to calculate the area of a model from a given view direction, over a given time interval, such as an orbit period. It can be used to calculate the exposed area of:

- Drag calculations
- Solar panels
- Radiation

Walker Constellation tool. The Walker tool is used to easily generate a Walker constellation using the Two Body, J2, J4, or SGP4 orbit propagators. Walker constellations are based on a simple design strategy for distributing the satellites in a constellation based on the total number of satellites, the total number of planes and the phasing between satellites in neighboring planes.



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STK Space Environment and Effects Tool (SEET)

Evaluate the effects of the space environment on spacecraft.

Spacecraft designers, analysts, and operators rely on SEET to calculate spacecraft exposure to ionizing particles, thermal radiation, and space debris throughout the orbit, which is especially critically due to higher levels of man-made debris and increasingly energetic natural phenomena, such as the sun's solar flare activities.

/ Key components

SEET's functionality is provided by six key components consisting of scientific models of the space environment. These components are seamlessly integrated into the STK user interface.

- Trapped radiation environment
- South Atlantic Anomaly (SAA)
- Untrapped radiation environment
- Particle impacts
- Vehicle temperature
- Magnetic field

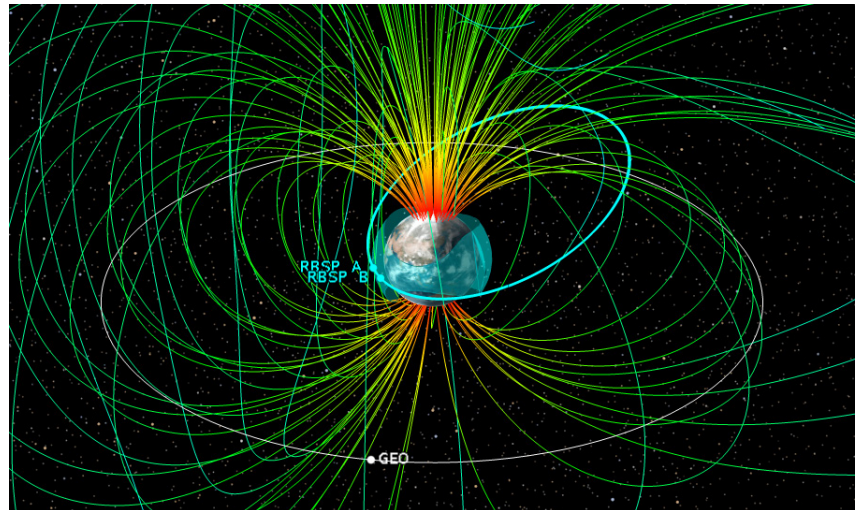
/ Trapped radiation environment

Information on vehicle dosing and incident energetic particle flux is important because devices on satellites degrade over time due to the total collected dose as well as the instantaneous dose rate.

- Computes expected dose rate and total dose due to energetic particle fluxes for a shielding thickness and materials.
- Computes the energetic proton and/or electron fluxes.
- Computes for a specified space vehicle as a function of time or for a specified set of spatial coordinates.
- Choose from AFRL CRRES or NASA standard models, or allow SEET to select the best model for the specific orbit.

/ South Atlantic Anomaly (SAA) component

SAA radiation can damage spacecraft electronics and cause Single Event Upsets (SEU), which can impair the functioning of electronic components.



- Computes entrance and exit times through SAA. SAA Transit component computes the energy flux and/or flux contour of SEU relative probability for altitudes between 400 and 1500 km.
- SAA model is based on data from the Compact Environment Anomaly Sensor (CEASE) detector.

/ Untrapped radiation environment component

Galactic Cosmic Ray (GCR). GCRs can lead to a variety of satellite anomalies, especially single event effects (SEE).

- Computes differential and integral fluxes and fluences.
- Provides three different options for GCR models: CREME86, ISO-15390, and Badhwar-O'Neill 2010.
- **Solar Energetic Particle (SEP)**. SEPs can cause problems similar to GCR, as well as other effects including increased ionizing dose. SEPs also cause other disruptions to technology, such as increased radiation dose to astronauts and airline crews and passengers, as well as degraded HF radio communications.
- Computes probabilistic fluences over mission lifetimes.
- Provides three different options for SEP models: JPL-91, Rosenqvist, and Emission of Solar Protons (ESP).

/ Particle impacts component

Define or select from lists of surface materials and properties that may be damaged by high-velocity impact with meteors and orbital debris.

- Computes the total mass distribution of meteor and orbital debris particles that impact a spacecraft along its orbit during a specified time period.
- Computes the mass distribution of these particles above a user-specified satellite surface damage threshold.
- The particle impacts algorithms are based on AF-GEOSpace meteor and debris models.

/ Vehicle temperature component

For vehicle sub-system design and operations, thermal environment energy combined with any internal heat dissipation requirements must be considered.

- Computes the mean temperature of a space vehicle, due to direct solar flux, reflected and infrared Earth radiation, and the dissipation of internally-generated heat energy using thermal balancing equations.
- Specify spherical objects or planar objects with particular orientation, and material emissivity and absorptivity.

/ Magnetic field component

SEET uses a highly customizable set of conditions to compute the local magnetic field at the current location. Information about the local magnetic field at the satellite is useful because these measurements can help give information about vehicle attitude.

- Computes total magnitude along the vehicle path or on a specified set of spatial coordinates using a chosen magnetic field model.
- Computes field-line tracing for display and magnetic conjugacy.
- Computes dipole L, McIlwain L, and B/Beq (ratio of magnetic field strength at the current location to that at the magnetic equator).
- Provides common magnetic field functionality with current AF-GEOSpace magnetic field models, including simply tilted dipole models based on time-interpolated moments of the full IGRF field representation, full time-interpolated IGRF, and full IGRF plus Olson-Pfitzer (1977) external field models.

/ Specialized report and graph options

Numerous customizable reports and graphs are available. Dynamic displays and strip charts containing SEET calculations can be displayed in real time as STK animates through a scenario.

/ SEET environment graphics

- SEET can display magnetic-field contour lines for a satellite, missile, or launch vehicle in both the 2D map and 3D globe.
- SEET can also display contours of the South Atlantic Anomaly (SAA) in 2D and 3D graphics windows.

/ SEET constraints

STK SEET constraints enable you to impose access constraints on a satellite, missile, or launch vehicle based on the effects of the space environment. You can also opt to exclude time intervals that satisfy a given constraint.



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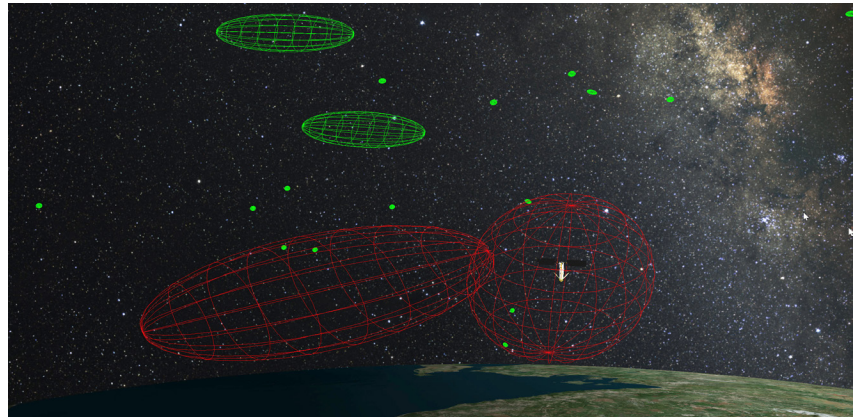
STK Conjunction Analysis Tool (CAT)

Determine time windows in which the launch or operation of a space object is affected by the proximity of another orbiting object.

/ Unprecedented computation speed

Pre-filtering of orbit elements enable CAT to quickly exclude space objects that cannot possibly have a close approach due to their orbit shape, distance between orbits, and the relative passage times when each object is close to the orbit of the other.

Using pre-filters provides unprecedented computation speed without reducing fidelity by decreasing the number of objects for which STK generates ephemeris data for the final stage of proximity calculation.



/ Error ellipsoids for close approach analysis

Error ellipsoids (threat volumes) more accurately model the uncertainty in the position of both the desired spacecraft and those that may have potential close approaches.

All secondary objects computed as close approaches with the primary object, as well as the associated close approach time intervals, can be added to STK for further analysis.

/ Leverages satellite database

CAT ensures the analysis is always up-to-date by taking advantage of the NORAD TLE database of more than 15,000 orbiting objects.

- Perform close-approach or laser-clearing analysis against the entire database in seconds.
- Select portions of the database or create your own.

/ 3D visualization of error volumes

The error ellipsoid for each primary and secondary (those in the Satellite database) are displayed in 3D.

- Error ellipsoids change from green to yellow to red during close approaches.
- Click on any ellipsoid for quick identification and retrieval from the database.

/ CAT analysis tool options

CAT provides four analysis options:

- Close Approach
- Advanced CAT
- LaserCAT
- Launch Window Analysis

/ Close Approach tool

Computes close approaches on a single selected satellite, missile, or launch vehicle. This tool is used to define a fixed error ellipsoid (tangential, cross-track and normal components) for the primary object and all of the secondary objects.

/ Advanced CAT tool

Performs close approach analyses for multiple satellites and datasets at a time with variable threat volume definitions.

- **Variable threat volume types.** Fixed, Orbit Class, Quadratic, Quadratic Orbit Class, Covariance, and CovOffset.
- **Related objects file.** Used to exclude objects that are supposed to be near the primary object(s) from calculation.
- **SSC hard body radius file.** Used to specify the size of objects being analyzed.
- **Nonlinear probability tool.** Used to compute conjunction probability for nonlinear relative motion. It is used to test for linear relative motion and provides two methods for computing conjunction probability - adjoining parallelepipeds (bundles) and adjoining tubes (cylinders).

/ LaserCAT tool

Assesses the potential of an unintended illumination of a satellite during a given laser run or within a lasing window.

- **Exclusion half-angle.** Defines the safety cone used in determining whether your laser operations come too close to other orbiting objects.
- **At risk file.** Speeds computation and enables you to focus your LaserCAT analysis on satellites that are truly vulnerable to inadvertent lasing and ignore other orbiting objects in the database, such as debris and rocket parts.
- **Potential victims report.** Identifies the space objects that will be within the safety cone around the beam during the operating period of the laser. Each object is clearly identified along with the time periods that it is at risk
- **Clear firing report.** Identifies the time periods when the laser may be used to illuminate the desired object while ensuring that no other space objects have entered the safety cone around the beam.

/ Launch Window Analysis tool

This tool is used to evaluate an entire launch window for safe and unsafe launch intervals.

- **Reports and graphs.** Blackouts and Clear Intervals.
- **Graphics options.** Launch Area, Blackout Track, Clear Interval Tracks, and Minimum Range Tracks.



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Geospatial Content Server

A comprehensive enterprise solution for hosting, processing, serving, and analyzing terrain, imagery, and other heterogeneous 3D data

This geospatial content management system, with its rich trove of terrain, imagery, and 3D models, includes:

- High resolution imagery, terrain, and 3D models
- Support for both STK and CesiumJS-based applications

/ Hosting options

- Privately host world terrain and imagery: process and curate your own world terrain data for hosting on-premises, behind the firewall on private networks
- Privately host terrain, imagery, and 3D tile processing that can be used to create data to visualize
- Local use of terrain, imagery, and models (no hosting required)

/ Secure access to data

- Supports modern security protocols such as OAuth 2.0, OpenID Connect, and SAML 2.0
- Comes with a built-in identity management system
- Integrates with standard identity providers, such as LDAP and Active Directory

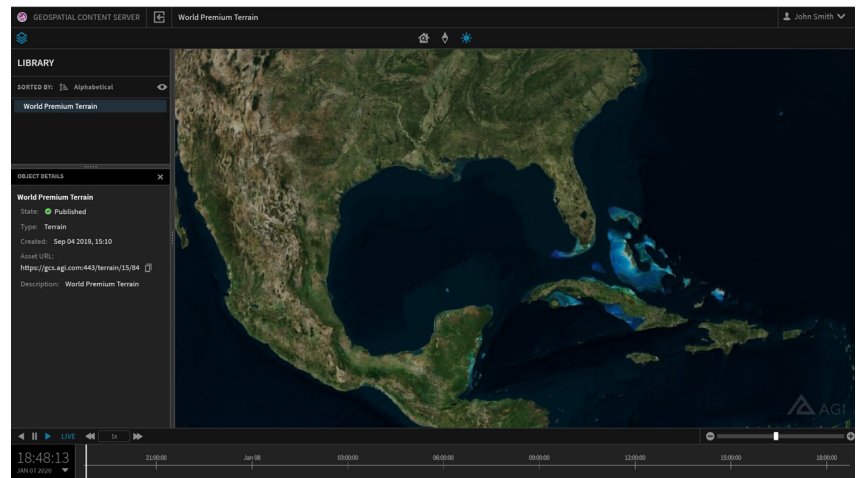
/ Easy access to data

- The web user interface of the Geospatial Content Server is accessible from any modern browser

/ Distributable architecture

Supports scaling to meet your enterprise needs:

- Ability to support more users as usage grows
- Allows for handling of massive datasets with easy viewing in a Cesium-based user interface



/ Terrain Server

/ Highlights

- Mosaicking separate terrain data sources into a global unified tileset
- Dedicated web server for hosting processed terrain
- Uses open terrain format, Quantized Mesh, avoiding vendor lock-in

/ Terrain Processing

- Level-of-detail pyramid is simplified within a known glance
- Client applications can precisely request terrain tiles where the difference in mesh geometry from the source data is not visually discernible
- Adaptive level of detail. At the root zoom level, meshes are simplified until roughly 150km in error from original source data. This error is cut in half for each subsequent tile level in the pyramid. (The allowable error between mesh and source data is ~150km for the root zoom level, however at this distance from the globe, there is no discernible difference, with far less geometry.)
- Through use of an irregular mesh for terrain geometry, merging data sources of different resolutions does not require all geometry to be upsampled to the maximum resolution



/ Terrain Hosting

- Uses open terrain format, Quantized Mesh, avoiding vendor lock-in
- Efficient storage on server through stand-alone database files processed from terrain tile sets
- Separation of resources between processing and hosting servers means processing does not affect hosting performance

/ Prepopulated with Rich 3D Geospatial Content

- Includes various-resolution global terrain data sets, 10-meter resolution global Sentinel-2 imagery, and 3D models in standard formats.

Terrain Data

Source	Coverage	Resolution	Attribution
USGS GTOPO30	Entire Earth	1000 meters	Produced by the U.S. Geological Survey
CGIAR SRTM	60N -60S	90 meters	Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT), available from https://srtm.csi.cgiar.org .
USGS National Elevation Dataset (NED)	United States	30 meters	Produced by the U.S. Geological Survey
USGS GTOPO30	Entire Earth	1000 meters	Produced by the U.S. Geological Survey
USGS CGIAR SRTM	60N - 60S	90 meters	Produced by the U.S. Geological Survey
USGS National Elevation Dataset (NED)	Continental U.S. and Alaska	10 meters	Produced by the U.S. Geological Survey
USGS National Elevation Dataset (NED)	North America	30 meters	Produced by the U.S. Geological Survey
USGS SRTM 1 arc sec	60N - 60S	30 meters	Produced by the U.S. Geological Survey
EU-DEM	Europe	30 meters	European Environment Agency (EEA) under the framework of the Copernicus programme, with funding by the European Union

Imagery Data

Source	Coverage	Resolution	Attribution
Sentinel-2 2019	56S – 84N	10 meters	EOX IT Services GmbH (Contains modified Copernicus Sentinel data 2017 & 2018)

“Pre-processed” file formats:

Format	3D model	Imagery	Terrain	Vector
3D Tiles	X			
Tile Map Service (TMS)		X		
Terrain Database			X	
CZML				X

File formats that require processing:

Format	3D model	Imagery	Terrain	Vector
CityGML	X			
NITF		X		
GeoTIFF		X	X	
USGS ASCII DEM, CDED, DTED, HRE, FLT, HGT, BIL, BIP, BSQ			X	



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TETK

Improve the efficiency and effectiveness of test and evaluation activities across the digital engineering product life cycle.

Test and Evaluation Tool Kit (TETK) supports test event planning, execution, and post-test data analysis for improved efficiency and effectiveness of test and evaluation activities. Build and validate detailed test plans, monitor test execution, and rapidly analyze post-test results to mitigate costs and reduce retest rates. Import your own unique system data to use alongside STK data and analysis artifacts. Monitor test execution in near real-time to make better decisions faster and replan on the fly.

Use Cases

Pre-test planning

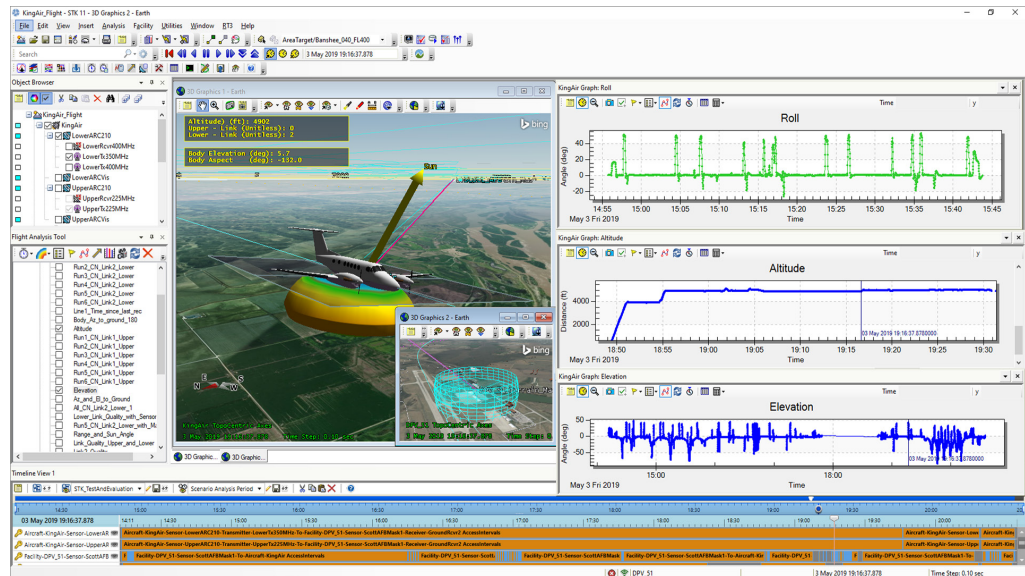
- Predict quality of telemetry and command and control (C2) links.
- Predict compliance with geometric, parametric, and physics-based constraints.
- Refine test point sequences and orientations to increase test point density.
- Define measures of effectiveness and measures of performance.
- Coordinate temporal and spatial relationships of test assets across multiple domains.

Test execution

- Assess test point attainment in near real-time and replan your missions on the fly.
- Visually monitor the performance of mission systems, range assets, GIS data, and more.

Post-test analysis

- Accelerate analysis of program-unique datasets by automating data ingestion and the generation of key analysis artifacts (e.g., graphs, reports, 3D visuals plus time).
- Accelerate anomaly forensics by visually interrogating relationships between complex datasets.



- Fuse data from onboard systems, payloads, data links, and range sensors for a complete understanding of test execution and system performance.
- Perform track-to-truth matching and track comparisons to validate sensor performance.
- Assess test results relative to specifications.

Key Value Points

- Maximizes test point density and reduces retest rates by analyzing timing and spatial relationships in test plans.
- Processes data quickly to enable immediate mission insights.
- Accelerates test performance assessments through comprehensive quick-look playbacks.
- Fuses data from onboard systems, data links, and range sensors for a complete understanding of test execution and system performance.
- Assesses whether previous test points have been achieved while subsequent test points are being executed, potentially saving money by enabling the retesting of failed points before the test sequence ends.
- Provides stakeholders with immediate insight into technical details through 3D visuals plus time, reports, and graphs.

/ Core Capabilities

- Automated import of custom data sets. Custom and repeatable mappings of data fields from file formats such as CVS, text, and HDF5 to STK analysis parameters.
- Visualization techniques to make sense of complex data relationships. Four-dimensional globe visuals synchronized with interactive graphs and reports.
- Automated workflows to perform common test and evaluation analyses. Includes, for example, track-to-truth comparisons for sensor performance validation.
- Time tagging and data assignment mechanisms to help manage large datasets. Displays only the data relevant to a particular time window and analysis objective.

/ Technical Details

/ Workflows

- Track to truth comparison. A workflow to set up and calculate geometric verification measures.
- Track automation workflow. Automation of the multiple steps in the process to ingest and analyze sensor tracks.
- Track events workflow. Automation of the steps required to evaluate radar queueing in conjunction with weapons events.
- Sensor volumes workflow. Visualize behavior of data-driven sensor volume.
- EW track ID workflow. Filtering of sensor tracks based on electronic warfare characteristics.
- Track measurements filtering and analysis. A workflow to create track measurement objects that enable you to assess and filter through visualization and decision-aid graphics.



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Behavior Execution Engine

Simulate the impact of system behaviors on mission success.

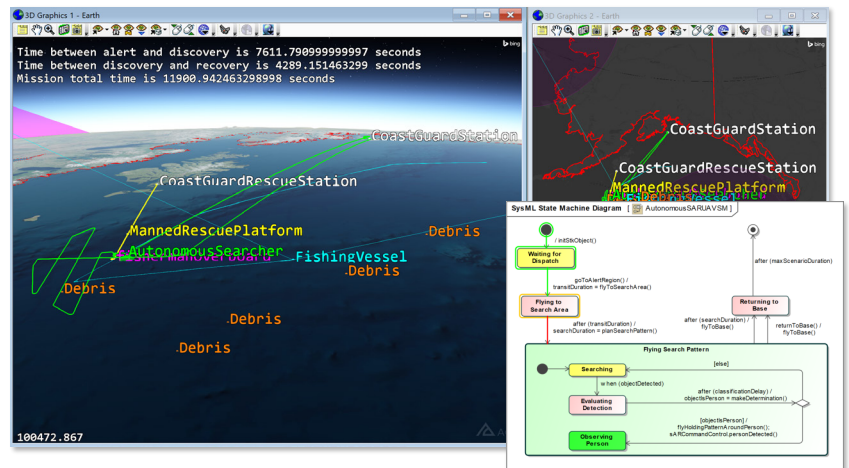
Systems Modeling Language (SysML) is a widely used standard for defining system architectures. However, to fully validate the ability of a SysML-based design to meet its requirements, projects must execute their SysML models in a full physics-based simulation of that system's operating environment. For example, to know that an autonomous vehicle can drive safely, its auto-routing behaviors — as defined in SysML — must be executed in a simulation that includes all the sensors, terrain, and conditions of the communications environment that the vehicle will encounter in the real world.

Behavior Execution Engine (BEE) forms the bridge between SysML behavioral models and the simulation environment. BEE establishes and evaluates correlations between transitions in SysML workflows and those same events within realistic simulations. For example, BEE will take "left turn" as defined in a SysML state machine and execute it in a physics-based simulation environment — such as Systems Tool Kit (STK) — to validate that the vehicle's sensor will detect an obstacle in its path.

BEE creates and evaluates interactions between your SysML models and their simulated operating environment to predict mission outcomes and assess capability performance.

Use Cases

- Analyze how disparate systems modeled in SysML behave and interact in a common simulation environment, such as STK.
- Evaluate system behaviors, instead of a prescribed sequence of events.
- Perform trade studies on the effectiveness of different behavioral designs.
- Assess how well SysML behavioral designs perform relative to Design Reference Mission (DRM) constraints and requirements.
- Analyze and debug SysML state machine flows in real time, as systems interact with one another and their simulated operational environment.
- Investigate root causes of failing requirements in any phase of the digital engineering life cycle.
- Observe active states and transitions as your simulation executes relative to environmental phenomenon.
- Explore new operational use cases with your digital prototype.



Key Value Points

- Enhances the accuracy of your digital prototype by enabling you to analyze and refine your SysML behavioral models relative to their performance in your system's targeted operational environment.
- Enables systems engineering collaboration.
- Includes customizable fidelity levels to support everything from initial concept studies through detailed engineering analyses.
- Integrates intuitively with existing system engineering workflows, enabling you to focus on system modeling using familiar SysML authoring tools rather than spending time creating physics algorithms, numerical integration schemes, and other approaches to represent environmental phenomenon.
- Explicit, thread-safe, time orchestration across the digital operating environment eliminates cross-system simulation anomalies and ensures accurate analysis.
- Enables you to consider complex calculations from your analysis tools — regardless of how long they take — in the flow of your executable architecture, since you can coordinate the advancement of your simulation in response to time-dynamic events, not just discrete time.
- Enables you to inject custom code into the time-dynamic events driving your simulation.
- Executes custom analysis tool code with modeled time events, change events, call events, signal events, and effects.

/ Core Capabilities

- **Customizable interfaces to external analysis tools.** Delegate architecture provides fully customizable one-to-one relationships between state machine transitions and operational environment events.
- **Simple behavior expression syntax and object-property navigation.** Maximizes development and analysis efficiency.
- **Feedback into Cameo Simulation Toolkit (CST) state visualization**

capabilities. Enhances awareness of simulation progress.

- **Supports discrete and continuous event detection.** Enables SysML system interaction with computationally intensive environmental calculations and discrete delays associated with human interactions.
- **Time management.** Synchronizes time across all systems operating in a shared digital environment. Coordinates time across all objects in the simulation

continuously as events take place instead of forcing all computations to take discrete timesteps.

- **Behavioral trade studies.** Enables execution of trade studies on SysML behavioral designs using an established integration with ModelCenter.
- **Thoroughly documented APIs.** Includes code samples, tutorials, reference topics, and demo applications to get you up and running.

/ Technical Details

/ Execution Engine

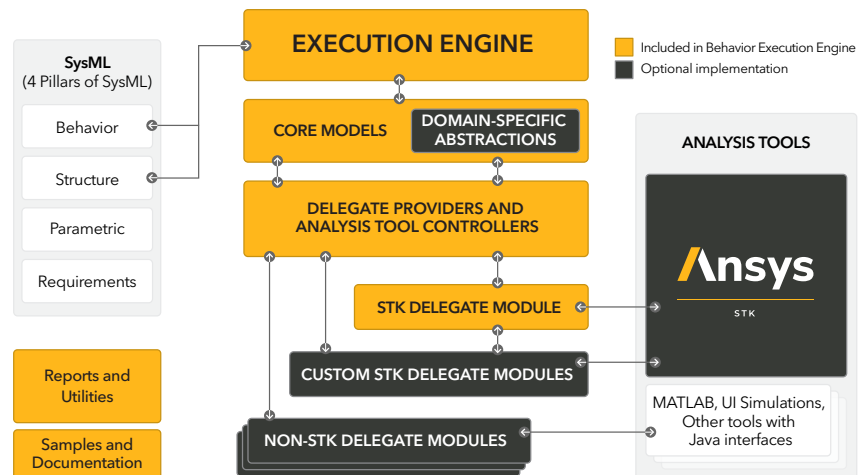
- Ingests, interprets, instantiates, and embeds your formal SysML models into operational environments modeled by STK or other analysis tools.
- Works with CST to animate SysML model progressions and support breakpoints in No Magic modeling tools. However, the BEE execution engine overrides the default CST execution engine.

/ Core Models

- Define elements of time and spatial geometry that the execution engine needs to perform event detection.

/ Delegate Modules

- Delegates are Java classes that define one-to-one correlations between blocks in your MBSE models and implementations in external analysis tools. Delegate modules contain collections of delegates.
- Enables you to define behaviors that your SysML models will exhibit during execution and represent the influence of an operational environment.
- BEE includes APIs and example delegate modules that you can extend to integrate with your preferred analysis tools.
- Includes an STK delegate module that provides a starting point for integrating your SysML models with STK's physics-based simulation environment.



/ Reports and Productivity Tools

- **Model Validation Report.** Runs a validation process against your state machines to confirm that opaque expressions are in agreement with the model elements they reference.
- **Element Locator.** Enables you to easily find elements in your No Magic modeling tool's containment tree, such as those identified in a Model Validation Report
- **Delegate Availability Report.** Shows the fully qualified type names of available delegates based on the loaded modules.
- **Block Usage Report.** Lists all properties and operations in use by the state machines defined in your simulation.
- **Java Code Generator.** Provides a mechanism to generate Java interfaces and classes based on the blocks in your MBSE models.
- **Runtime Code Generation.** Provides default implementations for simple types that you can optionally override.
- **Build, Install, and Debugging Support.** Includes custom scripts to support building, installing, and debugging delegate modules.



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