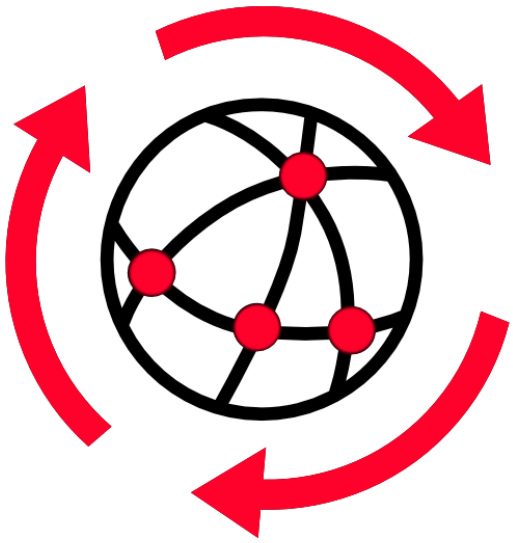
Operator's Toolbox V1.2 Documentation



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GETTING STARTED AND SETUP

Operator's Toolbox is a UI plugin designed specifically to improve the efficiency of common operational tasks. The tools made available in this plugin are mainly based on customer requests to automate certain processes within STK in an effort to reduce analysis time for real world scenarios. Operator's Toolbox contains a total of 14 tools to automate various processes including but not limited to: TLE import and update functionality, improved stored views functionality, automated chain/tracking interval creation, and new custom ground classification types. This document will walk through all of the utility's functionality along with provide insight into its proper usage.

Before opening the utility, it must first be installed in the proper location so STK can find the files. The install will likely be in zipped form and will need to be unzipped somewhere on your local drive. Once unzipped, open the new folder and move the "Operators_Toolbox_Install" folder and "OperatorsToolbox.xml" into the following directory: C:\ProgramData\AGI\STK 12\Plugins. If you are running STK 11 then the install location will be: C:\ProgramData\AGI\STK 11(x64)\Plugins. It is very important that the xml is outside the Operators_Toolbox_Install folder or the plugin will not be found by STK. The ProgramData location is the desired install location because the installed examples reference this location. This plugin can technically be installed in any location, which will be discussed in the next section. You may be prompted with the 'First Time Use Wizard', in which case you will follow the prompts on the pages.

Please note that you will likely need to unblock the dll if you downloaded the plugin from the internet. This is a Microsoft security protocol. Please refer to the Known Issues section. Additionally, any previous installs of Operator's Toolbox should be removed prior to installing the new version. It is recommended that you archive any previously saved templates or other personal files and then move them back in to the new install.

ALTERNATE INSTALL LOCATIONS

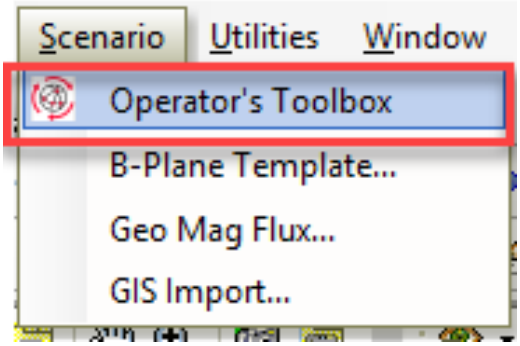
There are two other locations that you can install the OperatorsToolbox.xml and infinite locations for the actual install. The xml can also be placed in the C:\ProgramFiles\AGI\STK 11 (x64)\Plugins or <STK User Directory>/Config/Plugins. When placing the Operator's Toolbox folder, take note of where you place it. If you place the folder in the ProgramData file path mentioned above then you will not need to change anything, but if you place the folder in another location then you will need to change two things. First, in the xml, regardless of the xml location, the dll file path must be edited to point to your install location. The file path should point to the release bin directory of the Operator's Toolbox install directory. If you chose an alternate install, you will be prompted with a 'First Time Use Wizard' when you first open Operator's Toolbox. This is a series of interfaces to help reconfigure the install. The first page points to the OT install directory (i.e. 'Operators_Toolbox_Install' as discussed in the above section). The remaining pages help assign the database locations and event image locations. Typically, the database location paths and image folder will update automatically in the wizard after the install directory is chosen.

STK 11 AND STK 12 COMPATIBILITY

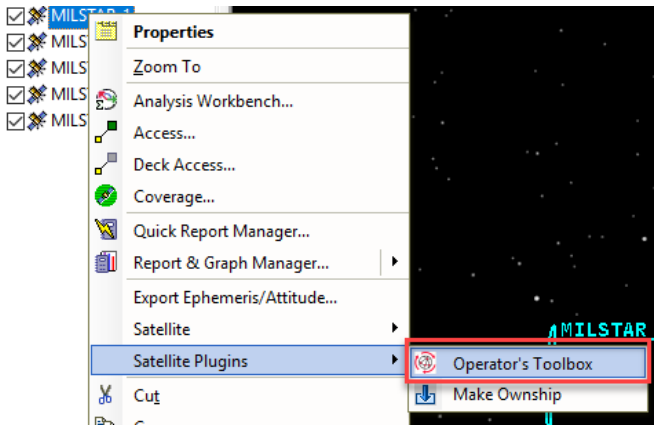
Everything created in Operator's Toolbox is backwards compatible with previous versions of STK, until 11.4. The only exception to this is Templates. Since Templates are based on saved STK objects, these are not backwards compatible with any previous versions of STK. Versions of Operator's Toolbox are forward compatible as of V1.1

OPENING THE PLUGIN

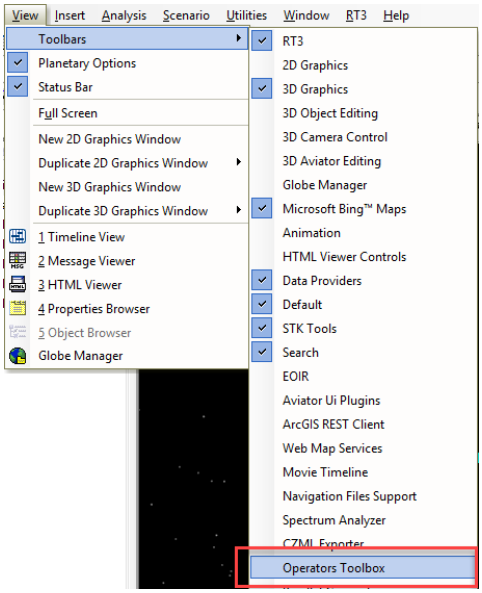
Once you have moved the files you will need to restart any open instances of STK that may be open on your computer. This will refresh the plugins directory and allow for the plugin to be loaded. Once you reopen STK the plugin will be made available to you. There are three different ways that you can open the plugin. First, with the scenario selected in the Object Browser you can find it as an option under the "Scenario" menu at the top of STK. This can be seen in the image below.



The plugin is also available by right-clicking on any object in the Object Browser and going to <Class Name> Properties. This method can also be seen in the image below.



The other method, and recommended method, is to add the plugin as a toolbar option. To do this go to View->Toolbars and select "Operator's Toolbox". This can be seen in the image below. This will add a toolbar option to the near the upper left of your screen. Once you open the utility it will automatically open on the right-hand side of the screen.



KNOWN ISSUES

There have been some known issues on download. If you experience any ‘dll’ errors in the message viewer, then you may need to unblock the dll. Windows does this in case the dll is malicious. To solve it you simply need to unblock it. If you installed it in the correct location the dll can be found here: C:\ProgramData\AGI\STK 11 (x64)\Plugins\OperatorsToolbox\OperatorsToolbox\bin\Release. Right click on the dll and go to properties. If the “Read-Only” checkbox is checked then uncheck it. Click okay and then reopen the properties. At this point you will likely see a “unblock” button at the bottom of the properties. Click unblock and then okay. That should solve the issue if you restart STK.

There is also a known issue regarding computer DPI/scaling settings. If you are experiencing poor layout, incorrect image sizes, or overlapping controls then you are likely suffering from this issue. Please read the Setting Panel Height section of the settings description.

Most pop-up pages in Operator’s Toolbox become the focus when opened and you cannot use any other interface until that page is closed. There are a few pages, the modify scripts page in Templates and the visualization page in Passive Safety, do not require focus so the user can continue to use STK while the page is open. This can cause these pages to get stuck behind STK. It is recommended that you either move these pages to another screen or close them when you are done using them.

BASIC GUI OVERVIEW

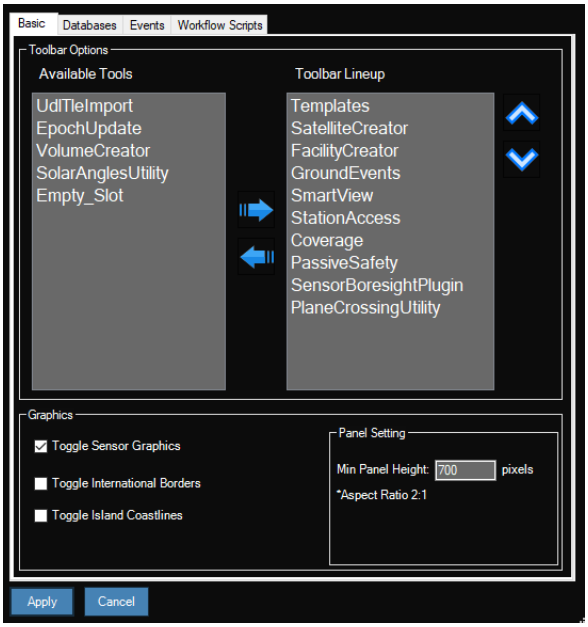
Operator’s Toolbox is set up as a set of panels, where each panel corresponds to a different tool. When you first open Operator’s Toolbox the GUI will pop up on the right side of the screen and look like the image below. Labels have been added to describe each tool available. The buttons/tools on the main interface can be changed from within the settings (see settings section). When a button is pushed a panel will then pop up corresponding to that particular tool. The entire tool will resize based on the number of tools that you currently have open. A tool can be closed by clicking the red-X in the upper right corner of the panel. This will resize the plugin again to remove the tool from the window. There is no limit for the number of tools that can be opened at any one time. Each tool will be described in detail in the following sections of this documentation.

Icon	Plugin Name
	Templates
	Satellite Creator
	Unified Data Library (UDL) TLE Import
	Satellite Epoch Updater
	Facility Creator
	Ground Events
	Smart View
	Station Access Utility
	Coverage Utility
	Passive Safety
	Solar Angles Utility
	Plane Crossing Times
	Volume Creator
	Sensor Boresight View

SETTINGS PAGE

The settings page can be opened by clicking the gear icon in the bottom left-hand corner of the main GUI window. When the GUI window opens it will look similar to the image below. The page is broken into four tabs, each of which will be described in the following sections. The preferences on this page are saved in a file called PluginPreferences.pref, which is located in the main folder of the plugin install.

BASIC SETTINGS



Toolbar Options

The top section of the Basic Settings is for the toolbar options, which specifies the plugins that will be available to the user on the main toolbar. Currently active tools are listed in the "Toolbar Lineup" list in the order that they appear on the toolbar. A plugin can be selected in the list and moved up and down using the arrows on the right.

There can be a total of 10 tools on the main toolbar at any one time. Tools can be switched out using the arrows between the toolbar lineup and the available tools lists. Any number of empty slots can be added to any slot on the toolbar by moving "Empty_Slot" into the Toolbar lineup in the desired location. If you try to add more than 10 tools to the toolbar, then you will get a warning indicating that you must first remove a tool before adding any others. If a tool is removed from the lineup it will be added to the Available Plugins list.

Graphics Settings

There are three checkbox options for graphics settings. The first is the "Toggle Sensor Graphics". This is applicable if you are loading satellites from the database that have sensors but you do not want to see the sensors. Sensors can be important for coverage calculations but the sensor graphics can make the 3D graphics window a bit cluttered. Simply uncheck this box to turn off all sensors graphics that are currently in the scenario. The sensors can still be used for analysis even if the graphics are turned off. If you add a sensor after you have turned this option off the graphics for the new sensor will still be displayed. If you do not want to see the new sensor graphics simply come back to this page and toggle the option on and off again. The final two graphics options will turn on country borders and island borders for all land masses around the world. These settings will revert to "Off" every time the utility is loaded.

In this section you will also find a button to turn off all FOM Legend graphics. If you have figure of merits in the scenario that contain legends (ex. From the coverage tool in this plugin) then this button will quickly remove all legends for all figure of merits in the scenario. It does not remove legend settings, only turns off the graphics.

Setting Panel Height

Because Operator's Toolbox is paneled by nature there have been some known graphics issues when using different DPI/scaling settings. To provide an easy method to mitigate these issues, all controls have been tied to the height on the panels, which can be set on this page. The decision was made not to dynamically resize the panels on startup because of small resulting displays on 4K monitors. Instead a minimum value is specified and the display can only grow from that value. The width of the panel will always be half minimum panel height, even though the length of the panel can change dynamically above this value. Manually setting this value makes it usable on higher DPI machines and allows the user to make the display bigger or smaller as they desire. The table below provides the recommended panel height based on common graphics settings. It is not recommended to set the value below the number specified, but there should be no issue going larger (as long as you have room). The minimum allowable value is 300 pixels.

Resolution	Scaling	Panel Height (pixels)
1920x1080	100%	700
1920x1080	125%	800
1920x1080	150%	900
3840x2160	150%	1000
3840x2160	175%	1100
3840x2160	200%	1200
3840x2160	250%	1500

DATABASES

You can specify custom locations for the satellite database, satellite catalog and the area target directory. The satellite database is a text file that list specifies satellite propagation parameters and is in TLE format. The plugin will be able to read any file type as long as the text inside the file is in TLE format.

The satellite catalog is by default an excel spreadsheet that specifies other satellite information that is not specified in the TLE. This information includes things like common name, constellation name, type (i.e. GNSS, MW, Weather, etc.), and sensor FOV if you would like a sensor attached. The current catalog is saved in the main plugin databases directory but it can be pointed to any file as long as it has the correct format. For a file to have the correct format it must have a header line, 12 columns, and the SSC number must be populated for every line. Additionally, the utility has the ability to read a CSV file as long as it follows these same parameters. If you add additional lines to the catalog they will be added to the possible database import options on the next startup of the utility. The catalog is used exclusively when adding new assets.

The area target directory is a csv file that has an area name specified in each line. The default file is also located in the main plugin directory. Lines can be added to this file at any time but the names of each area MUST match one of the options available in the “Area Targets” folder that is located in the main plugin directory.

The Templates Directory is the folder location where you wish to store all generated templates. The Templates tool will also reference this path when searching for existing templates to load into the scenario. If using install location, then the folder location would be <OT Install>/Databases/Templates.

The UDL address is used to request a TLE download from the Unified Data Library. The UDL will provide up to date, or archived data for any satellite that is currently tracked in the database. The address on install is configured for use on the unclassified side. The UDL tool can be used on the classified side by changing this address on this page to the correct classified address. To obtain the classified address please reach out and it can be provided for you.

GROUND EVENT TYPES AND IMAGES

This section of the settings page gives you the ability to add and remove different ground event types from the plugin. To add a new type simply click the “Add” button and a new line will appear called “NewType”. You should change the name to something of your choosing and then select an image to go along with it. You can either type in the file path or click the ellipsis to browse to the file location. It is recommended that you use an image that is either a PNG or JPEG. If you do not specify an image then no image will be displayed in the plugin but you can still select the type as an option. DO NOT REMOVE THE TYPE “Unknown” FROM THE LIST. This type is used as a fallback if there is an unknown issue with a spreadsheet import. If you would like to remove a type simply select it and click remove. If you have an event of a specific type and then remove that type from the list then the event will still be displayed with the deleted image but it will no longer have a type associated with it in the definition. It is recommended that you then go back into the event definition and change the type to something that is in the list.

WORKFLOW SCRIPTS

Workflow scripts allow the user to connect to common STK events. Each one of these events will be explained below. When an event is fired a script or task can be executed. Each workflow script is executed through a command prompt. If a workflow script is enabled, as denoted by the checkbox to the right of each script, the script or task specified in the first line will be executed. If the option is available, you can accompany the call with a set of command arguments, specified in string form. Each command argument is specified by a space character, as is typical with command line arguments. It is up to the user to handle the argument inputs on the scripting end. Arguments are only required if the user’s script is looking for them. The recommended scripting languages are either VBScript or Python; however, the functionality can handle .exe and other application calls. Other scripting languages are likely supported, but this has not been tested. MATLAB is not a supported language. A sample of the GUI can be seen in the following image.

Language Notes

If you are running python scripts, there are a few things to note. First, it is assumed that you have an environment variable that ties a python script to the py.exe function. This is typically default if you have Python installed on the machine. If you do not have the environment variable, the script path should point to the py.exe file and the first argument should be the path to the desired Python script file. It is also important to note that Python will execute will a command window open. This means you will be able to write things to the window inside of your script, as is typical in a python script. Scripting errors are displayed in this window as well.

If you are running VBScript, there are a few other things to note. VBS does not execute with a command window open but if there is a scripting error, the built in Windows debugger will pop up and give an indication as to the issue in the script. VBS will execute faster than Python so it is recommended for shorter tasks. Python is recommended for more advanced tasks.

If you get a pop-up that says 'Script Error', it is an issue with the inputs and typically it is the script line. Make sure the file path is valid. If the script path is valid, any error interior to the script will be displayed via the language specific debugging system.

On STK Save

This event is fired after the scenario is saved. The saving process will be complete when the script executes. This process will run in parallel to STK, allowing for continued use of STK. Recommended use cases: configuration management or passing of data.

On Scenario Close

This event is fired before the scenario is closed. This process will run in parallel to STK, allowing for continued use of STK. Recommended use cases: configuration management or passing of data.

On Animation Pause

This event is fired after the Animation Pause button is pressed. The animation will be stopped when the scrip executes. This process will run in parallel to STK, allowing for continued use of STK. Recommended use cases: Movie making or EOIR in the loop

On Object Added

This event is fired after an object is added to the scenario. The full path to the new object is passed to the script as a string input. This can be accessed for use in the script. An example of this is shown below in VBScript. This process runs in serial with STK, meaning that the STK GUI will pause until the script finishes executing. Recommended use cases: passing data to other running processes or configuration management.

```
Dim args

Set args = Wscript.Arguments

msgbox("Object Added: "+args.Item(0))
```

On Object Deleted

This event is fired after an object is deleted from the scenario. The full path of the deleted object is passed to the script as a string input. This process runs in serial with STK, meaning that the STK GUI will pause until the script finishes executing. Recommended use cases: passing data to other running processes or configuration management.

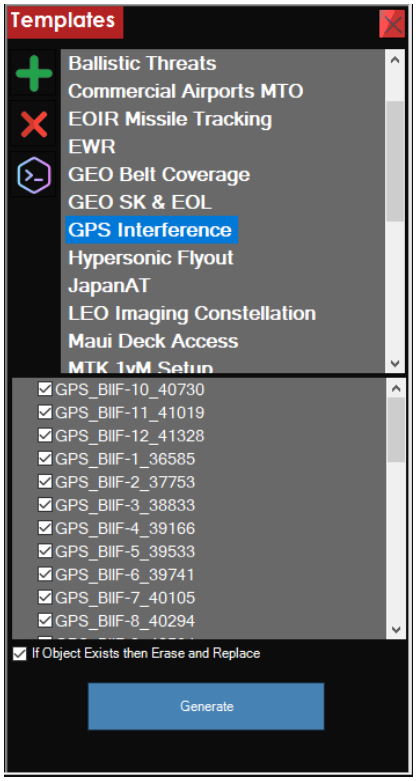
On Animation Playback

This event is fired when the play forward button is pressed. The script will be executed on every time step while the animation is playing. It is important to note that this event fires a lot, so use it with caution. Recommended use cases: Movie making or EOIR in the loop

TEMPLATES

NOTE: Required licenses vary based on the required modules for a given template. Workflow Scripts requires Integration

Templates is one of the most powerful tools available in Operator's Toolbox because of its ability to quickly recreate entire object configurations of any type. The tools purpose is to allow the user to save any number of objects, with their associated properties and object dependencies, as a "Template" such that it can be imported into any new scenario. While there are already tools to do this on a single object basis, like the Standard Object Database, Templates allows any number of objects to be imported at once and it is far faster than any other method currently available. When you open the Templates tool a GUI panel will pop up that looks similar to the image to the left. The list at the top of the page defines all templates that were previously created and saved by the user. The Template files can be found in the following directory: <OT_Install>\Databases\Templates\<Template Name>. When a template is saved all object files are copied to a new folder within this directory such that it can be accessed by the plugin at a later time.



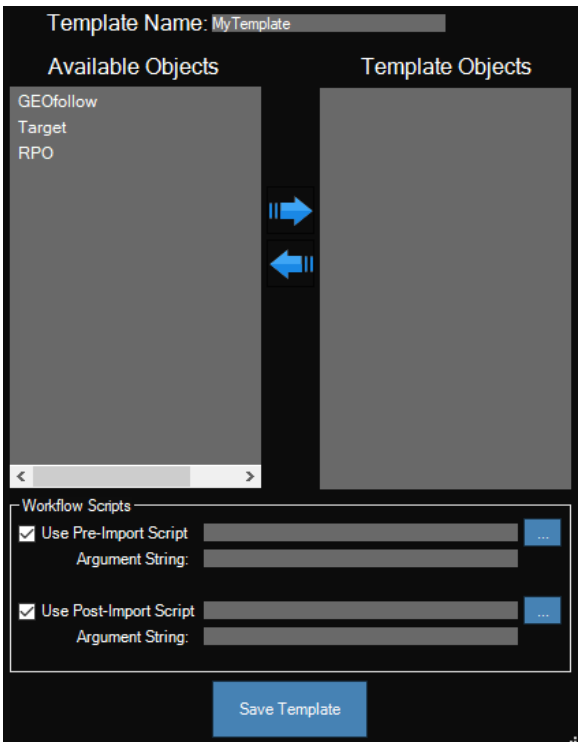
Selecting a saved Template will display all objects in that Template to the display on the bottom half of the tool. Each object will have a checkbox next to it that will by default be checked. Any object can be unchecked from this list and it will not be imported from the template. The only exception to this is when there are object dependencies. For example, if you have a constellation object checked, but all of the objects in that constellation are unchecked, it will still import all of the constellation objects even though they are unchecked. This can be mitigated by not importing the constellation object and then the unchecked objects will not be imported. This is true for any object that groups objects together (i.e. Constellation, Chain, CommSystem). It is also important to note that any child objects that are associated with objects in the Template will also get imported by default if that object is checked. This will be discussed in more detail when discussing Template creation. There is also a checkbox below this, that is checked by default, and says "If Object Exists then Erase and Replace". This means that if you import a Template that has an object with the same name as an object in the scenario, it will remove the existing object and replace it with the imported Template version.

Selecting a saved template and clicking the "X" button will permanently remove the Template from existence. This cannot be undone and a message will pop up verifying that you wish to delete the Template. Clicking the "generate" button will populate all checked objects in the scenario. It is important to note that some Templates will come in with time dependent data from original creation. Because of this, anything that requires a computation will need to be recomputed. Some examples include Comm Systems, Coverage Definitions, and Chains.

Selecting a saved template and clicking the scripts button will allow the user to edit the workflow scripts for that template. This functionality will be discussed in detail in a following section, you can also reference the Workflow Scripts portion of the Settings documentation.

CREATING A NEW TEMPLATE

A new Template can be created by clicking the green plus sign in the upper left-hand corner of the GUI. This will open a panel that looks similar to the image below.



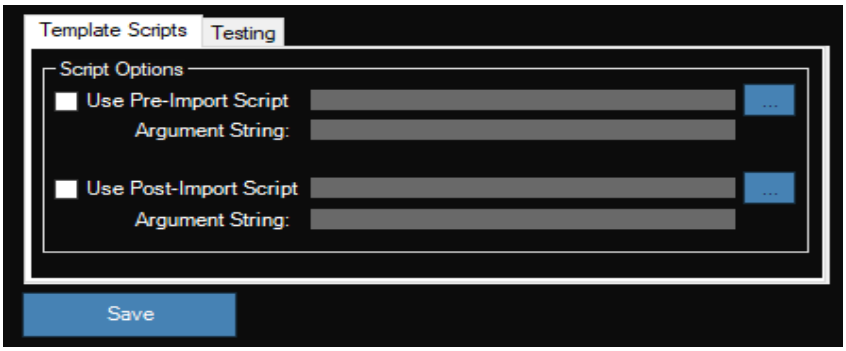
The template name is specified at the top of this page and the created folder, placed in the directory specified in the section above, will have the same name. All available objects that can be added to the template are shown in the left-hand column. Any number of objects can be moved into the Template Objects on the right-hand side, and multi-select is available for this page. It is important to note that the order that you move objects into the new Template is important. Typically, everything will work regardless of order; however, you can speed up the import process by using a logical import order. For example, if you have a CommSystem object then it is best to import all dependent objects (i.e. transmitters, receivers, jammers, and associated constellations) first prior to importing the actual CommSystem object. This will keep STK from searching for the dependent files in the middle of the import process. You can save a Template for future use by clicking the “Save Template” at the bottom of the window. The main Templates GUI will then update to show this change.

It is also important to note that there is no way to edit a Template once it is created. To edit a Template, it is recommended that you import the original version into a scenario, make changes to the objects as necessary, and then delete and recreate the Template using the new object versions.

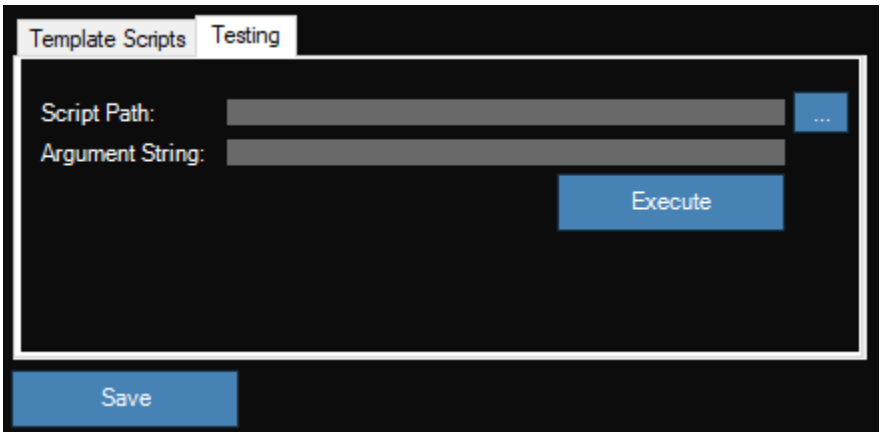
Workflow Scripts

Workflow scripts allow the user to execute a script or task before or after a template is imported. Each workflow script is executed through a command prompt. If a workflow script is enabled, as denoted by the checkbox to the left of each script, the script or task specified in the first line will be executed. You can browse for the script in a file explorer by clicking the ellipsis button to the right of this line. If the option is available, you can accompany the call with a set of command arguments, specified in string form. Each command argument is specified by a space

character, as is typical with command line arguments. It is up to the user to handle the argument inputs on the scripting end. The recommended scripting languages are either VBScript or Python; however, the functionality can handle .exe and other application calls. Other scripting languages are likely supported, but this has not been tested. MATLAB is not a supported language. A sample of the GUI can be seen in the following image. This can be found on the New Template GUI, without the testing option, or from the Scripts button on the main Templates interface. The Pre-Import Script will execute in serial to STK, meaning that the template will on import until the script has finished its execution. The Post-Import Script will execute in parallel to STK, meaning that the user can continue to use STK while the script executes.



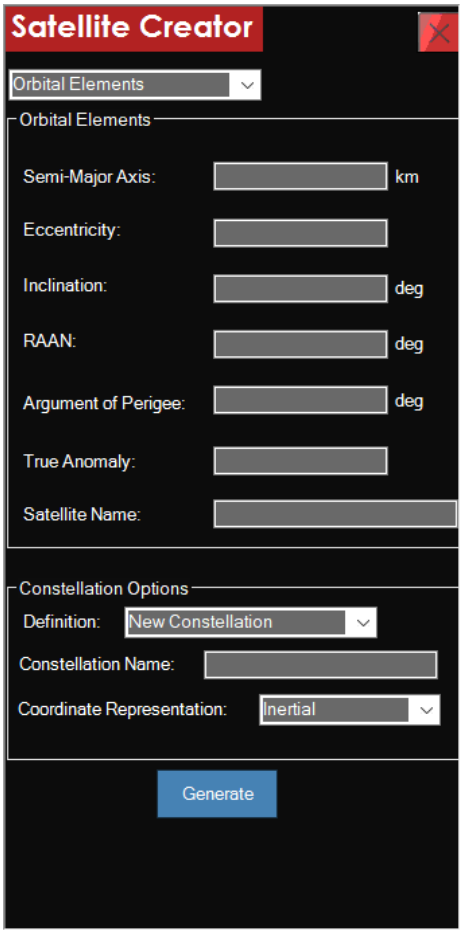
The testing page of this interface is used for quickly testing scripts without needing to import a template. The interface for this will look similar to the image below. The script and argument line work the same as all other workflow scripts. The difference here is that the script will be executed when you click the ‘Execute’ button. This process will execute in parallel with STK. Settings on this testing tab are not saved once the page is closed, so the page should remain open if you wish to continuously execute scripts. DO NOT SPAM THE EXECUTE BUTTON.



SATELLITE CREATOR

Note: This tool requires an STK Professional license

The satellite creator is meant as a one-stop-shop for satellite creation and updates. The tool includes import options for TLE/TCE, ephemeris, orbital elements, and a custom satellite database. The custom satellite database allows a user to define custom metadata for a user specific TLE database and then import satellites based on that metadata. These tools will also update satellites to the most recent TLE data if the source is updated. Satellite Creator is not meant to replace all satellite import options, rather help expedite the process for the user by applying common settings and grouping objects. When you open the page it will look like the image to the left.



There are four import options available in the dropdown at the top of the page. Each import type will be discussed in detail in the following sections. Regardless of import method a constellation option must be chosen for any imported satellite. This is critical for defining your coverage assets. Using the default constellation will add all new assets to the "Assets" constellation, which will be created in your scenario if it is not already. The second option is to add your assets to a pre-existing constellation if you already have one. The third option is to add your assets to a new constellation of your choosing and you must specify the name. Correctly assigning the constellation will make assigning coverage assets very easy in the future.

The coordinate representation was added to help visualize different kinds of satellites. The two options are Earth Fixed and Earth Inertial systems. Common practice is to leave the representation as Inertial all satellites except GEOs, which are typically fixed.

IMPORT FROM TLE

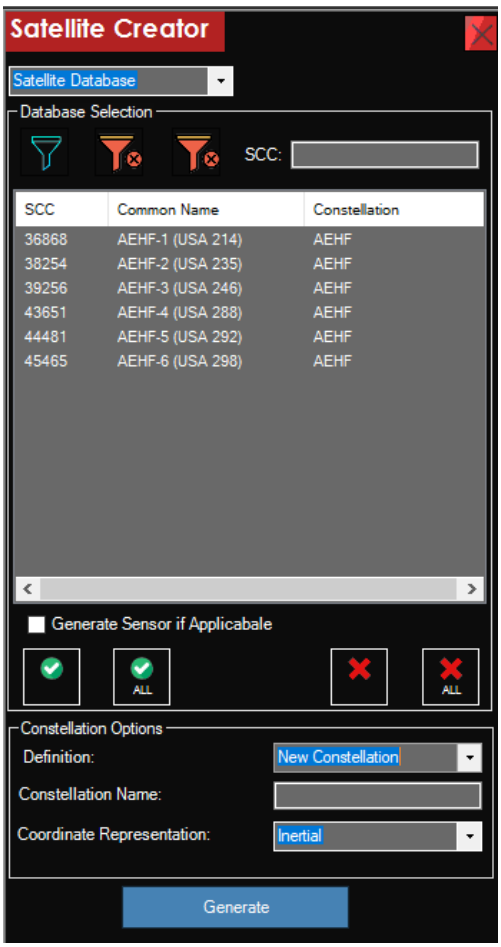
When this page is first opened the "Import from TLE" option is selected by default. The text box at the top allows you to type in a file path of your TLE file or click the ellipsis button to browse to the file location. The utility can read a file with any file extension as long as it follows correct TLE format. It will import ALL of the assets located in the file and add them to the constellation option or your choice.

INSERT WITH ORBITAL ELEMENTS

If you would like to manually define a satellite's orbit then select the "Orbital Elements" button. This will change the center section of this page to include text boxes or the six orbital elements along with a satellite name. All of these values must be specified for the satellite to be created. If your chosen orbital elements are not valid then the utility will inform you that the orbital elements were wrong. Once again make sure that the constellation option is chosen correctly before creating the satellite.

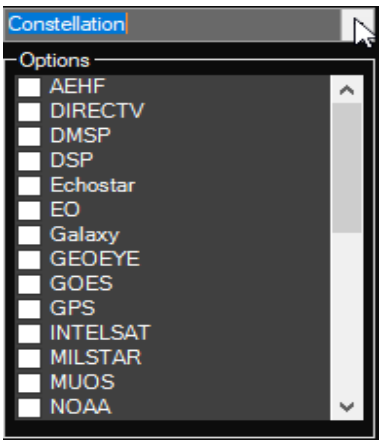
IMPORT FROM DATABASE AND SATELLITE CATALOG

Importing from the database is by far the powerful way to import new satellites into your scenario. When you select the “Database” option at the top of the form, the center section of the form will become populated with all of the possible import options as shown in the image below. Keep in mind that it will take several seconds for the database to load in, depending on the size.



You can select or multi-select any number of assets in the list and select them with the button on the right. Additionally, there are options to select all and remove selected assets. When an asset has been selected it will be highlighted. Keep in mind that no satellites will be created until you click the generate button.

There are three filters above the satellite database list that can modified to limit the amount of results that are being shown. The top dropdown of each filter allows you to search on different properties such as Constellation, Color, Nation, Orbit Regime, and Type (i.e. GNSS, Weather, MW, etc.). All of these properties are specified in the satellite catalog spreadsheet. The names of these categories can be changed by modifying the column header names in the spreadsheet. If a new option is added in the spreadsheet to one of these properties then it will automatically be added as an option in the filter, which is below each dropdown. The user can choose any number of options for each filter. This option allows you to browse through all the possible property options for the selected property. The image below shows searching based on the Constellation metadata option. The filter form will automatically close when the mouse leaves the form. If a filter is active the icon will turn blue. The options chosen in each filter will stack on top of each other, allowing for the combining of search criteria. The user can also search based on SSC. This search option will filter on any existing filter options. If no filters are active, it will search the whole catalog.



It is important to note that your catalog is not what the utility is creating the satellites from, rather it is using the catalog to define properties. The satellites are being created from the satellite database file, which is specified on the settings page. By default, the satellite database is the database that comes installed with STK but this can be pointed to any file on your computer as long as it has TLE format. If you try to add a satellite from the “database” option and you get the following error “<SSC#>- Could not load from database”, it is likely because your database file does not contain the same SSC information as the catalog. In this case check to make sure that there is an entry in your database for the given SSC.

The tool will change several properties of the satellite to match fields in the catalog. This includes changing the satellite color, changing the frame representation, and changing the name to match the common name or other name if no common name is available. The tool will also add the satellites to their correct constellation, based on user input, and do the same for sensors if there is a FOV specified in the catalog and the "Generate Sensor if Applicable" box is checked. A very important thing to note is that the tool not only brings in new satellites based on TLE data but also replaces existing data if required. The tool will determine if the satellite in question is already in the scenario and if it is then it will replace the TLE data without recreating the satellite from scratch. This preserves any custom settings that the user may have set earlier in the design process.

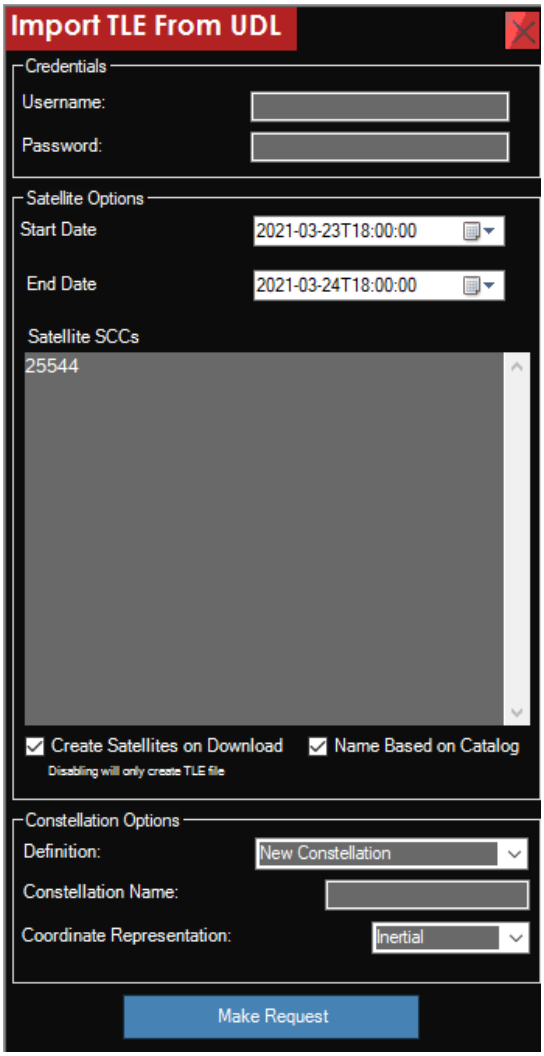
IMPORT FROM EPHEMERIS

The Import from Ephemeris option provides a quick way to import an ephemeris while also setting constellation and frame representations. A file will need to be selected from the browse option, denoted by an ellipsis button. The name of the satellite will correspond to the name of the imported file, but without the extension. If Time-Slip is enabled then the time will pre-populate with the scenario start time. An error will be thrown if you do not insert a valid slip time. The constellation options are available at the bottom of this page the same way they are for the other import options (discussed above).

IMPORT TLE FROM UDL

Note: This tool requires an STK Professional license

The Unified Data Library (UDL) is online data library that contains various data that can be used inside STK. This is tool specifically designed to download TLE files from the UDL database. It is important to note that you will need to request a UDL account before being able to use this tool. Additionally this tool can be used in both unclassified and classified environments. By default the tool will be configured for unclassified use, but this can be changed by modifying the UDL URL that is shown on the settings page. If you are working in a classified environment and need the high-side address please reach out to obtain this address. When the tool is opened it will look like the image below.



The top section of this page is for the user's UDL credentials and these will be user specific. If you use the wrong username or password an error (unauthorized) will appear when you make the request. Any satellite that will be imported will be specified in the "Satellite Options" section of the page. The time frame specifying when you want TLE data for the specified satellites. By default, both the start and end date will be the current time as specified by the computer. These dates and times should be modified for the particular scenario. Using the default settings will pull in the latest data. If no data is found for a particular satellite, while using the current data/time, try moving the start time backwards by a day or so. It is possible that new data is not available for the current day and the last available update was from the day before. There is a convenient date picker to make this easier. The text box in the center of this window is where all SSC number are specified. The SSC numbers can be separated by a comma, tab, or new line character. It was designed this way such that a string can be copied and pasted into this box every day to update all satellites in the scenario quickly. If the satellite already exists in the scenario it will only update that satellite with the new TLE information and will not change other satellite properties in any way.

When a request to the UDL is made, by clicking the "Make Request" button, the plugin will attempt to pull data for all specified satellites in the given list for the specified time period. If there is a problem with the import then an error will appear specifying the SSC number that has an issue. If there is valid data from the UDL a TLE file will be written in the scenario directory and the satellites will also be created using the same information. There is a checkbox to not create the satellites in the scenario and only write the TLE file. This can be useful if you want to update the TLE files without bringing heavy objects into the scenario itself. If the 'Name Based on Catalog' checkbox is enabled, the imported satellites will use the name specified in the Satellite Catalog (see Satellite Creator documentation). If this option is not selected, or the satellite desired is not

in the catalog, the name of the satellite will be in a format of the SCC number followed by the source of the data, which is typically 18th SPCS.

The constellation options at the bottom of this page follow the same rules as the constellation options discussed in all of the previous sections. These settings will be applied to any satellite that gets imported from the UDL. If a satellite is not created when the request is made then these settings will be ignored.

UBTAINING UNCLASSIFIED UDL ACCOUNT

The Unified Data Library was made and maintained by the company BlueStaq. As a result the login credentials must be obtained from them. Credentials are requested from the UDL storefront, which can be accessed via the link below.

UDL Storefront: https://unifieddatalibrary.com/storefront/#/login?returnUrl=%2Ffirst-time%3FreturnUrl%3D%252F

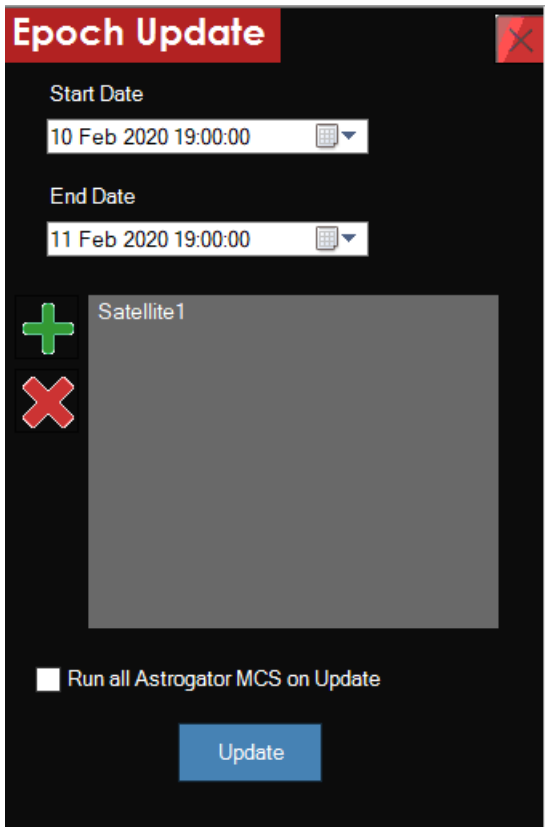
When on this page you can click “Request Account” to fill out the required information. Making an account is free and provides a lot of extra benefits beyond this plugin. The UDL hosts a large variety of data that could be helpful for different portions of your mission. When you get a UDL account it is highly recommended to browse the storefront.

If you are looking for a classified UDL account, and have the ability to access it, state this in your message when requesting your account. Someone from the Unified Data Library will contact you will more details.

SATELLITE EPOCH UPDATER

NOTE: The "Run All Astrogator MCS on update" option requires an Astrogator license.

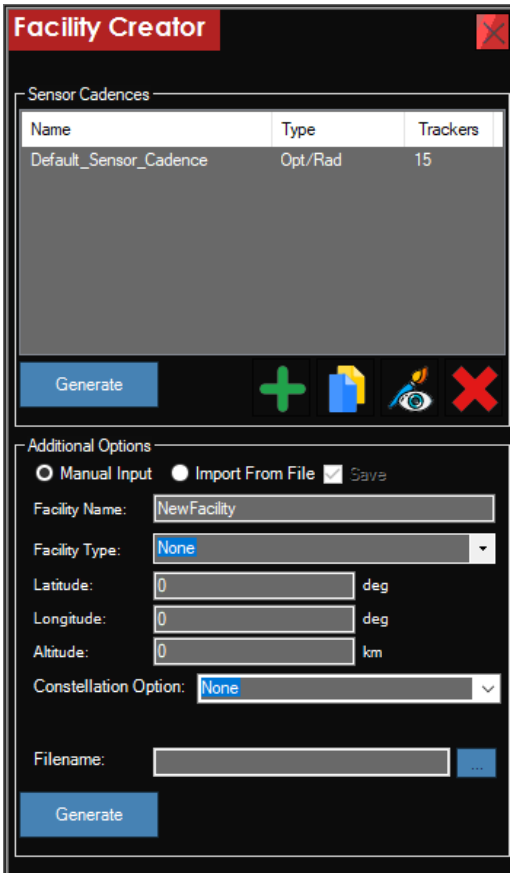
There are many instances when the scenario analysis interval changes but the object availability interval does not change with it. The Epoch Updater is a simple tool that allows the user to quickly update the availability times for any satellite in the scenario, including Astrogator satellites. This tool is not applicable to any other object type except satellites. The new updated start and stop times are specified in the boxes at the top of this window. There is also a date picker to help expedite the process. All available satellites will be listed in the main window in the middle. To update a satellite it must be selected in this list and then added to the update list by clicking the green "plus" button. When a satellite is selected, that line in the list will become bold. Clicking "Update" will change the availability time for each selected satellite, regardless of propagator, and re-propagate the satellite. The only exception to this is any Astrogator satellite. Because there is an infinite number of possible configurations for a MCS, it is difficult to pinpoint exactly how to update the time frame of an Astrogator satellite. Instead, the option was added to "Run all Astrogator MCS on Update". If this is turned on then any selected Astrogator satellite will be run instead of updating the availability times. This should be used with caution as each MCS is different, so check the message viewer for any possible errors in the propagation.



FACILITY CREATOR

NOTE: This tool requires a STK Professional license

Facility Creator allows the user to save and modify sensor cadences. Sensor cadences, in this sense, are defined as a set of radar or optical trackers that make up a whole tracking network. This tools not only creates the site locations, but also creates the attached sensor objects will all the required constraints. The tool also allows the cadences to be saved to a database so they can be used in any scenario once they are originally created. When the tool is opened the window will look like the image on the left.



There are two main sections of the GUI: Sensor Cadences and Single Facility. Sensor cadences are defined as a set of stations, either optical, radar, or both, that will be used in the tracking process. The Sensor Cadences section displays any cadences that were saved to the database on a previous run. All saved cadence information is stored in the location: C:\ProgramData\AGI\ STK 11 (x64)\Plugins\OperatorsToolbox\Databases. This main window will indicate the type of the cadence and the total number of trackers available. Creating a new cadence will be discussed in detail in the next section. At the bottom of the Cadence section there are five buttons. The “Generate” button will create the selected sensor cadence inside of STK. This will add the facilities, sensors, and corresponding constellations to the scenario. The remaining buttons from left to right are “Add Cadence”, “Duplicate Cadence”, “Edit Cadence”, and “Delete Cadence” respectively. There is no way to undo a delete action.

If it is not desirable to import a whole tracking system and instead only one facility is desired then the Additional Options settings can be used. The Additional Options section uses the same sets of constraints as the sensor cadences but the user is limited to the default constraints in this case. The “Facility Type” will define the constraints either to have none, optical constraints, or radar constraints. The exact constraints used here will be discussed in the next section. There is also an option to add the single facility to a constellation if that is desirable. If the facility has a valid type (i.e. not set to None) then the corresponding sensor will be added to its own constellation if there is a constellation option chosen. Using a facility name that already exists in the scenario will result in updating the existing facility with the settings shown on this page. Clicking the “Generate” button at the button of this section will create the facility, and sensor if applicable, in the scenario.

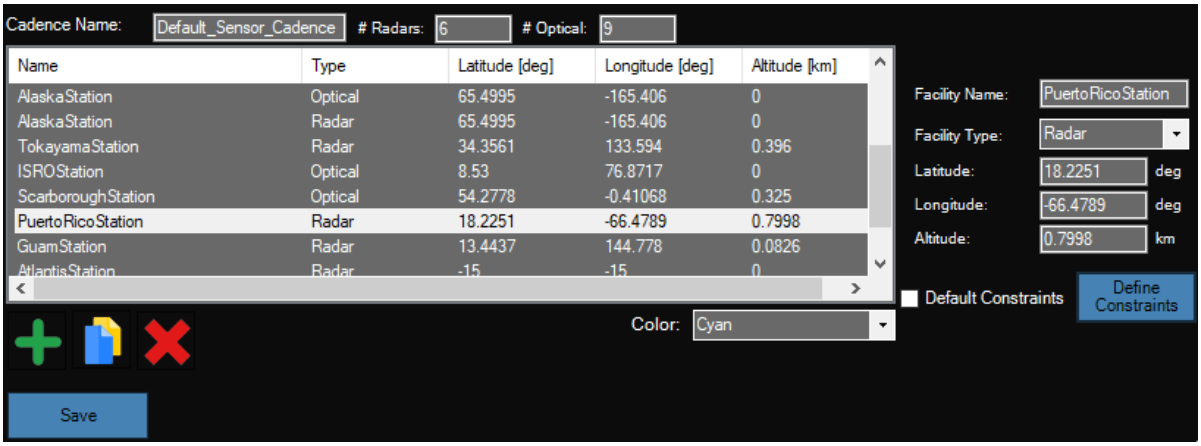
The Additional Options section also has an option to import facilities from a file. This can be enabled by selecting the “Import from File” radio button. This will allow you to browse to a file using the ellipsis button next to the filename. If the ‘Save’ checkbox is enabled, the facilities specified in the file will be saved into your local cadence database. The file can be one of two options. The first option is a .json file that follows the format of a normal OT cadence database. An example of this format can be found here: <OT Install>\Databases. The file can also be a text file where each line denotes a facility in the following comma separated format:

<FacilityName>,<Lat>,<Long>,<Alt>

All imported facilities will be assigned the proper sensor and constellation based on the selected option. The .json option will only add the facilities to the database, not create the sites in the scenario.

NEW CADENCE

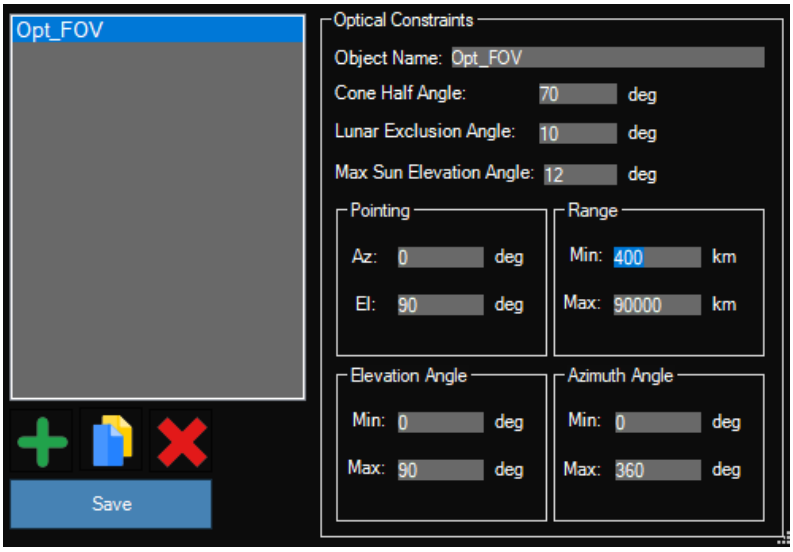
When a cadence is created or edited a window will popup that looks like the image below, however a new cadence would appear with an empty table. The first thing to mention in the “Save to Database” checkbox at the bottom of the window. If checked, any changes made to a cadence (or a new cadence) will be saved to a local database such that they can be generated in any scenario. Unchecking this option will still save the cadence but it will be saved in the local scenario directory. The cadence will still appear in the main Facility Creator GUI, but only for this particular scenario.

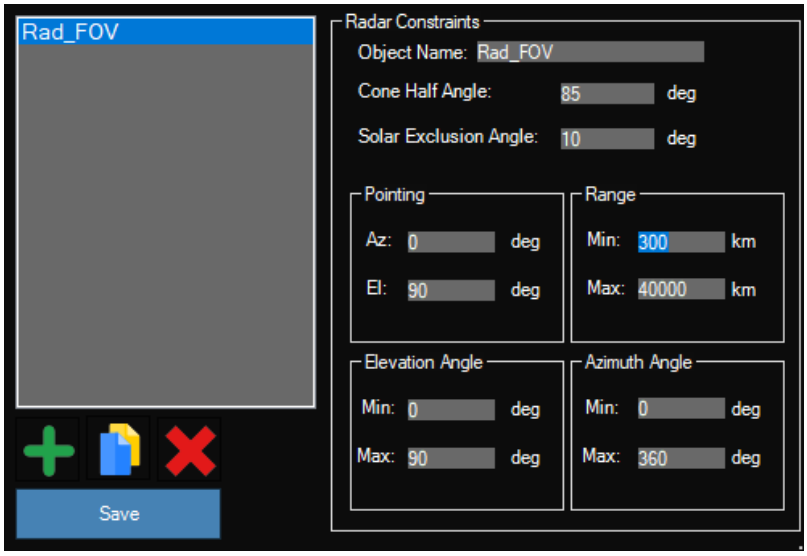


The top of the page defines the name of the cadence and keeps a running tally of radar and optical sites as they are created. The table will show all stations in the cadence along with various information such as sensor type and location. A station can be added to the cadence by clicking the green “plus” button. As with other pages there is also a duplicate facility and delete facility option. Note the duplicate facility option will copy all custom constraints that may be defined. This will add a line to the table and automatically select it. The settings for the selected station will be displayed on the right side of the page. As the values in these settings are changed the values in the table will automatically be updated. The location settings are straight forward and the altitude is referenced from the WGS84 ellipsoid. It is possible to have several stations with the same name. This allows for several sensors to be attached to the same site, with a maximum of one radar and one optical sensor for each station.

The facility type defines the type of constraints that will be applied to the accompanying sensor. There is a different set of constraints for both the optical and radar options. For a new facility the default constraints will be applied for the selected type and the “Default Constraints” checkbox will be checked. These constraint values can manually be changed by unchecking this option and then the “Define Constraints” button will become active. Clicking this button will allow for custom constraint values for a given site. The radar and optical constraint pages are shown below for reference.

The constraints definition page allows the user to specify any number of sensors for each site. A sensor can be added, duplicated, or deleted using the corresponding buttons below the sensor list. There must be at least one sensor on each site. Each sensor contains its own set of constraints. Make sure you do not reuse names on the same site. It will not break if you do, it just wont generate two separate sensors.


Opt_FOV
Save
Optical Constraints
Object Name: Opt_FOV
Cone Half Angle: 70 deg
Lunar Exclusion Angle: 10 deg
Max Sun Elevation Angle: 12 deg
Pointing
Az: 0 deg
El: 90 deg
Range
Min: 400 km
Max: 90000 km
Elevation Angle
Min: 0 deg
Max: 90 deg
Azimuth Angle
Min: 0 deg
Max: 360 deg


Rad_FOV
Save
Radar Constraints
Object Name: Rad_FOV
Cone Half Angle: 85 deg
Solar Exclusion Angle: 10 deg
Pointing
Az: 0 deg
El: 90 deg
Range
Min: 300 km
Max: 40000 km
Elevation Angle
Min: 0 deg
Max: 90 deg
Azimuth Angle
Min: 0 deg
Max: 360 deg

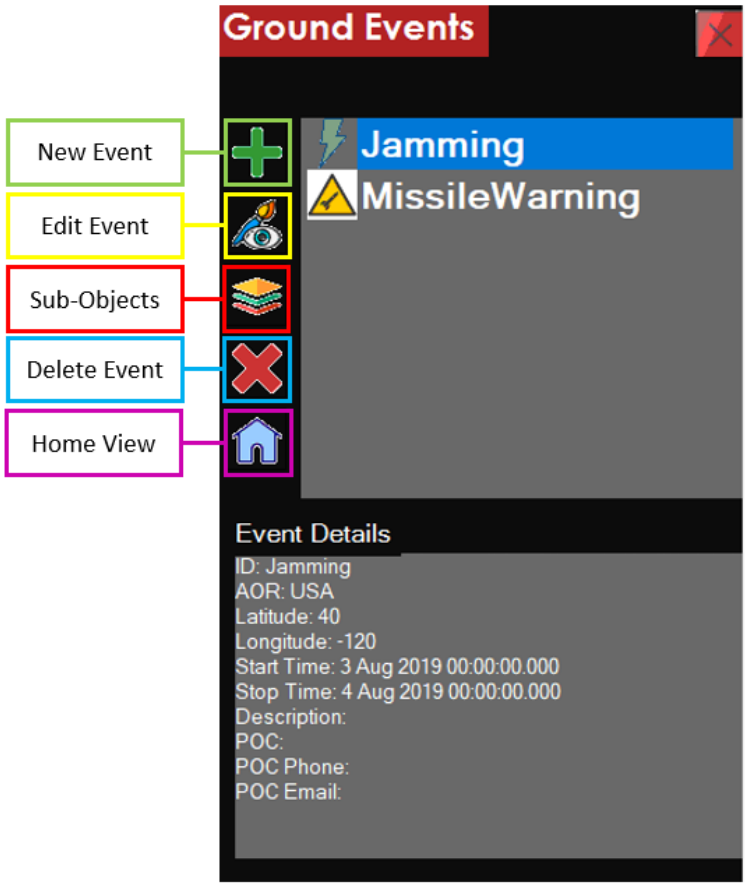
GROUND EVENTS

NOTE: This tool requires an Analysis Workbench License

OVERVIEW

The Ground Events tool serves two major purposes. Mainly it allows the user to classify stationary ground objects into any number of user defined types beyond the three basic types given in STK (i.e. place, facility, and target). This also allows the user to specify specific images to be associated with each type when they are created. These types and images can be set on the Settings page of the main Operator's Toolbox GUI. The second purpose of the tool is to associate a time interval and metadata with a stationary ground object. This helps define a schedule of when events are happening around the globe, and provides an easy interface to see important information.

When the tool is opened the GUI panel will look like the image below. The primary buttons have been labeled for convenience. When the tool is opened a new timeline will be created called "Event Timeline" which serves to house all time components when events are created. The Timeline View will automatically be switched to this new timeline.



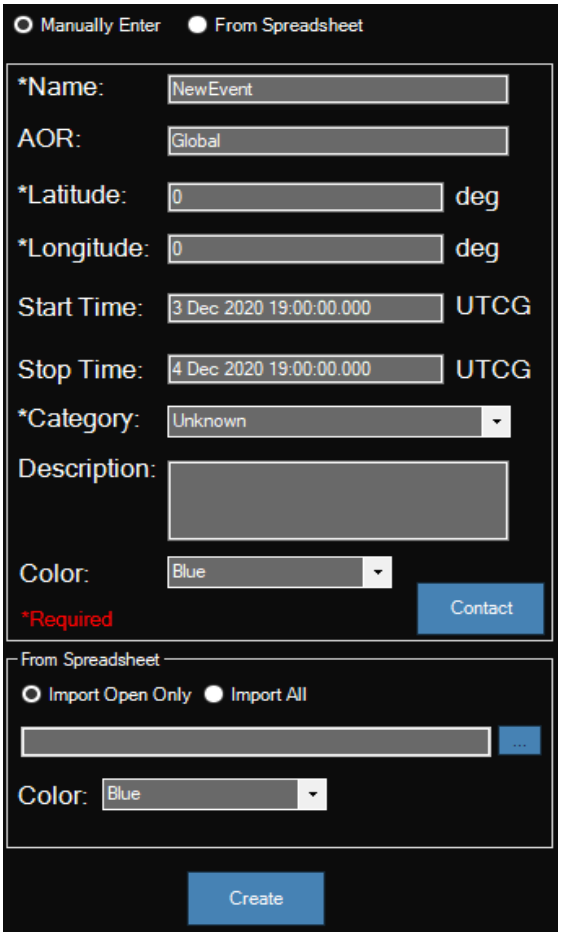
As events get created they will be populated into the top table with their associated name and icon. Clicking an event will zoom to the object in the 3D graphics window and display event information in the bottom section of the tool. Where this data comes from will be discussed in the next section. The one thing to note is that the POC

details can only be populated from the spreadsheet option and cannot be manually added in the GUI. The Home View button will reset the 3D graphics window to the home view. Creating events and adding sub-objects will be discussed in later sections.

When an event is created the information is automatically saved to the scenario directory, even if the scenario is not saved. This serves as an auto-save feature when creating a large number of events. When the tool is loaded it will automatically search for pre-existing events in the scenario directory. If there are events that were previously created in the current scenario then they will be loaded into the scenario.

MANUAL EVENT CREATION

Creating an event manually is the default selection when this page is opened and it will looks similar to the image below. For the event to be created it must, at the very least, have a valid name and a valid latitude and longitude value, in degrees. If a valid start and stop time are not specified it will be labeled as "Unspecified" in the event details and it will not show up in the Timeline View. If the times are valid then a timeline component will be added for the time period specified. To specify event contact information, click the "Contact" button. This will open another form allowing the user to enter a POC name, phone, and email for the event.



IMPORT FROM SPREADSHEET

Importing from a spreadsheet is the most efficient method of bringing in or editing a large number of events at once. To use this feature first select the "From Spreadsheet" radio button located at the top of the page, which will allow you to select a file path for your spreadsheet. You can either type in the path directly or click the ellipsis to browse to the file. A sample spreadsheet is provided in the install. You an import only "Open" events or all events by toggling the radio buttons below the file path. Importing open events only will not load any events with a status of "Closed". All imported events will be changed to the color specified in the dropdown.

If you wish to specify your own file the format is critical to have the events loaded correctly. The sheet must have at least 22 columns with the 21st and 22nd column being the latitude and longitude, respectively. The event information should begin in row 3, with the first two rows being empty and column headers respectively. Most of the data entries can theoretically be left blank if desired but a few entries MUST be specified for each event. For a line to be read in correctly there must be a valid event#/ID and a valid latitude and longitude value, in deg. If a line does not meet these requirements the utility will inform you that there was a problem reading that particular line. If you do not specify valid times, or no times at all, the time frame will be brought in as "Unspecified" and no timeline component will be created. Additionally, it is important to match the Category/Type to an option in the types list (located on the settings page). The category in the spreadsheet must be the same as the option in the type list or it will be brought in as type "Unknown". To change

the type, you can always go back into an event and edit it manually if this happens or you can ensure that the spelling syntax is the same in the type list as in the spreadsheet.

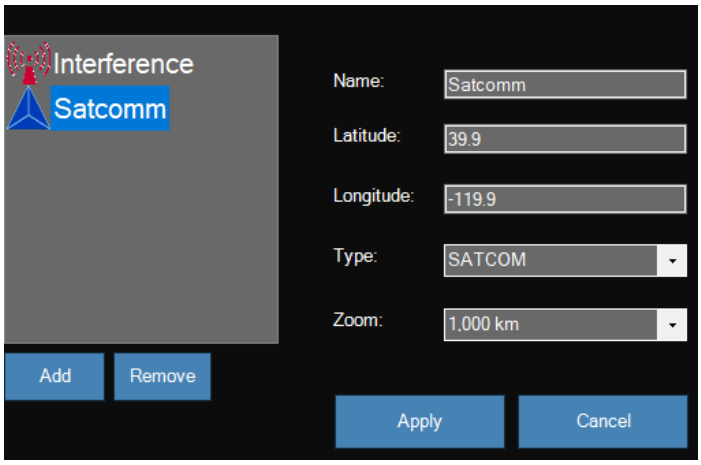
The import from spreadsheet option also gives an easy tool to update every event in the scenario. When you load in events from a spreadsheet it will automatically check if any event in the spreadsheet is already available in the scenario. If the event already exists it will update all of the existing properties with the properties in the spreadsheet. This is a quick way to update all the metadata associated with an event.

EDIT EVENT

To access the edit menu first select an event in the main GUI window and then click the "Edit" button. This will open up the edit menu for your currently selected event and the display will look similar to the image below. The form almost exactly matches the manual import page and gives you the same edit options. The form will be pre-populated with the established information for your event. Changes on this page will only applied to the event after you click the "Apply" button. Changing the times to an invalid time will result in the time component getting removed from the timeline. The latitude and longitude values must remain as valid degree values.

INSERT SUB-OBJECTS

Inserting Sub-Objects gives an extra level of detail to any given event. Sub-Objects can be added by selecting an event in the main GUI panel and clicking "Sub-Objects". This will bring up a window similar to the one shown below. Click the "Add" button to add a new sub-object to your chosen event. Each sub-object can have its own location and type that is separate from the parent event. Clicking the "Remove" button will remove the currently selected sub-object from the list. The zoom level specifies when you will be able to see the sub-object as you are zooming in with the camera. A higher zoom value means that you will be able to see these objects from a higher camera altitude.



Sub-objects can be re-loaded from a previously saved scenario with an event file; however, there is currently no way to add sub-objects from a spreadsheet like you can with the parent events. Removing a parent event will also remove all of its children sub-objects from the scenario.

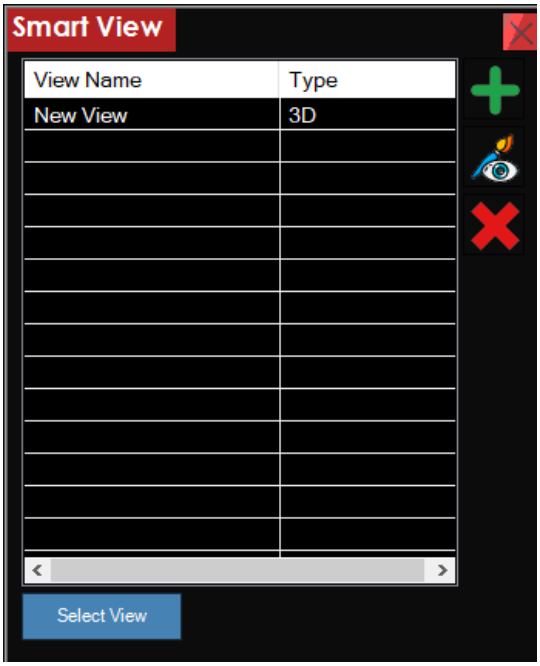
SMART VIEW

NOTE: Most functionality can be used on STK Free. Analysis Workbench required for proximity plane

Smart View is meant to boost the capabilities already found in the default stored views. A default stored view allows a user to save a camera position, time, and timestep. A smart view allows a user to not only include those features but also data displays, universal lead/trail settings for moving vehicles, and options to hide or shows groups of objects and vectors with each view. There are also new built in view types for the 2D graphics window.

MAIN GUI WINDOW

In the main GUI window there are several buttons that need to be explained. The image below shows the main GUI for this tool, with the key buttons on the right side of the interface.



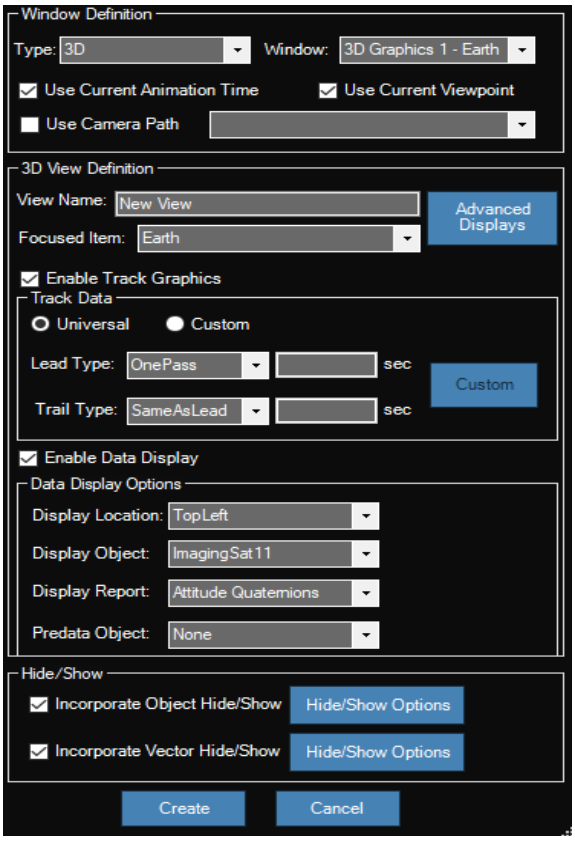
You can create a new view by clicking the New View button, denoted by the plus icon. The specifics of this will be discussed later. When you create a new view, it will be populated into the list on the left. The list also shows whether the view is a 2D or 3D view. To switch to a view select it in the list and then click the “Select View” button. Clicking “Edit View” will open an edit window for the currently selected view. Clicking the “Delete” button will delete the selected view and there is no way to undo this.

Also note that once views are created, they can be selected from the Smart View dropdown when the icon is pressed on the main Operator’s Toolbox toolbar.

CREATE A NEW VIEW

When you click the “New View” button on the main GUI it will open a pop-up panel to define your view. There are four different view types to choose from and they can be toggled by settings the Window Definition->Type. Additionally, each view can be applied to a particular window. All available windows will be populated in the Window dropdown. If the 2D view option is selected then the populated windows will be the 2D window names instead. Each view’s settings will be discussed in the following sections.

3D VIEW TYPE



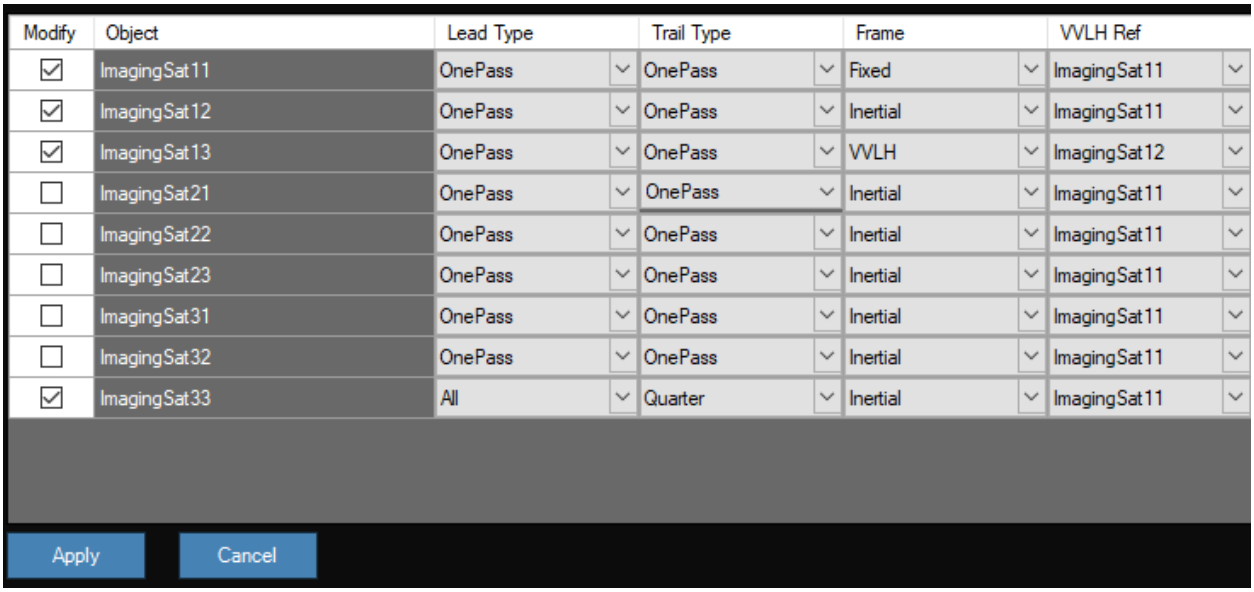
The 3D view gives the most versatility when creating a new view. Selecting “Use Current Animation Time” and “Use Current Viewpoint” together is the same as creating a normal stored view. This will save all of your view settings as a normal stored view would. There is also an option to tie the view to a camera path. If this option is chosen, the current viewpoint option will not be available and a valid, existing camera path must be selected. Using a camera path not update the timestep by default. To change the timestep, use the timestep override on the Advanced Displays page.

The view must be named in the 3D view Definition. This name should be unique and can contain any characters of your choosing. The “Focused Item” is the object that will be zoomed to when the view is executed. If “Earth” is selected the resulting viewpoint will be the Home View. The focused item is irrelevant if “Use Current Viewpoint” is selected.

There are several options that fill up the rest of the display. These will be discussed in the following sections.

Track Graphics

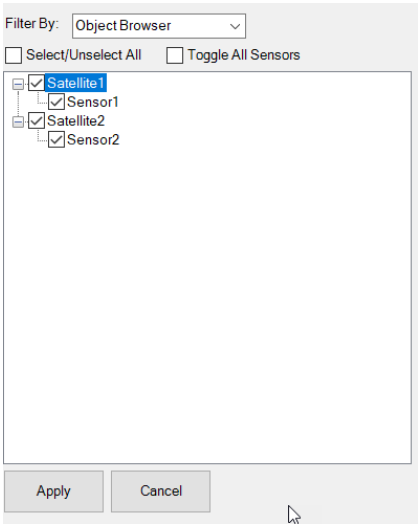
Track options are applied to the particular window of interest. It will also turn off track graphics from other frames that are present in the same window (on satellites only). The Universal Orbit Track option can be enabled by selecting the “Universal” checkbox. These settings are similar to those found on the 3D Graphics->Orbit page of a satellite’s properties. The difference here is that the options chosen will be applied to all moving objects in the scenario. This includes satellites, aircrafts, missiles, launch vehicles, ships, and ground vehicles. If the custom option is chosen, then the ‘Custom’ button can be used to modify each object individually. This interface will look similar to the image below. You can modify an object by checking the modify checkbox on the left of each line. You can modify the lead and trail options for all object types, and you can also modify the frame representation for satellites. If VVLH is selected, then it will use the reference in the right most box on the line. You can right-click on a box to apply that setting to the whole column.



Data Display

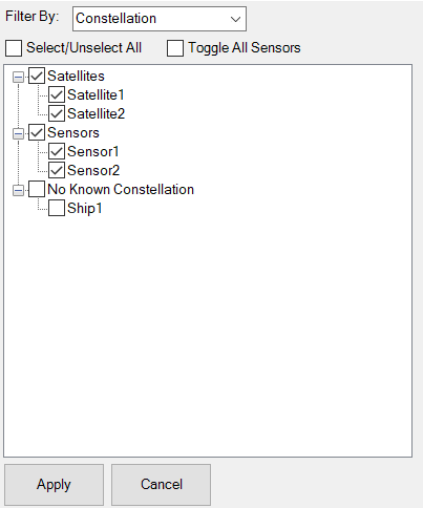
The Data Display option can be enabled by clicking the Enable checkbox. Whenever a view is selected the assigned data display will be turned on. If no data display is assigned to a view then there will be no data display when the view is selected and all previous displays will be removed. The Display Location gives options for nine possible display locations on the 3D Graphics Window. The Display Object is what the data is tied to. Every time the Display Object is changed a new Display Report List will be generated based on the display object's class type. All possible data display options will be displayed in this list. If the selected report requires Pre-Data, such as a reference for RIC, then this can be selected in the Pre-Data field. It is up to the user to know when Pre-Data is required. Typically, it is when the user needs to select an object in the Report and Graph Manager prior to the report generation. This tool does not support reports that require more than one Pre-Data entry.

Object Hide/Show



Object Hide/Show is probably the most powerful functionality available in this plugin. This functionality can be extremely useful for demos, movie making, or other applications where large-scale object toggles are necessary. This functionality is available for all view types. Turn on Object Hide/Show by selecting the checkbox and click the "Hide/Show Options" to bring up the options panel. The page will look similar top to the image on the left, only populated with the objects in your scenario. The toggles at the top allow a user to quickly turn all objects on/off or toggle all of the sensors, which can be useful for many reasons. Whatever selections are made in the list will be applied to the view every time that the view is selected.

To quickly toggle constellations, you can change the Filter By option to "Constellation". This will cause the window to look like the second image in this section. Anything placed inside a constellation object will be appear

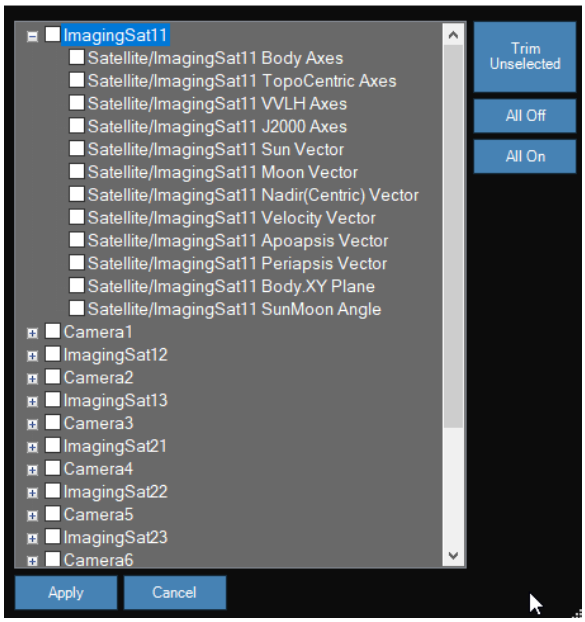


in its own block that can be toggled. This will turn off or on an entire constellation at once. All objects not assigned in a constellation will appear under the “No Known Constellation” section.

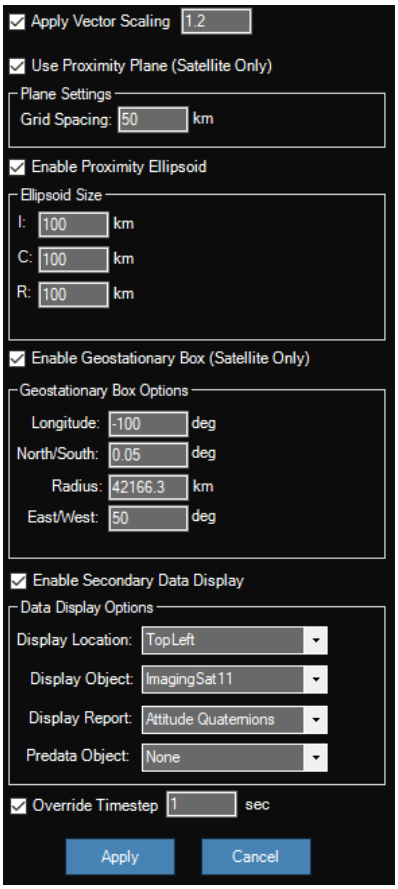
Vector Hide/Show

Turn on Vector Hide/Show by selecting the checkbox and click the “Hide/Show Options” to bring up the options panel. This will look similar to the following image. The display will list out all objects in the scenario. Under each object you will find a set of VGT components listed out. These options are populated from the 3D Graphics->Vector page of the object’s properties. If you want to use custom components, then add the components to the object’s 3D Graphics->Vector settings page. Once they are added on that page, they will appear in Vector Hide/Show. Because there could potentially be a large number of components to toggle on, the “Trim Unselected” button was added. This will remove all unselected components from the object’s 3D Graphics->Vector page (it does not remove anything from AWB). This allows the process to execute much faster and is recommended whenever Vector Hide/Show is being used.

Select the VGT components that you wish to turn on for the view. All unchecked components will be turned off for the view. You can also turn off/on all VGT components by using the buttons on the right-side of the panel.



Advanced Displays



The Advanced Displays pages adds a few additional options for a 3D view. The display can be seen in the image on the left.

The vector scaling option will change the Vector scaling for all components, on all objects. Note that this is a log scale, which is consistent with the default STK VGT scaling options.

The proximity plane option will add the intrack/crosstrack plane for the selected satellite. The selected satellite is the Focused Item on the previous window. This option is only available for satellites. It will also provide grid spacing on the plane, where the ring distances are specified by the textbox on the display.

The proximity ellipsoid will add a graphical ellipse around the focused object, with the specified dimensions. Note that the ellipsoid is in ICR coordinates. This is the same ellipsoid option that be found on the 3D Graphics->Proximity properties page of an object.

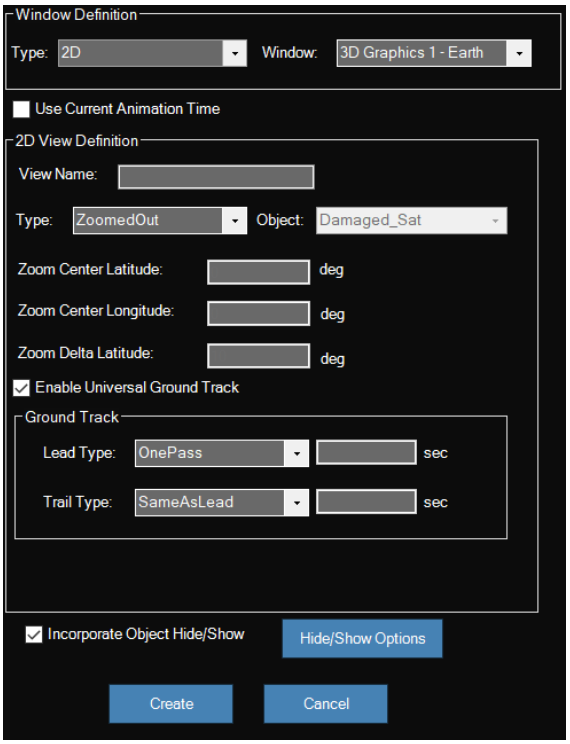
The Geostationary Box is meant for station keeping views. This will create a station keeping box at the specified location and with the specified size. This option is applied to the focused object and can only be used for satellite objects.

The secondary data display works the same way as the primary display. It recommended to use a different screen location than the primary data display. A primary data display is not required to use the secondary display. For more information, read the section above regarding data displays.

The override timestep option will change the animation timestep to the value specified. This will supersede any timestep saved in a current viewpoint.

If this page is opened from the edit menu, there will also be a button to remove a sensor boresight view. If you do not have a sensor boresight view linked, then this button can be ignored. This is discussed later in the documentation for the Sensor Boresight View Plugin.

2D VIEW TYPE



There are several options on this page that are similar to the 3D View type. For example, the Window definition section is exactly the same and you can use the current animation time the same as any other view. Instead of universal obit track settings, the 2D view type offers the Universal Ground tracks which will be applied to all satellites in the scenario. Object Hide/Show is also available for this view point. It is important to note that the Object Hide/Show settings are applied to ALL windows and not just the selected window. This means that wit will be applied to both 2D and 3D graphics windows.

There are three main options with 2D view type. The type can be changed by switching the "Type" dropdown in the 2D View Definition. The first option is "Zoomed Out". This option will change the 2D graphics window to the default view, which is all the way zoomed out so you can see the whole map.

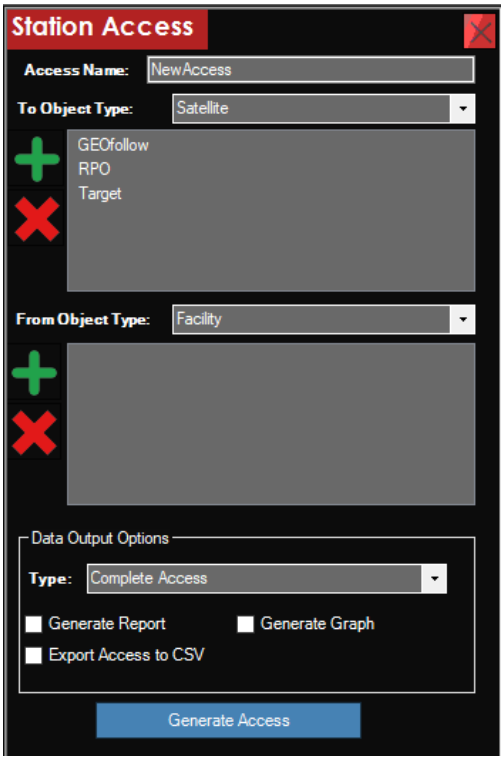
The second option is "Specify Center". This allows the user to specify a specific latitude and longitude position to zoom to when the view is executed. Additionally, the zoom level can be specified by changing the "Zoom Delta Latitude". A lower delta will result in a more zoomed in view.

The third and final option is "Object Center". This allows you to specify an object in the scenario to zoom to when the view is executed. If the object is moving it will not track the object, it will only zoom to the object's position at a given time. Additionally, you can specify the Latitude Delta for this option as well to control the zoom level.

GROUND STATION ACCESS

Note: This tool requires an STK Professional license

The Station Access tool serves to expedite the process of creating large scale access computations that involve constellations and single link chains. The tool will not only create the chain and constellations if required, but also add any time components to the time view, export data, or create access reports if required. For normal 1v1 access it is still recommended to use the default STK access tool. When the tool is opened the GUI will look like the image on the left. The first thing to mention is the Access Name which is specified at the top of the window. This will be name associated with the chain and any constellations that are created in the process. Clicking Generate more than once for the same access name will result in a refresh of that particular access. If assets or data output types are changed between runs then the settings will be updated for that given access. If an access name has not been used before then the components required for the access will be created.



As with any access calculation it is split up into the From objects and the To objects. Any number of objects can be selected from each section. If more than one object is select for either From or To then a constellation will be created for that group. A chain will be created to link all From and To objects. The type of object can be defined by the filter dropdown for both the From Type and the To type. Objects can be added to the computation by selecting them in the list and clicking the green “plus” sign next to that group. The line will become bolded once it is selected. Similarly an object can be removed from the computation by selecting it in the list and clicking the delete button. Multi-select is available for these panel. The only exception to this is when the constellation option is chosen. In this case only one object can be chosen. While this tool was originally designed for station access, the constellation option allows the user to use this tool with any object type or group by placing them into constellations beforehand.

The data output options control how the access will be computed and what data will be displayed. There are two options for data output: Complete Access and Individual Object Access (i.e. Strand Access). Regardless of which option is chosen the corresponding time components will be added to the timeline as soon as the access is generated. If Individual Object Access is chosen then each strand access will be added to the timeline view. Additionally, there are checkboxes to either generate an access report, graph, or export the resulting intervals to a CSV file in the scenario directory. The data will correspond to the data output type chosen.

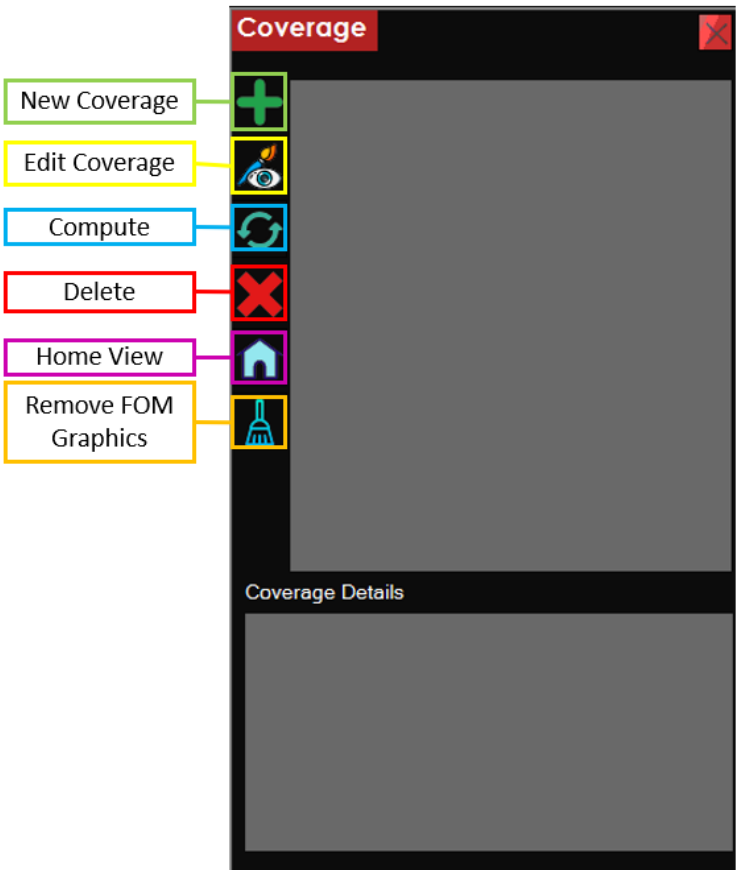
COVERAGE

NOTE: This tool requires a Coverage and STK Professional license

The Coverage Utility serves to expedite the process of creating coverage definitions and figure of merits. It will create the coverage definition and figure of merit for the user along with settings common user settings and configuring the FOM graphics based on the FOM type. There are built in options for global coverage, Country/Region (with custom user area targets as an input options), and Object Area of Interest coverage. Object AOI coverage is new to this tool and allows the user to specify any number of ground objects as centers for coverage areas, along with their defining area around the centers.

BASIC OVERVIEW

The coverage tool is meant to provide an easy interface to create and manage coverage definitions in the scenario. The tool includes a large variety of built in options along with the ability for full customization. When the tool is opened the GUI will look similar to the labeled image below.



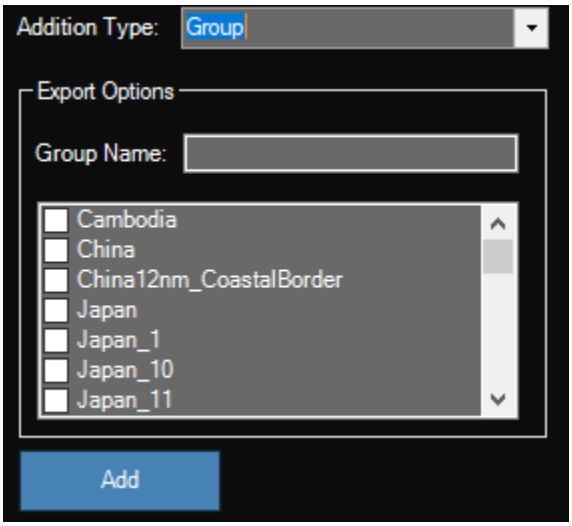
The table at the top of the page will become populated as coverage definitions are created. If there are preexisting coverages in the scenario that were not created in this plugin then they will still show up in the list but there will not be the ability to edit or change those coverages in this plugin. Only coverages defined in this plugin can be edited within the plugin. When a coverage is selected in this list the 3D graphics window will automatically zoom to that location and display a set of metrics to the Coverage Details panel. The details consists of the figure of merit type, the unit, the current animation time, and the overall FOM values at that specific time. Additionally, if the

coverage has already been computed then a legend will appear showing the contour values for the selected coverage. If another coverage is selected all of the data is changed for the new coverage and all previous legends are removed from the window.

To the left of the top table there is a set of five buttons, which are labeled in the image above. The options for “New” and “Edit” coverage will be discussed in the next section. The Delete button will unload the selected coverage definition and figure of merit from the scenario. If there are associated area targets for Object AOI coverage then those area targets will also be removed. All associated assets will remain in the scenario. Because selecting a coverage will automatically zoom to the location, a Home View button was added for a quick graphics toggle on this page. The “Compute” button allows the user to compute the selected coverage in the list. This can be very helpful if small changes were made external to the tool and you want to incorporate that into the analysis result. The bottom button, with a broom icon, will clear all FOM graphics what were generated by this tool that are active on the 3D graphics window.

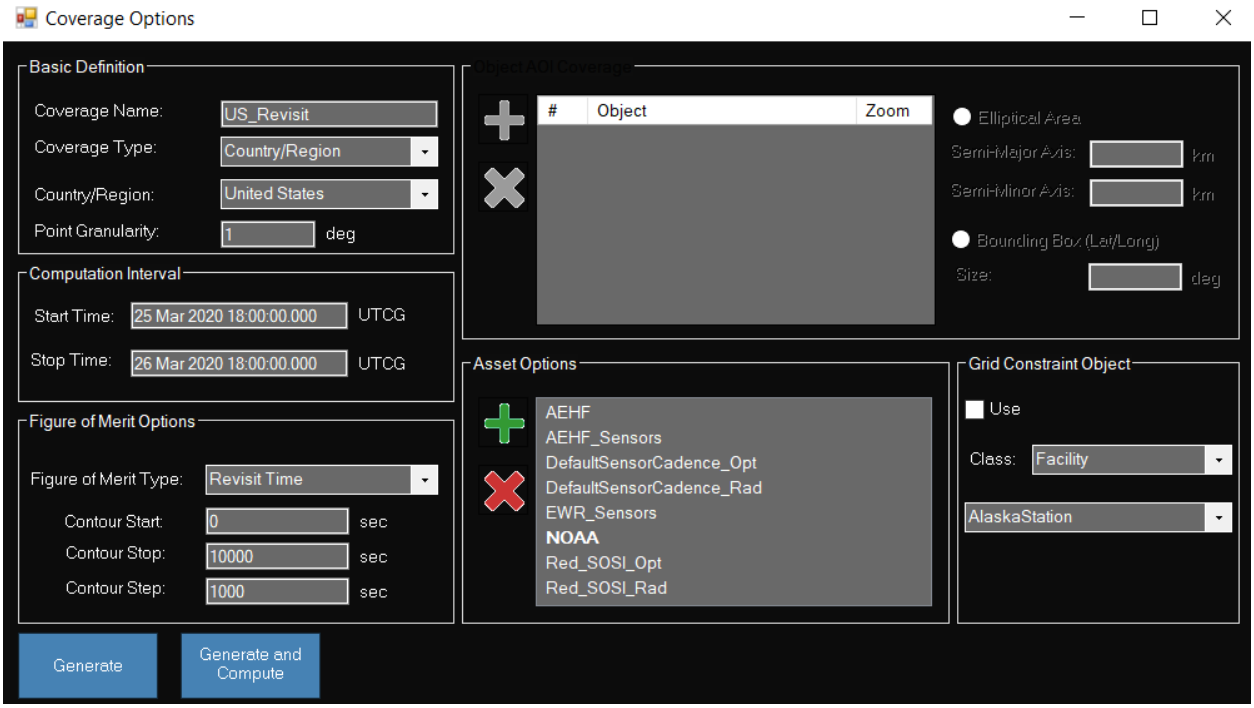
ADDING AREA TARGETS TO DATABASE

To add an area target to the database, you can click the button at the bottom of the main Coverage interface. This will pull up an interface similar to the one below. There are two addition types: single and group. Single will give you a dropdown to choose an area target in the scenario. That area target will be added to the database, with the name based on the existing name in the Object Browser. If Group is selected, you can add multiple area targets into the database at once. When accessing the database in the coverage options, the selected area targets in the group will appear as one entry, with the name specified on the page.



COVERAGE OPTIONS

The options page will appear when a new coverage is created or when a selected coverage is edited. When the properties are opened it will look similar to the image below. Each set of controls will be explained in the following subsections.



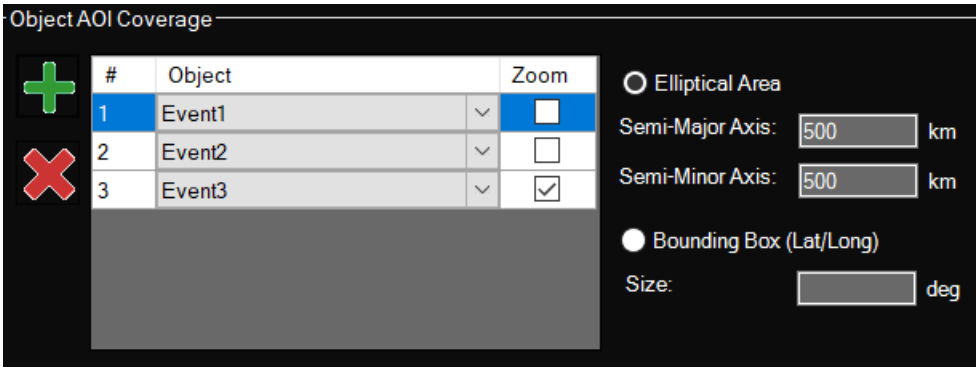
There are a few settings that will automatically be changed regardless of the setting chosen on this page. The option to Automatically Recompute Access is turned off. Instead, use the compute button on the main GUI of this tool. Additionally, the grid points of the coverage definition are turned off. This is for better graphics overlay of the figure of merit.

Basic Definition

The basic definition section sets the overall shape and node density of the coverage definition. The coverage should be given a unique name in the “Name” field. The associated figure of merit will have the naming convention “<CoverageName>_FOM”. The “Coverage Type” field defines the type of coverage that you would like to create and there are three types: Object AOI, Country/Region, and Global. Each of these types and their settings will be explained in the following sections. The point granularity defines how close the grid points will be from each other in degrees. The default value for this is 1 degree, unless Global is chosen and then it will default to 6 degrees.

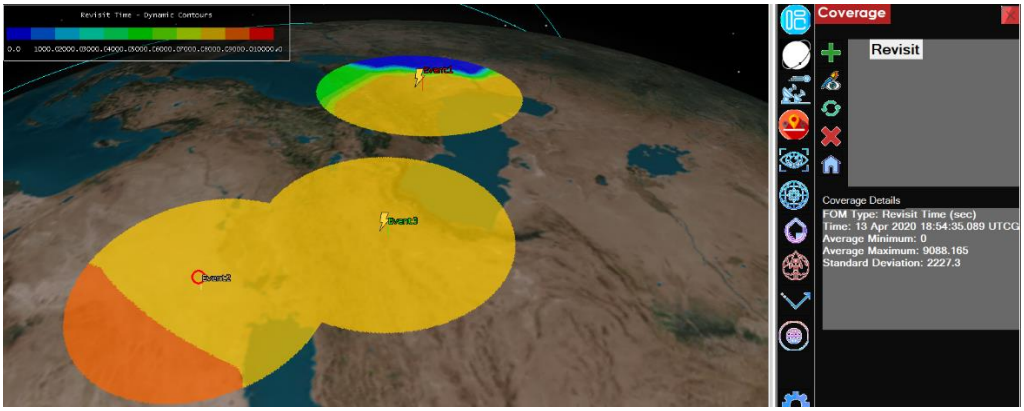
Object AOI Coverage

Object AOI coverage is a new way to consider grouping together and organizing coverages. The goal of Object AOI coverage is to provide an easy way to center a coverage definition on a pre-existing ground object. The tool also allows the user to center on multiple ground objects and have those areas be considered in the same coverage definition. The options for this will become available when the coverage type is set to “Object AOI”. When this is set the options of Object AOI coverage will become available in the upper-right corner of the page and it will look similar to the image below.



The table on the left defines all of the area target centers that you would like to associate with this coverage. This table will not be populated if this is a new coverage but new lines can be added or deleted from the table by using the buttons to the left of the table. Every time a line is added there will be an option for the object and the zoom. The object defines the center of that area and the dropdown will contain all objects in the scenario of type facility, place, or target. The zoom defines what object will be zoomed to when the coverage is selected from the main GUI. There can only be one object selected at a time and previous selections will be removed when the option is changed. If no object is selected as the zoom object then the view will default to a Home View.

The options to the right of the table define the size of the area around each object in the table. The values here are applied to all objects in the list and the areas can either be defined as an ellipse or a bounding box. If ellipse is chosen then the user will be prompted to add a semi-major and semi-minor axis in km. The semi-major axis points north-south and the semi-minor axis points east-west. If bounding box is chosen then the user is prompted for a size in degrees. This is the size of the box in degrees latitude and longitude away from the center. Using the settings in the above image would result in a coverage similar to what is shown in the image below.



Country/Region Coverage

Country/Region coverage can be selected by changing the coverage type in the basic properties of this page. When this type is selected the Country/Region dropdown will become available. This will allow you to select your country/region of interest. The items listed here are based on the AOIs.csv file that is located in the main plugin directory. The direct path for this can be changed and redirected on the settings page. The options that show up in the list are defined by each line in the csv file. To add new options to the list first add a line to the csv file with the name of the area. Additionally move the area target files (.at, .at3) for that area target to the database directory, which is typically found here: C:\ProgramData\AGI\STK 11 (x64)\Plugins\OperatorsToolbox\Databases\AreaTargets The name of the target files must be the same as the name in the csv. The only exception to this is spaces. Spaces

are accepted in the csv and the area target files should still have the same name but with the spaces replaced with underscores.

Global Coverage

Global coverage works exactly the same way as Country/Region coverage except you do not need to select an area of interest. By default, it will create a global grid that has points 6 deg apart. Be careful decreasing the point granularity for a global coverage as it can lead to long computation times.

Computation Interval

The start and stop time specifies the time period that coverage data will be computed for. If you are computing a very large or lengthy coverage calculation it will likely take a long time to compute. If you do not want to wait as long, you can consider changing the times in this section to decrease the computation time. Times are only accepted in UTCG format.

Figure of Merit Options

The figure of merit (FOM) defines what kind of data you would like to visualize on the globe. There are eight options built in to the plugin, but all options are available in the FOM properties which can be accessed from the object browser menu. The contour start and stop values give boundaries for the graphical display and step value defines the number of different colors will be displayed in the gradient. A default set of contour values will be pre-populated when the type is changed but you may wish to modify these specifically for you data. Default colors of blue to red will be assigned to visualize the data but they can also be changed in the FOM properties if desired. The eight FOM types will be described in the table below.

Type Name	Description
Coverage Time	Coverage Time measures the amount of time during which grid points are covered. Because Coverage Time does not have a dynamic definition, no time-dependent information is computed. Calculated as percent of overall computation interval. Static contours
Revisit Time	Revisit Time measures the intervals during which coverage is not provided (also known as "the gaps"). The dynamic definition of Revisit Time computes the duration of the current gap in coverage for each grid point. If a grid point is accessible at the current time, the gap duration is computed as zero. Dynamic contours
Navigational Accuracy (PACC)	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 on board Global Positioning System (GPS) satellites. If four or more of these satellites are in view of a ground receiver, a navigation solution consisting of the position of the receiver and the offset between the receiver clock and the GPS clock can be

	computed. Measures only the accuracy associated with the positional portion of the navigation solution. Dynamic contours
Dilution of Precision	Dilution of Precision (DOP) measures the relative degradation or reduction in the certainty of a navigation solution based on one-way range measurements from a set of transmitters. Most often, the transmitters are those on board Global Positioning System (GPS) satellites. If four or more of these satellites are in view of a ground receiver, a navigation solution consisting of the position of the receiver and the offset between the receiver clock and the GPS clock can be computed. Measures only the dilution of precision associated with the positional portion of the navigation solution. Dynamic contours
N Asset Coverage	N Asset Coverage measures the number of assets available simultaneously during coverage, where N is between zero and the total number of assets defined in the coverage definition. Dynamic contours
Simple Coverage	Simple Coverage measures whether or not a point is accessible by any of the assigned assets. An evaluation of the dynamic behavior of simple coverage computes a value of 1 for points that are currently in an access period and 0 for points that are not. Dynamic contours
Age of Data	Age Of Data measures the time between the end of a coverage interval and the current time. The dynamic definition of Age Of Data is the time since the most recent prior coverage interval ended; it is defined as 0 if the point is currently covered, and as 1000000 seconds if the animation time is prior to the first access period. Dynamic contours
Custom	This allows the user to use the edit abilities of this plugin while using a fully custom FOM. If this option is chosen the FOM will be created if it does not exist already but all other FOM properties are left unchanged. It is up to the user to fully define the FOM.

Asset Options

Assets can be assigned to a coverage in the “Asset Options” section of this page. You can select any number of constellations to compute your coverage but make sure you click the select button for each desired option. The selection will turn bold when it is selected. Constellations are the only object type that will appear in the options. This is to promote easier use with the rest of this plugin. All assets in a constellation are applied to the coverage. When a coverage profile is saved any assets selected or removed, from previous saves, will be applied to the coverage.

Grid Constraint Object

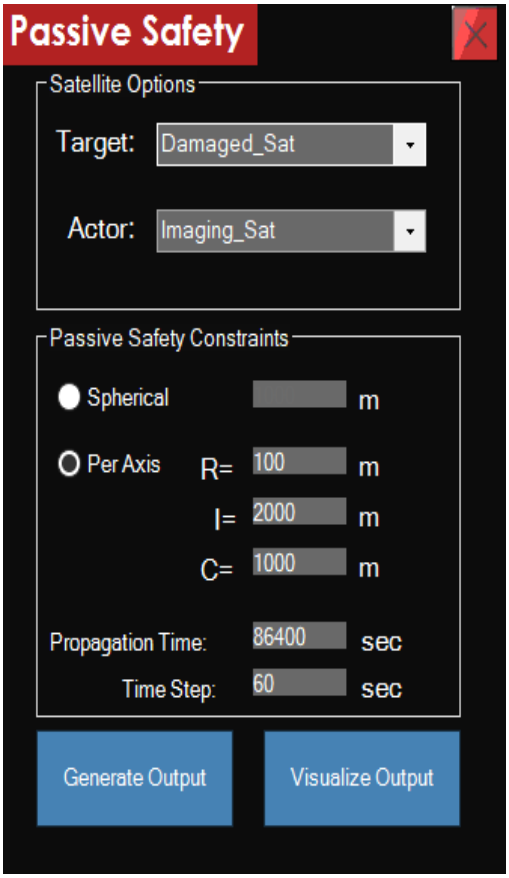
The coverage can include a grid constraint object by selecting the “Use Constraint Object” checkbox. The options for this are defined in the table below.

Control	Description
Constraint Class	Select an object class. For all object classes, the basic properties of the object, excluding positional information, are applied to the grid points. (Note: when using an Aviator aircraft as a grid point, or a child of the Aviator object, the attitude of the Aviator object will be topocentric)
Constraint Object	To assign additional access constraints to the grid points, select the object you wish to use in the constraint object list. By selecting a specific object, all of the properties and constraints that apply to that one object, excluding positional information, are also applied to every point in the grid. Before you select the object in the Instance list, make sure you have set all of the attributes you want to apply.

PASSIVE SAFETY CHECKER

NOTE: This tool requires an Astrogator license

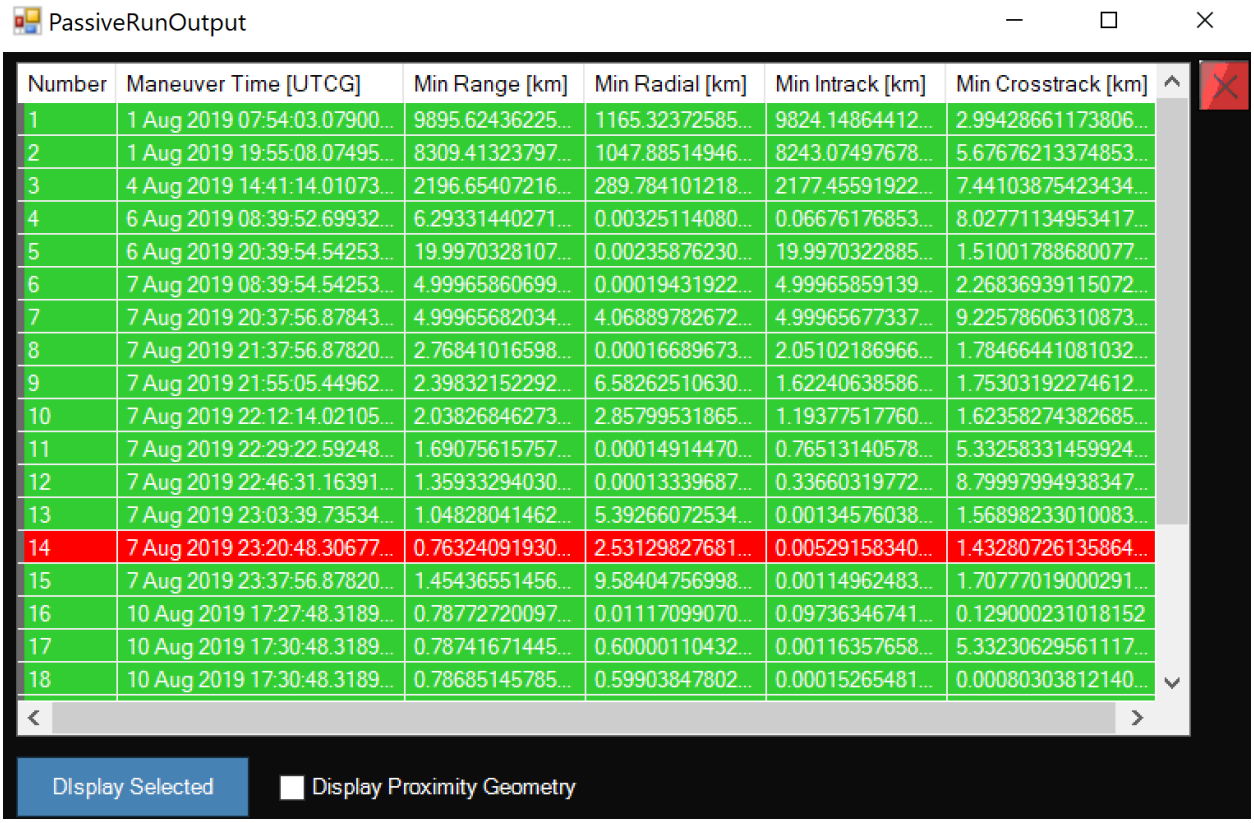
The Passive Safety Checker is meant for use in Proximity Operations or Close approach trajectories. The main goal of the tool is to verify that the acting satellite will not come within close proximity of the target if something goes wrong. Passive Safety guarantees that if something goes wrong with one of the maneuvers, the naturally generated trajectory, without any additional maneuvers, does not come within a specified user volume around the target. The volume of the satellite can be defined as a sphere or a box surrounding the target, with dimensions in the RIC frame. The main GUI for this tool can be seen in the image below.



The Target and Actor satellites must be set to different satellites. You will receive an error message if this is not the case. The “Keep Out Zone” for the target satellite is defined in the “Passive Safety Constraints” section of the tool. The keep out zone can be defined as a symmetrical sphere or a box surrounding the target that is defined in the RIC frame. The Propagation Time defines how long you want to check each passive safety maneuver run and the Time Step defines how often you want to check the data against the required constraints. It is important to note that the generated passive safety trajectory will only be generated for the time specified after the maneuver, not necessarily to the end of the scenario interval. When all of the settings have been set accordingly you can calculate the results by clicking the “Generate Output” button. The “Visualize Output” button will remain unavailable until you have generated output at least once.

PASSIVE SAFETY OUTPUT

The output from the Passive Safety run can be seen and visualized by clicking the “Visualize Output”. This will pull up a new panel that looks like the image below. The table will list out all of the maneuvers for the actor satellite along with the relative minimum position to the target satellite if the next maneuver cannot be executed, as defined above. If a particular maneuver meets the user specified constraints then the line will show up green, and it will show up red if it does not meet the constraints. Each trajectory and set of constraints can be visually displayed in the 3D graphics window by using the options at the bottom of this page. Checking “Display Proximity Geometry” will visually show either a sphere or box around the target, with the size depending on the user specified constraints. The user can select a line in the table and then click “Display Selected” to show the naturally generated trajectory if the next maneuver cannot be executed. Typically the new trajectory line will show up as green and will only be seen for the propagation time specified on the previous interface.



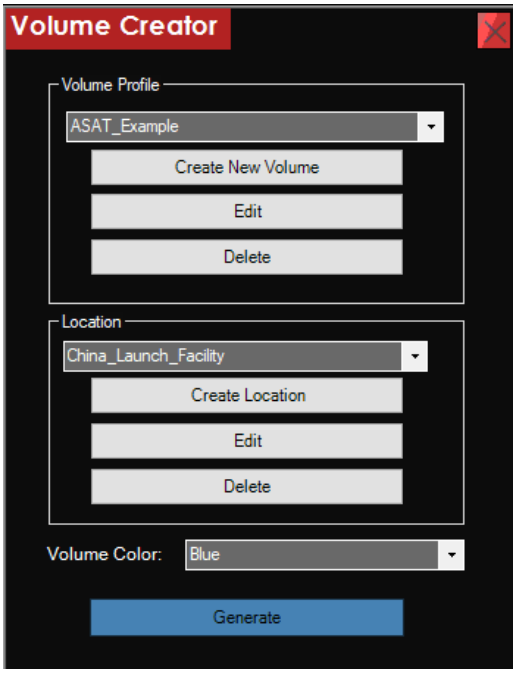
VOLUME CREATOR

NOTE: This tool requires a STK Professional license

The Volume Creator allows the user to create analytical volumes in space based on ground range, altitude, azimuth and elevation constraints. The tool will create the volume at a specified ground location. This can be used for situational awareness, threat assessments, or any other use case involving a 3D keep out zone or area of regard. The tool saves the volumes and locations in a database so they can be used in any scenario after they are initially created.

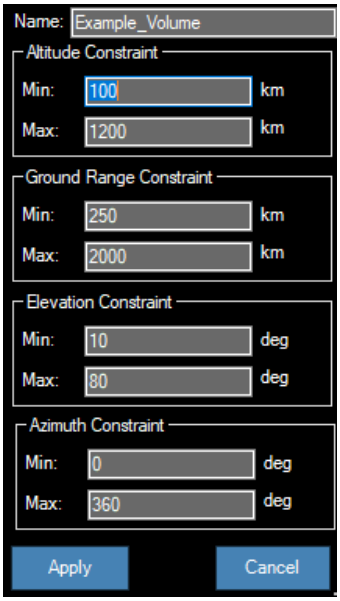
The Volume Creator will create a sensor approximation for an area of regard. The tool was originally designed for an ASAT threat volume, but it can be applied to many other applications. This tool was originally designed to create DA to LEO threat volume and will always provide high-side error around the outer rim of the volume. This is because the sensor approximation assumes spherical behavior at the edge of the volume, when in reality the volume curvature changes as the launch elevation angle changes. For more accurate results the use of a Missile Tool Kit (MTK) Flyout Fan profile is recommended. It is also important to note that graphically the volume will not look correct (as of STK 12.1) because of the altitude constraint. There is a known bug in STK where an altitude constraint cannot visually be seen for a complex conic sensor. Analytically the constraint is applied and the results will quickly show this, but graphically it will never look correct. A fix for this is set to be implemented.

When you open the tool it will look like the image shown below. Every time a volume configuration and launch site location is made it is saved to a database so it can be used in any scenario. For both volume and location configurations there are options to create new, edit, or delete the configuration. When the “Generate” button is clicked the selected volume will be created at the specified facility.



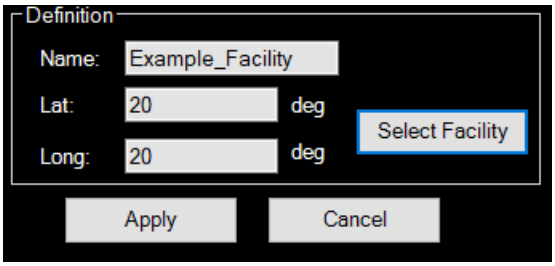
CREATING A NEW VOLUME

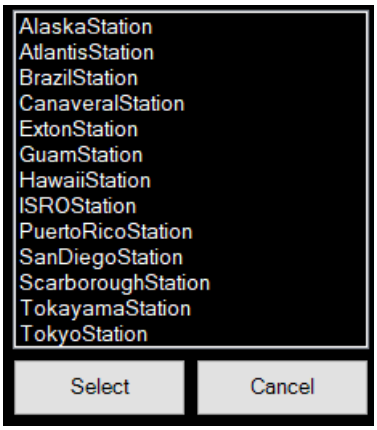
The sensor approximation for the ASAT volume is defined by a set of constraints to represent the maximum range of the missile. These constraints include altitude, ground range, azimuth angle, and elevation angle. When a volume is created or edited a window will appear that looks like the image below. For each configuration these constraints must be set and the volume must be given a name. Clicking apply will add (or apply change to) the volume in the database.



CREATING A NEW LAUNCH SITE

A launch site is based on latitude and longitude and the altitude is based off of the WGS84 ellipsoid. The images below show the GUI for creating a new facility or using an existing facility as the launch site if that is desirable. The use of this interface is very straight forward.

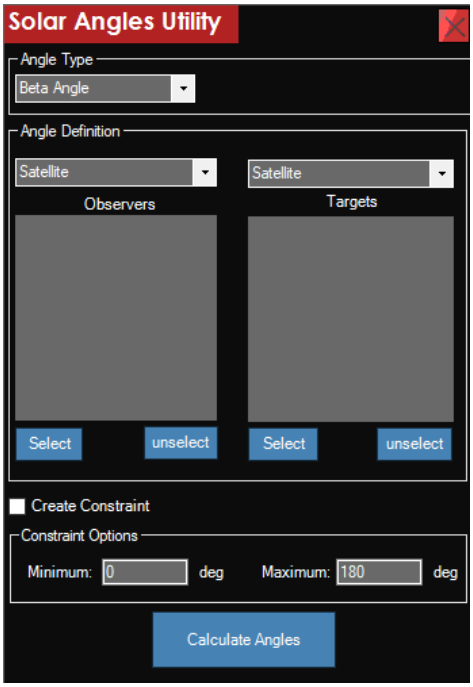


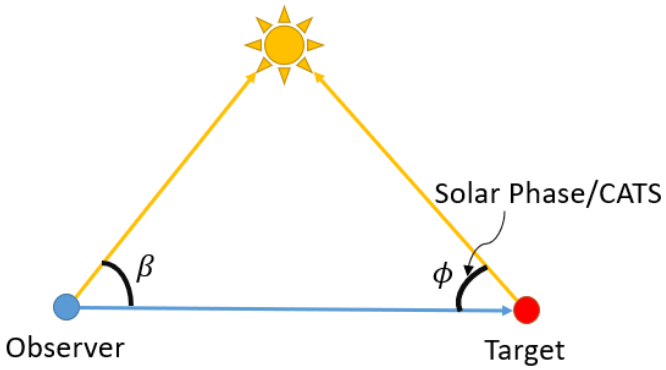


BETA ANGLE CALCULATOR

NOTE: This tool requires an Analysis Workbench license

This tool is designed to calculate the beta angle or Solar Phase/CATS angle between any number of observers and targets. The beta angle and solar phase angle can be defined by the image below. This tool will create all of the Analysis Workbench components required to report out the angle values. When the tool is opened it will looks like the image below. Observers can be of the type satellite, sensor, or facility. The targets can be of type satellite, missile, or aircraft. Changing the dropdown above either list will update the list with the new set of objects. Any number of objects can be selected in both lists and multi-select is available. There is also the option to create a constraint by clicking the "Create Constraint" checkbox. This allows the user to enter a minimum and maximum value between 0-180 deg. This will create a condition in Analysis Workbench that can be used elsewhere in STK. When the "Calculate Angles" button is clicked a set of vectors and angles are created in Analysis Workbench to create the Beta Angle. There will be a displacement vector between each observer and target along with the corresponding angle between that displacement vector and the sun vector located on the observer. There is an acknowledgement when the process is finished.





PLANE CROSSING UTILITY

NOTE: This tool requires an Analysis Workbench license

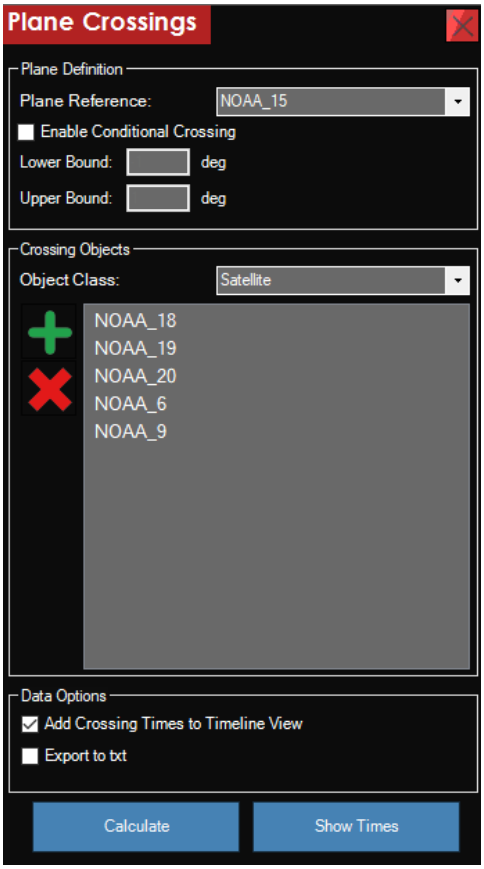
The plane crossing utility is a powerful tool that will calculate all times when any number of objects cross the orbital plane of a specified satellite. The plane reference must be a satellite object, but the crossing object can either be moving or stationary on the ground. Crossing is defined as the time when an object's position vector (defined as the displacement vector between the center of the Earth and the object center) crosses the orbital plane of the reference. The orbital plane is defined as the plane consisting of the reference satellite center point as the origin, the velocity vector as the constraint, and the orbit normal (as defined in STK) perpendicular to the new plane. This tool will create allow required Analysis Workbench (AWB) components to calculate and report out the times for either the exact crossing or a conditional crossing where the user specifies an angle offset from the crossing. The following set of AWB components, listed in the table below, will be created for each combination of crossings.

Component	**AWB Type**	**Parent Object**
Orbit Plane	Plane	Plane Reference Satellite
Angle to Orbit Plane	Angle	Crossing Satellite
Angle to Orbit Plane	Calc Scalar	Crossing Satellite
Crossing Bounds (if Conditional)	Condition	Crossing Satellite
Crossing Times	Event Time Array – Times of Extrema	Crossing Satellite
Bounded Crossing Times (If Conditional)	Event Time Array – Times of Condition Crossing	Crossing Satellite

The following image shows the interface of this tool while opened in Operator's Toolbox. The plane reference satellite is set by choosing a satellite in the Plane Reference dropdown in the top section. In this section you will also find a checkbox to enable conditional crossings. If this is checked, then the ability to specify lower and upper bounds of the crossing becomes available. If this option is chosen, the user will be provided with both the actual crossing time along with the conditional crossing times.

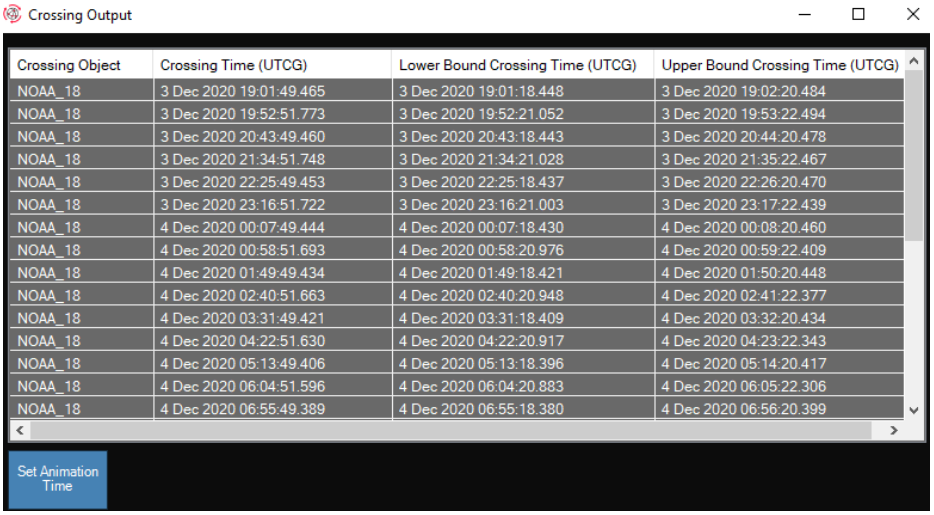
The user can assign any number of crossing objects in the Crossing Objects section. Objects can be added or removed to the calculation by selecting them in the list and clicking the add or delete buttons respectively. The type of crossing object can be changed by changing the object class dropdown. Changing the class will clear the selected list. A separate calculation is required for each crossing class.

There are two data options available at the bottom of the tool: add to timeline and export to txt. If the add to timeline option is enabled, both crossing times and conditional crossing times for all crossing objects will be added to the timeline view. In Export to txt is enabled, then a txt fill containing all crossing and bounded crossing times, along with information about the objects and bounds, will be exported to the scenario directory. The calculation is started by clicking the "Calculate" button. The "Show Times" button is not active until after the calculation is complete. There will be an acknowledgement when the computation is complete.



SHOW TIMES

After a calculation is completed, the Show Times button becomes active to the user. If this button is clicked, it will pull up a popup similar to the one in the following image. The page will display the crossing object, the crossing time in UTCG, and any bounded crossing times in UTCG. If a line is selected and the "Set Animation Time" button is clicked, then STK will jump to specified crossing time.



SENSOR BORESIGHT VIEW PLUGIN

The Sensor Boresight View Plugin will create a new 3D graphics window based on viewpoint of a selected sensor. The interface for this tool can be seen below. The new window will be based on the sensor selected at the top of page. This tool will only allow for simple conic, rectangular, and EOIR sensors. Only sensors of these types will be available as options. The vertical dimension is specified in pixels. The horizontal dimension of the window is determined based on the sensors field of view and type. The view created in the new window will also follow the sensor's pointing configuration. Note that if you use the 'Center' position method for a sensor, the view will likely be inside the parent's model, resulting in that texture filling the view. Move your sensor to a point where the parent's model would not be in the way. This forces the user to use a realistic sensor location.

On top of the created view you can a few different graphical displays. The first option is for a display of latitude, longitude, altitude, and time. This is tied to the parent object of the sensor. The Show Compass option will display a compass in the lower left corner of the screen. The Rulers option will add a graphical ruler of the top and right die of the display. These are arbitrary displays and are not tied to any set distance. There are several crosshair options, if so desired, that will display in the center of the display. There may be times when you wish to point a different direction of the sensor's body frame along the up axis of the graphics window. If this is desired, uncheck the 'Auto Selected Up Vector' checkbox and select our desired axis. Note that Z is the boresight.

There is also the option to tie a sensor boresight view to an existing Smart View. This option is available at the bottom of the page. If this option is selected, all of the sensor view settings will be saved and the same view will be created when the selected Smart View is executed out of the Smart View interface. Once this option has been added to a smart view, it can be removed by editing the view and going to the Advanced Displays page.