FliteScene® 2.7.3
Digital Moving Map Overview

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Contents

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List of Figures

Introduction

This document provides an overview of the FliteScene® digital moving map product. FliteScene provides advanced situational awareness for the most demanding conditions faced by military and civilian flight crews. The wide range of features and flexible configuration provided by FliteScene allows the digital mapping system to support a variety of mission needs for all types of aircraft. These advanced map capabilities are described herein.

The following is a summary of features that are new or enhanced in FliteScene since version 2.6:

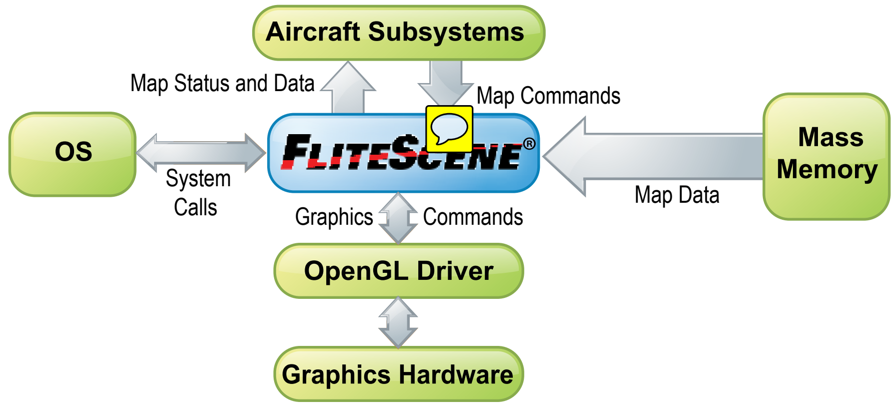
- Bathymetric Data Processing and Overlays
  - Slope Shade, Depth Contours, Depth Bands
  - Depth Query
- Enhanced ECRG: Lower Memory, Better Performance
- Enhanced PDF: Embedded Images
- Enhanced Symbology
  - Time Effectivity
  - JMPS Drawing Files
  - Improved Render Performance
  - Dynamic symbol file loading
  - Symbol File Declutter
- Enhanced Range Bearing: Data Returned via Command I/F
- Enhanced Font Rendering Performance
- Elevation/Depth Re-grid Optimization and Automatic Fallback
- 32-bit and 64-bit compatibility

Note: Some of the features described in this overview are labeled as Beta, meaning that the feature is available in FliteScene, but has not been formally qualified as part of the Harris Formal Qualification Test (FQT) process. For each Beta feature, more feedback is desired from the user community before making it a full production feature.

Environment

FliteScene can be provided as a software library for easy incorporation into applications within an integrator's system, or can be provided as a stand-alone application complete with a comprehensive Bezel Key-style Human Machine Interface (HMI) which can be easily reconfigured via an XML file. *Figure 1* shows the high level interfaces to FliteScene.

FliteScene supports a standard OpenGL interface and can be integrated with Commercial Off-The-Shelf (COTS) processors and graphic accelerators. FliteScene receives messages from the aircraft subsystems that control the map display and tasks to be performed. Responses are sent out to the aircraft subsystems in response to the input command messages and as an indication of FliteScene status. Requests for map data are sent to mass memory. File responses and data are received from mass memory. The interface to the rendering engine (Open GL ES SC 1.0) is used to render the map. The interface to the operating system is used for system services and thread control. The operating systems supported by FliteScene include Windows®, INTEGRITY®, VxWorks®, Linux®, LynxOS®, VxWorks® 653, Android and iOS.



■ *Figure 1—FliteScene environment*

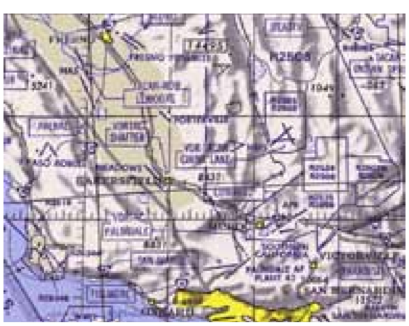
Operational Features

This section provides an overview of the FliteScene features from a functional perspective. The user's interface for command and control of these features varies depending on how FliteScene is used within an integrator's system. A description of the Bezel Key-style HMI used for the stand-alone configuration of FliteScene can be provided upon request.

DISPLAY MODES

FliteScene display modes are commanded by selecting a view, an underlay product (or products for multilayer maps), and a range. The available views are 2D, 3D, data frame, and blank. Underlay products provide the base map/imagery layer and are available in CADRG/ECRG, CIB®, and GeoTIFF (including Street Map) formats at various scales. The range selection allows the user to specify the range of map coverage from top to bottom of the display, when the zoom selection is 1.0. All display modes of FliteScene can be rotated, panned, and zoomed.

With FliteScene 2.7 and up, users no longer need to specify which elevation scale to use for elevation overlay features such as slope shading, contour lines, elevation bands, and Height Above Terrain (HAT). FliteScene will automatically determine the appropriate elevation scale, or depth scale for bathymetric data, to use based on the scale of the selected underlay product and the setting of the REGRID_OPTIMIZATION tag as described in the FliteScene Database Design Document (DBDD). If the desired resolution is not available, FliteScene will automatically attempt to use a lower level resolution (also known as Automatic Elevation Fallback).



■ *Figure 2—2D view, with CADRG 1:5M underlay*

2D View

2D view renders the map in plan view, as a paper map would normally be read. The underlay products that can be viewed in this manner are CADRG/ECRG, CIB®, Street Map, GeoTIFF, and Digital Terrain (see "Map Underlay"). Various map overlays can also be viewed (see "Map Overlays").

Figure 2 shows a CADRG 1:5M map in 2D view.

3D View

3D view renders the map in perspective view, as if the user were looking at the actual geographic area. Map images can be draped over a 3D rendering of the terrain. 3D view is offered in two options, cockpit view and wingman view. A subset of the various map overlays can also be viewed (see "Map Overlays"). Multiple levels of detail can be displayed in the 3D scene, whereby closer locations can be displayed at higher resolutions than distant locations.

Operational Features

Cockpit View

In cockpit view, the eye-point is set at the ownship position to give the appearance of looking out of the cockpit. The eye-point can be set to match the ownship heading and pitch (i.e., to simulate pilot looking straight ahead), or can be set independent of the ownship heading and pitch (i.e., to simulate pilot looking in other directions rather than straight ahead).

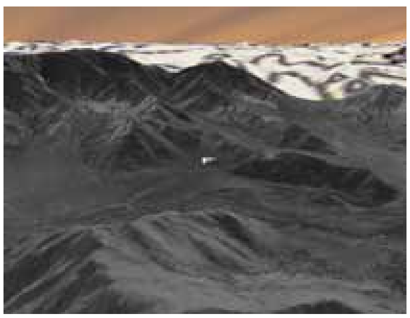
Figure 3 shows a map in perspective mode, cockpit view.

■ *Figure 3—3D cockpit view*

Wingman View

In wingman view, the eye-point is at a configurable perspective away from the ownship, looking at the ownship position. The eye-point can be set to different depth, tilt, and azimuth settings as described in the FliteScene Interface Control Document (ICD).

Figure 4 shows a map in 3D perspective mode, wingman view.



■ *Figure 4—3D wingman view*

Data Frame View

In data frame view, nongeographically referenced images are displayed. Data frames can be JPEG, JPEG2000, bitmap, TIFF, PDF, PNG, or icon images. Examples of potential data frames are checklists, diagrams, approach plates, aerial photography, and Flight Information Publications (FLIP) charts. Data frames can have symbology overlays.

Figure 5 shows a PDF approach displayed in data frame view.

■ *Figure 5—Data frame view*

MAP UNDERLAY

FliteScene underlays are created from standard database products provided by the National Geospatial-Intelligence Agency (NGA), and various commercial sources. The standard database products used for the map underlay are the same products used in aircraft mission planning systems, which ensures the maps displayed in the cockpit are identical to those seen during mission planning. In both 2D and 3D views, FliteScene can display multiple map layers concurrently (e.g., Imagery over Chart, High Resolution over Low Resolution, etc.).

Compressed Arc Digitized Raster Graphics (CADRG)

CADRG underlays can be displayed in 2D and 3D views. CADRG underlays are created from scanned aeronautical chart source data (MIL-PRF-89038).

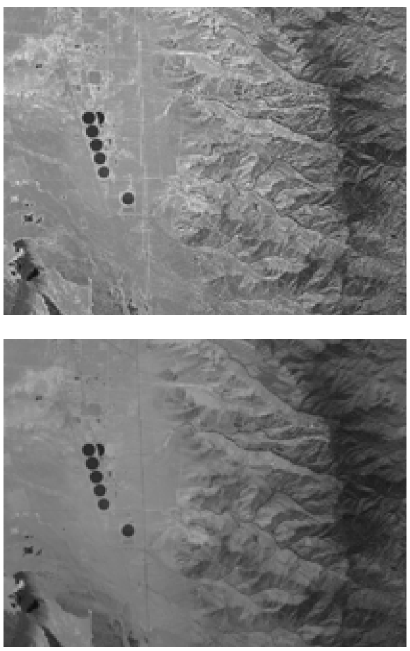
FliteScene provides Configurable Product Codes to support any number of CADRG products at any supported scale. Once a product code as been configured (i.e., assigned) to a map product, then users can enable that map for display using the product code as a reference. FliteScene supports the following CADRG scales:

- 1:5,000,000, 1:2,000,000, 1:1,000,000, 1:500,000, 1:250,000, 1:200,000
- 1:100,000, 1:50,000, 1:36,000, 1:35,000, 1:26,000, 1:25,000, 1:24,000
- 1:23,000, 1:22,000, 1:21,120, 1:21,000, 1:20,000, 1:18,000, 1:17,500
- 1:17,000, 1:16,666, 1:16,000, 1:15,500, 1:15,000, 1:14,700, 1:14,000
- 1:12,800, 1:12,500, 1:12,000, 1:11,800, 1:11,000, 1:10,560, 1:10,000

Figure 6 shows a 1:500K CADRG map in 2D view.

■ *Figure 6—CADRG underlay*

■ ***Figure 7—ECRG underlay***



■ ***Figure 8—Image auto contrast***
Top: Auto-contrast enabled
Bottom: Auto-contrast disabled

■ ***Figure 9—GeoTIFF underlay***

Enhanced Compressed Raster Graphics (ECRG)

ECRG underlays can be displayed in 2D and 3D views. ECRG data is derived from digital source maps, like ADRG, but processed and reformatted into an ECRG format (MIL-PRF-32283). The same data types (scales) supported for CADRG can be displayed for ECRG.

In FliteScene 2.7, the ECRG feature was enhanced for better performance and lower memory consumption. ECRG memory options can be configured using the ECRG_ENABLED tag as described in the DBDD.

Figure 7 shows an ECRG map in 2D view.

Controlled Image Base (CIB®)

CIB® underlays can be displayed in 2D and 3D views. CIB underlays are generated from georeferenced satellite imagery source data (MIL-PRF-89041).

FliteScene provides Configurable Product Codes to support any number of CIB products at any supported resolution. Once a product code has been configured (i.e., assigned) to a map product, then users can enable that map for display using the product code as a reference. FliteScene supports the following CIB resolutions:

- 10-meter
- 5-meter
- 2-meter
- 1-meter
- 0.5-meter

When CIB Auto-Contrast is enabled, FliteScene will automatically adjust the image contrast to improve the displayed image quality.

Figure 8 shows an example of image auto contrast.

GeoTIFF

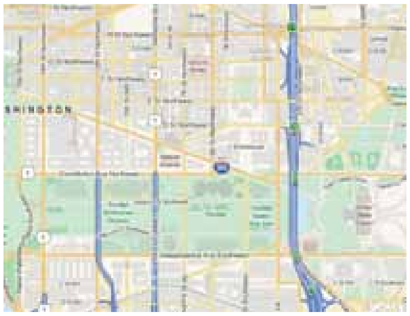
GeoTIFF underlays can be displayed in 2D view, and in 3D view if the graphics driver supports clip planes. GeoTIFF underlays can be created from a variety of sources and can contain a variety of information (e.g., map chart and/or imagery). A GeoTIFF image uses the TIFF standard, but contains GeoKeys specifying a geographic location for the image. GeoTIFF files can contain multiple tiles, where each tile is 256x256 in size.

FliteScene's Configurable Product Code feature is also used for GeoTIFF based maps and imagery. For each configured GeoTIFF product code, the user can configure:

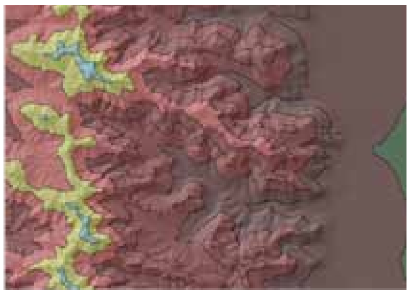
- Up to five catalog files that specify the location and GeoTIFF files to load for this GeoTIFF product.
- The range that FliteScene should use for sorting the GeoTIFF image tiles associated with this product code. In this sense, range provides a mechanism to create multiple scales of GeoTIFF map/image products. This range is also used by FliteScene to determine the appropriate elevation or depth resolution to use for any enabled elevation or depth overlays.

In addition to loading GeoTIFFs from catalog files during initialization, FliteScene supports loading GeoTIFFs dynamically via the Command I/F during run time. Product Codes can be configured for these dynamically loaded GeoTIFFs so that the user can enable/disable them like any other map product.

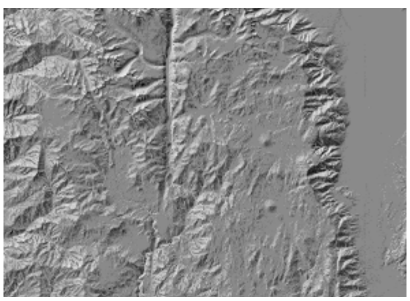
Figure 9 shows a GeoTIFF underlay in 2D view.



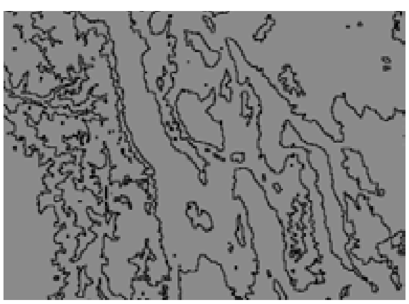
■ ***Figure 10—Street Map underlay***



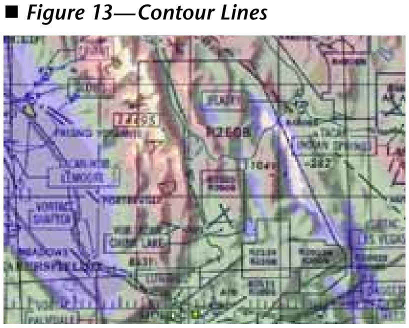
■ ***Figure 11—Digital Terrain in 2D View***



■ ***Figure 12—Slope Shading***



■ ***Figure 13—Contour Lines***



■ ***Figure 14—Elevation bands***

Street Map

Street Map underlays can be displayed in 2D view, and in 3D view if the graphics driver supports clip planes. Street Map underlays can be created from a variety of sources that are converted to GeoTIFF as described in the FliteScene Database Design Document (DBDD). FliteScene's Configurable Product Code feature is also used for Street Maps as described in the GeoTIFF section.

Figure 10 shows a Street Map underlay in 2D view.

Digital Terrain

Digital terrain can be the displayed in 2D and 3D views. The Digital Terrain underlay is a solid programmable color over which elevation overlay features (e.g., bands, shading, and contours) are displayed.

Figure 11 shows a Digital Terrain map in 2D view.

MAP OVERLAYS

Once the underlay(s) of the digital map has been established, overlay graphics pertinent to situational awareness can be applied. Map Overlays are dynamically updated in response to changing map positions, changing aircraft altitude, changing terrain underlying the map position, and new user commanded map values.

Slope Shading

Slope Shading can be displayed in 2D and 3D views. Slope shading is the lightening and darkening of the base color and certain map overlays to represent a virtual sun position's effect on the slope and orientation of the terrain. The terrain facing towards the virtual sun is brightened, while the terrain facing away from the virtual sun is dimmed. The degree of luminance is based on the pitch of the terrain.

Figure 12 shows a Digital Terrain underlay in 2D view with slope shading enabled.

Contour Lines

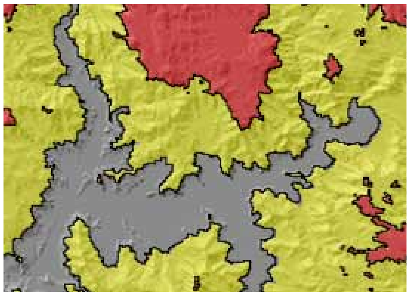
Contour lines can be displayed in 2D and 3D views. Contour lines are drawn where the absolute elevations of adjacent terrain points are above the base elevation and straddle a selected contour elevation. The color and interval of contour lines are programmable.

Figure 13 shows a Digital Terrain underlay in 2D view with contour lines enabled.

Elevation Bands

Elevation bands can be displayed in 2D and 3D views. Elevation bands are dynamic translucent (tinted) overlays based on elevation range intervals that highlight the terrain at different altitudes. The number of elevation bands, height of elevation bands, and colors of the elevation bands are programmable (up to 8).

Figure 14 shows a 1:5M CADRG map in 2D view with elevation bands enabled.

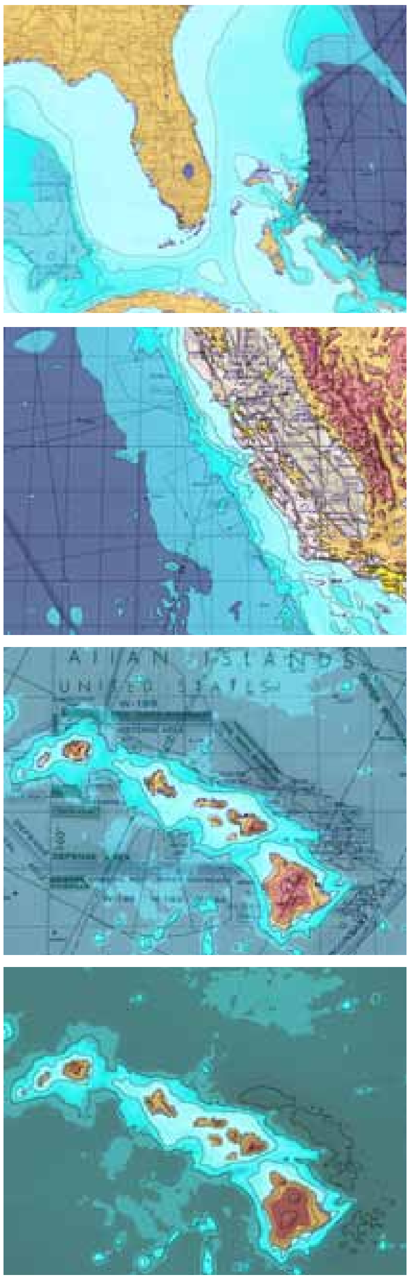


■ ***Figure 15—Three-band HAT***

Height Above Terrain (HAT)

HAT is a subset of elevation bands that can be displayed in 2D and 3D views. A tinted overlay is used to indicate areas on the map where terrain is above the aircraft altitude. Two-band HAT tints the areas where the terrain is above the aircraft altitude. Three-band HAT adds a warning color to indicate when the aircraft altitude is within a configurable warning distance of the terrain. For two- and three-band HAT, the tinted areas change size as the aircraft changes altitude to indicate safe flying areas to the flight crew.

Figure 15 shows Digital Terrain in 2D view with three-band HAT and contour lines enabled.



■ ***Figure 16—Depth Shading, Contours, and Bands***

BATHYMETRY OVERLAYS

In addition to processing elevation data for the Slope Shade, Contour Line, and Elevation Band overlays, FliteScene 2.7 can process bathymetric data and display the following overlays in 2D views:

- Depth Shading
- Depth Contours
- Vertical Bands

These overlays are similar to their elevation overlay counterparts, with the following differences:

- Supported depth data resolutions are 2, 1, 0.5, 0.1, and 0.5 arc-minutes. Refer to the FliteScene DBDD for more details on the source data format, which is derived from Digital Bathymetric Data Base—Variable Resolution (DBDB-V) data.
- Up to 64 Vertical Bands that can be displayed. For each band, the following can be specified via the Command I/F:
  - Vertical data type to use: elevation or depth data
  - Starting and Ending vertical values (band width)
  - Color

Figure 16 shows bathymetry in 2D with depth shading, contours, and 64 vertical bands using depth data.

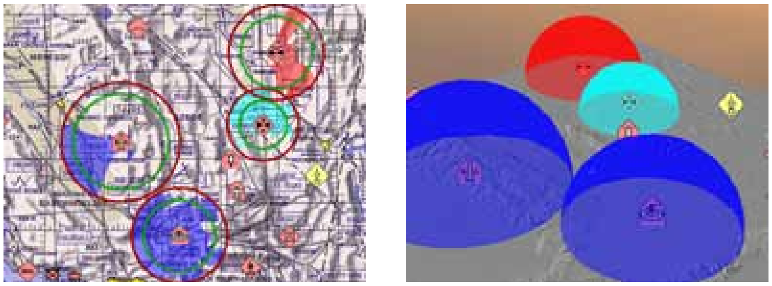
Object Visibility (aka Intervisibility)

Object Visibility is used for any ground object where the range of an object and/or line-of-sight visibility from an object is important (e.g., an airport beacon, on-the-ground radio, etc.). The following discussion uses threats as the object of interest, but, this can be applied to any object.

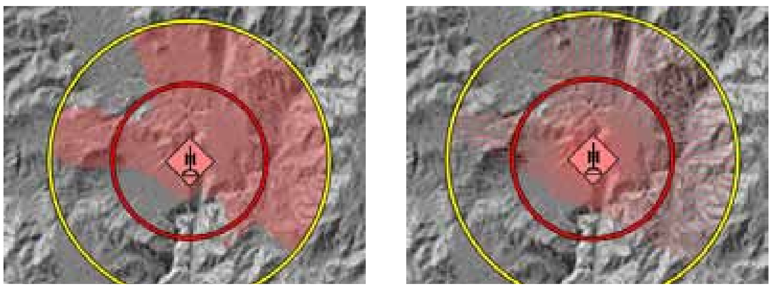
FliteScene manages and displays both predefined and pop-up threat data, which includes threat symbols, threat rings, threat intervisibility (TIV) patterns (2D only), and threat domes (3D only). Predefined threat data can be created from a variety of sources (e.g., FalconView® threat files) that are converted to XML, or Threat Site/Characteristics (XML files) as described in the FliteScene DBDD. Pop-up threat data is sent to FliteScene in real time via the FliteScene command interface. As the map position changes, FliteScene automatically sorts the threats and displays, if enabled, (a) the closest number (configurable) of the threat symbols/rings within the display range, and (b) the closest number (configurable) of TIV patterns. Sorting can be configured based on the ownship position or on the map center.

Operational Features

Threat symbols can be set via a MIL-STD-2525 code or an icon filename, and are displayed, when enabled, at the threat's location. MIL-STD-2525 tactical symbols are described later herein. FliteScene can display any tactical symbol from MIL-STD-2525C Appendix A.



■ ***Figure 17—Left: 2D; Right: 3D. Object visibility in 2D (area pattern) and 3D views***



■ ***Figure 18—Left: area; Right: spoke. Object visibility patterns (area and spoke)***

Up to three overlay rings can be displayed for each threat: the detection ring, lethality ring, and calculated ring. When enabled, the detection and lethality rings are displayed using the threat's detection and lethality ranges. The calculated ring is only displayed if the calculated threat intervisibility range is less than the detection range. The color of each ring is configurable.

Threat intervisibility patterns are translucent (tinted) overlays that show the areas where the aircraft can be seen from a threat, given its altitude above ground level relative to the surrounding terrain. This pattern can be configured to be an Area or Spoke pattern as shown in Figure 18. The threat intervisibility overlay is continuously updated as the aircraft altitude (or other provided reference altitude) changes so that tinted areas show where the aircraft could be detected. Conversely, untinted areas depict areas where the aircraft could be hidden from detection by intervening terrain. The color of each TIV pattern is configurable.

Threat domes are translucent (tinted) 3D overlays that show the threat detection range in 3D. The dome radius is equal to the detection radius. The dome color is the same color as the 2D intervisibility pattern color. No intervisibility calculations are performed when rendering a threat dome. It behaves as a three-dimensional detection sphere.

Threats can be moved, deleted, or queried for metadata as described in the Cursor section.

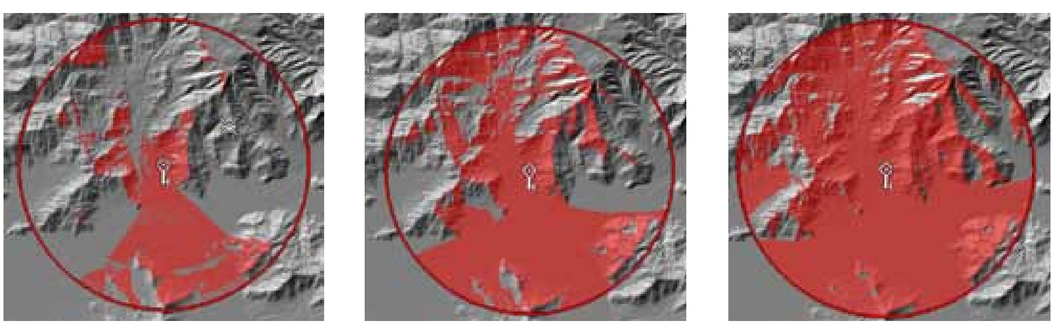
Figure 17 shows threat data in both 2D and 3D.

Ownship Visibility

FliteScene can display Ownship Visibility in 2D view. Ownship Visibility is similar to Object Visibility (discussed in previous section) in that they both graphically convey line-of-sight information. The difference is a follows:

Ownship Visibility shows areas that are visible to (can be seen by) the ownship given the ownship's current location and altitude. This pattern changes dynamically as the ownship moves. Tinted areas indicate where the ownship has line-of-sight visibility. This can be useful for determining the lowest altitude the ownship can fly (or hover) and still see an area of interest.

Object Visibility shows areas that are visible to ground based objects given a reference AGL altitude. Tinted areas indicate where the object has line of sight visibility to anything at or above the reference altitude. This can be useful for determining the highest AGL altitude an aircraft can fly (or hover) without being seen by the object.



■ ***Figure 19—Left: low altitude; Middle: medium altitude; Right: higher altitude. Ownship visibility.***

The color and translucency of the visibility pattern can be changed dynamically by the user.

Figure 19 shows three visibility patterns for an ownship at the same location, but different altitudes.

Geo Chips

Geo chips can be displayed in 2D view (and 3D view if the graphics driver supports clip planes). Geo chips are monochromatic or color bitmap, JPEG, JPEG2000, TIFF, PNG image overlays that are geographically referenced to the map. Geo chips may be translucent or opaque. When a geo chip is too small to be discernable on the map scale currently selected, a "too small" symbol is displayed at the geographic location of a geo chip. When a geo chip file is enabled for display but the file is not available, a "location" symbol is displayed at the geographic location where the geo chip should be. The "location" and "too small" symbols can be enabled or disabled by the user.

■ ***Figure 20—Geo chip***

Figure 20 shows a 1:50K CADRG map in 2D view, with a geo chip, "too small" symbol (symbol located in the upper left corner of the image), and a "location" symbol (symbol located to the right of the geo chip).

Note: Refer to the GeoTIFF section for an alternative way to display images georeferenced on the map using the static or dynamic GeoTIFF feature. The primary difference between the geo chip feature and the GeoTIFF feature is that geographic information is already contained within the GeoTIFF files, whereas for geo chips, the user must provide geographic information for the image as described in the FliteScene ICD.

Vehicles and Sensors

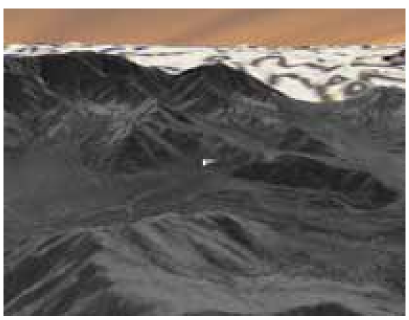
FliteScene supports a configurable number of vehicles (e.g., ownship, UAV), and can display various features for each vehicle, including: Vehicle Symbol, Trend Dots, and a History Trail. In addition, one or more sensors can be configured for each vehicle, and FliteScene can display various sensor features, including: Sensor Overlay Pattern and Sensor Point-of-Intercept.

■ ***Figure 21—Ownship symbol 2D***

Vehicle Symbol

Vehicle symbols can be displayed in 2D and 3D wingman views. In 2D view, the symbol representing each vehicle is configurable. In 3D wingman view, each vehicle symbol is a predefined cone object. FliteScene displays each symbol taking into account the heading and position of the vehicle received via the command interface, and the orientation mode of the map (North-up, Heading-up, Slew angle, etc.).

Vehicle symbols can be icon-based or MIL-STD-2525 based, and can be changed during run time via a message over the command interface.



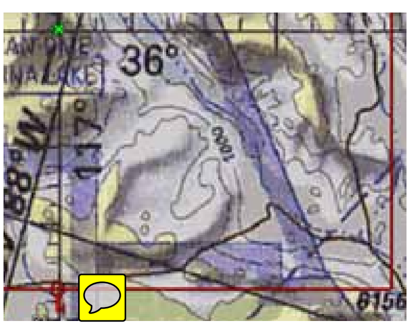
■ ***Figure 22—Ownship symbol 3D***

Figure 21 shows a 1:2M CADRG map in plain view with the default 2D ownship symbol.

Figure 22 shows a Digital Terrain map in perspective view with the default 3D ownship symbol. Note: FliteScene supports multiple vehicles where each vehicle can be represented by a unique symbol. Ownship is a term that represents the user's vehicle.

Off-Screen Vehicle Indicator Symbol

When the map is slewed in Plan View such that the ownship is off screen, FliteScene can display an Off-Screen Vehicle Indicator symbol to provide an indication of where the ownship is relative to the screen center. Information conveyed by the Off-Screen Vehicle Indicator includes:

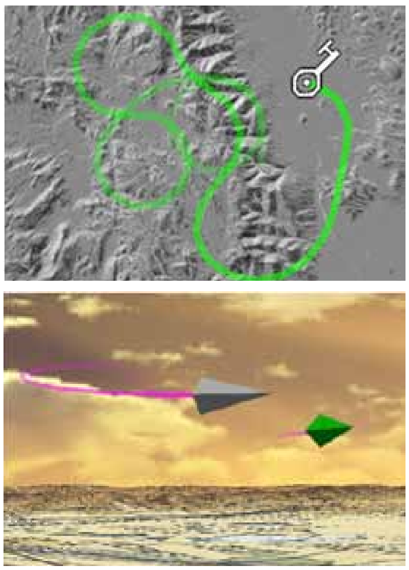


■ ***Figure 23—Ownship off-screen indicator***

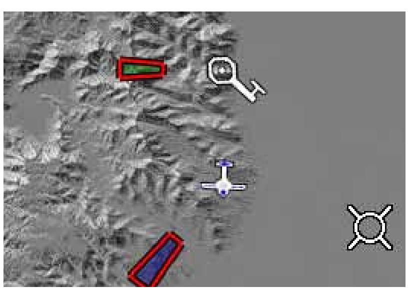
- Distance from the indicator's location to the ownship's location
- Indication of ownship's heading relative to the underlying map

Figure 23 shows a partial screen example where a north-up map has been slewed and the Off-Screen Indicator symbol conveys the following information relative to the screen center: (a) the ownship is south of screen center, (b) the ownship's heading is north, (c) the ownship is 21.4 nautical miles from screen center.

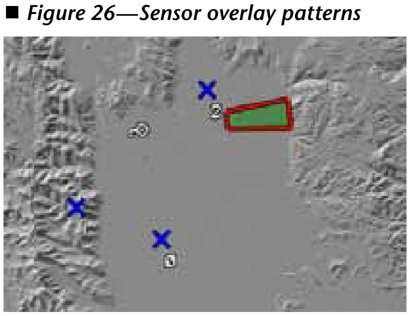
■ ***Figure 24—Ownship trend dot symbols***



■ ***Figure 25—Top: 2D; Bottom: 3D. Ownship history trail***



■ ***Figure 26—Sensor overlay patterns***



■ ***Figure 27—Sensor capture point***

Also shown in Figure 23 are: (a) a slew location symbol, which FliteScene displays (when enabled) to indicate the slew position, and (b) a red border which is typically not shown, but is shown in this example to illustrate the border at which the Off-Screen Indicator symbol will be displayed. The dimensions for this border are configurable.

Vehicle Trend Dot Symbols

Trend dot symbols can be displayed in 2D view. Trend dots are displayed to show the expected progression of a vehicle at given time intervals based on velocity and turn rate. The user can display up to four trend dots at programmable times (seconds from current vehicle position) and in a programmable color. If a trend dot's time is set to 0, then the trend dot is disabled.

Figure 24 shows a 1:500K CADRG map in plan view with the ownship symbol and trend dot symbols displayed.

Vehicle History (Beta)

FliteScene can log and display vehicle history information. The time interval between log events is configurable. When enabled, a Vehicle History Trail is displayed in 2D and 3D views. The number of locations displayed for the history trail and the display parameters (e.g., color) are also configurable.

Figure 25 shows an ownship with history trail enabled. Note that older locations appear to fade away.

Sensor Overlay Pattern (Beta)

For each sensor, FliteScene can display an overlay pattern in 2D view which represents where a sensor is looking, taking into account the sensor's location, altitude, azimuth, pitch, and field of view received via the command interface. The pattern is projected at the sensor's point of intercept elevation, which is recalculated at a configurable interval. If no point of intercept elevation is available, then the pattern is projected at sea level and displayed in a different color. The display parameters of the overlay pattern are configurable.

Figure 26 shows two sensor overlay patterns displayed—one for a sensor onboard the ownship, and one for a sensor onboard a UAV.

Sensor Capture Point (Beta)

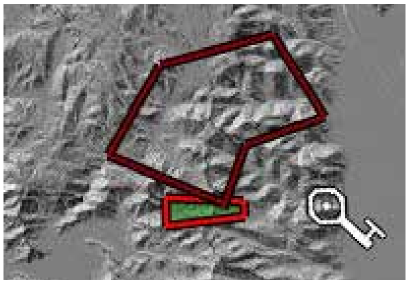
For each sensor, FliteScene can display a configurable number of sensor capture point symbols in 2D view, where each symbol represents the point of intercept of where a sensor was looking at a specific moment in time, taking into account the sensor's location, altitude, azimuth, and pitch at the time when the capture command was given. The symbol icon used is configurable. A number is displayed next to each symbol to indicate the sequence number of the capture.

Figure 27 shows three capture points from an onboard sensor.

Sensor Perimeter Highlighting (Beta)

For any sensor, FliteScene can display, in 2D view, a perimeter highlight based on a connected series of sensor capture points. With this feature, users can use sensor capture points to highlight an area of interest (e.g., fire, oil slick, search area, danger zone, etc.). The perimeter highlight characteristics are configurable (e.g., max points, line color).

Figure 28 shows a sample perimeter highlight captured from an onboard sensor.



■ ***Figure 28—Sensor perimeter highlighting***

3D Sensor Fusion (Beta)

In 3D Cockpit View, FliteScene can display a sensor footprint with embedded sensor images blended into the 3D scene, as shown in Figure 29. The sensor footprint and embedded images track the sensor parameters and input images provide to FliteScene resulting in real time sensor/image display updates within the 3D moving map. The optional bezel key feature, as shown in this figure, is described in the bezel key Symbols section.

■ ***Figure 29—3D sensor fusion***

Geo-Symbology

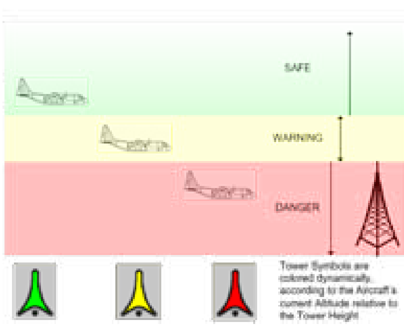
FliteScene manages and displays both predefined and pop-up geographically referenced symbology, which includes Vertical Obstruction (VO) Points, Manual CHUM, ECHUM, MIL-STD-2525 Tactical Symbols, Drawing File Symbols, Local Point Symbols, Route Symbols, DAFIF, and ARINC 424 symbols. Pre-defined symbology can be created from a variety of sources (e.g., NGA shape files, FalconView® files, XML files, ARINC 424-18 files) as described in the FliteScene DBDD. Pop-up symbology is sent to FliteScene in real time via the FliteScene command interface. As the map position changes, FliteScene automatically sorts the symbols and displays, if enabled, all of the applicable symbols within the display range. Manual CHUM, Drawing File Symbols, and Local Point Symbols can be loaded when commanded via the command interface and decluttered by filename.

Vertical Obstruction (VO) Points

VO points can be displayed in 2D and 3D views. The symbols representing tower, building, pylon, and other VO points are configurable. Each VO point is colored according to the potential danger it poses to an approaching aircraft (see Figure 30).

VO points may be decluttered by height and/or by type. An optional text label displaying the Above Ground Level (AGL) or Mean Sea Level (MSL) heights in feet can be displayed to the right of the VO point in plan view. In perspective view, VO point symbols are drawn on top of a stem, which marks the position of the VO point on the terrain.

Figure 31 shows a 1:5M CADRG map in perspective view with VO points displayed.



■ ***Figure 30—VO Dynamic Coloring***

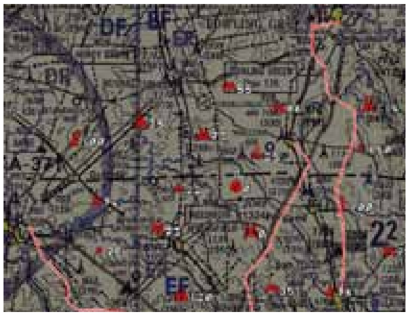
Manual CHUM

In 2D view, FliteScene can display manual CHUM line and point data read from FalconView® manual CHUM files (*.mch). Manual CHUM data can be decluttered by type (line or point) or by height in the same manner as VO points. The symbols used for manual CHUM point data are configurable.

The manual CHUM line colors are defined by the input files. Manual CHUM point colors can be set to mimic the VO point dynamic colors (Figure 30), or can be set to a single color via the command interface. An optional text label displaying the AGL or MSL heights in feet can be displayed to the right of the manual CHUM points.

■ ***Figure 31—Vertical obstruction points***

Figure 32 shows manual CHUM line and point symbols. Note in the figure that the map underlay has been dimmed in to make the symbology stand out. The level of map dim applied can be controlled by the user via the command interface.



■ ***Figure 32—Manual CHUM lines and points***

ECHUM

FliteScene can display ECHUM line and point data in both 2D and 3D views for ECHUM data read from FalconView® ECHUM files (*.ech). Each input file can be associated to its corresponding CADRG product by configuring the ECHUM file to the appropriate map Product Code. When ECHUM is enabled, FliteScene rasterizes the ECHUM objects onto the associated map. The symbols used for ECHUM point data are configurable.

ECHUM line colors are defined by the input files. An optional text label displaying the AGL or MSL heights in feet can be displayed to the right of the ECHUM point symbols.

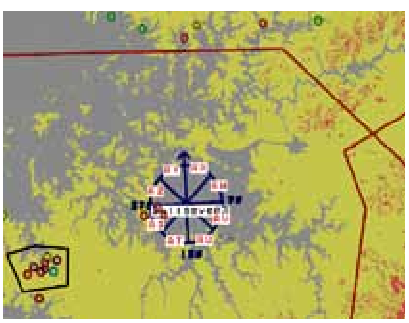
Figure 33 shows ECHUM point data in red, rasterized onto an ONC 1:1M map.

■ ***Figure 33—ECHUM points***

MIL-STD-2525 Tactical Symbols

FliteScene can display MIL-STD-2525 tactical symbols as defined in Appendix A of MIL-STD-2525C, Common Warfighting Symbology. Tactical symbols can be displayed in 2D and 3D views. Tactical symbols are composed of a frame and fill, icon, modifier, optional direction of movement, and optional text label. Tactical symbols can be predefined and loaded during initialization or defined dynamically by the user and set via the command interface. The user can declutter tactical symbols by their affiliation and dimension.

The symbol icons and corresponding symbol codes used for tactical symbols are fully configurable via an XML configuration file. The default symbols and codes are defined for MIL-STD-2525C; however, users can modify the XML file to use their own symbol sets for the MIL-STD-2525C codes, or even create their own codes.



■ ***Figure 34—Drawing file symbols***

Drawing File Symbols

FliteScene can display Drawing file symbols in 2D for drawing file data read from both FalconView® and Joint Mission Planning System (JMPS) drawing files (*.xml). Drawing file symbols may be two-point lines, polylines, polygons, rectangles, ellipses, axis of advance, bull's-eyes, or text. Drawing File symbols are commonly used for, but not limited to, the following:

- Threat Zone Matrix: Used to depict areas of increased threat activity
- SAFIRE Tracker: Compilation of recent SAFIRE reports
- Boundaries: Depicts geographic areas belonging to different controlling agencies
- Terminal Airspace Sectors: Control measure for entering and exiting terminal airspace without transmitting aircraft position in plan text
- Operational Tactical Graphics: Boundaries and phase lines and areas for ground operations

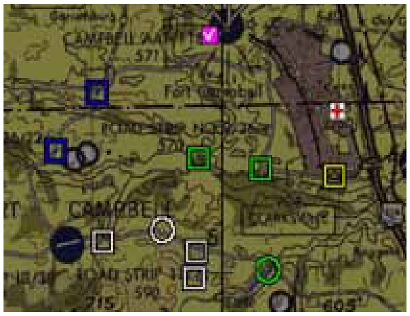
Drawing file objects can be enabled/disabled by filename. Figure 34 shows drawing file symbols on Digital Terrain in 2D view.

Local Point Symbols

In 2D and 3D views, FliteScene can display Local Point symbols derived from FalconView® local point files (*.lpt) converted to an XML format as described in the DBDD. Up to 216 point types are supported, and the symbol used for each point type is configurable. Local point symbols can be displayed with or without a text label. Common uses of Local Point symbols include, but are not limited to, the following:

- Unit points of interest: LZ/PZ locations, FARPs, medical facilities, and other features of interest.
- Air control points: A series of labeled points covering a geographic area used to enhance air safety and control.

Figure 35 shows local point symbols on a dimmed chart underlay in 2D view.



■ ***Figure 35—Local point symbols***

Route Symbols

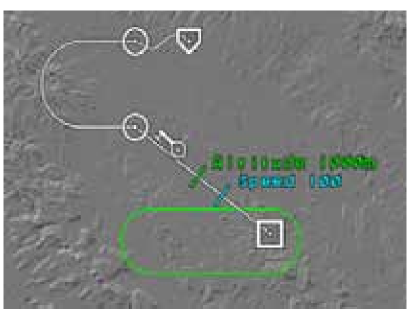
Route symbols, which include waypoints, route legs, and corridors, can be displayed in 2D and 3D views. The symbol icons for each waypoint type, along with other route display parameters, are configurable. Route data can be decluttered globally, by route, and by type. ID and text labels can be displayed for each waypoint.

Figure 36 shows an ownship route and an UAV route, where each vehicle also has trend dots enabled.

■ ***Figure 36—Route waypoints and legs***

FliteScene also supports the following features, as shown in Figures 37 and 38.

- Serpentine Legs
- Turning Legs
- Racetracks
- Speed/Altitude Gates
- Route Display in 3D



■ ***Figure 37—Enhanced route featuers***

The route line example shown for the 3D route in Figure 38 is a "highway in the sky" texture. However, this texture is configurable and can be set to any image the user desires to see. Also shown in this figure are waypoints and corridor lines. All of the route components can be individually declutter if desired.

■ ***Figure 38—3D route display***

ARINC 424 Symbols

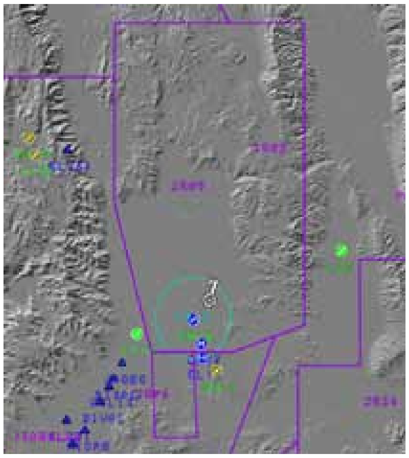
ARINC 424 is an international standard file format for aircraft navigation data maintained by Airlines Electronic Engineering Committee and published by Aeronautical Radio, Inc. Many popular navigation databases use the ARINC 424-18 file format, including the FAA National Flight Database and Jeppesen®.

FliteScene can display, in 2D view, the following ARINC 424 symbol types:

- VHF and NDB Navaids
- Waypoints
- Enroute Airways
- Heliports
- Airports
- Runways
- Restricted and Controlled Airspaces

Each of these types can be individually decluttered. Metadata can also be displayed for any selected point object. The display characteristics (e.g., line color, label color) are configurable. The maximum scale at which a particular type should be displayed is also configurable (e.g., "hide above" declutter).

Figure 39 shows the following ARINC 424 symbols: Restricted and Controlled Airspaces, Airports, Heliports, and Waypoints.



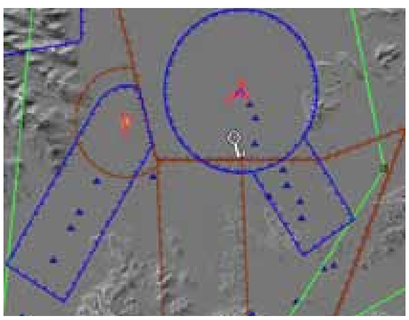
■ ***Figure 39 —ARINC 424 symbology***

DAFIF Symbols

FliteScene reads standard DAFIF-T format files provided by NGA to generate DAFIF symbology—no preprocessing is required.

FliteScene can display the following DAFIF symbol types:

- Airport
- Runway
- Heliport
- Boundary
- Route
- Navaid
- Special Use Airspace
- Waypoint

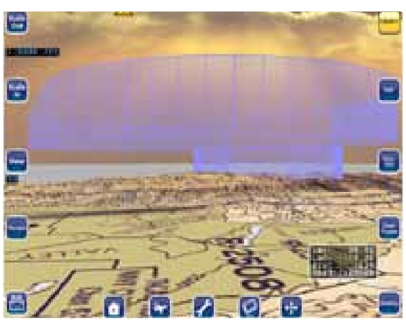


■ ***Figure 40—DAFIF symbology***

Each of these types can be individually decluttered. Meta data can also be displayed for any selected point object. The display characteristics (e.g., line color, label color) are configurable. The maximum scale that a particular type should be displayed at is also configurable (e.g., "hide above" declutter).

Figure 40 shows DAFIF objects on slope shaded terrain. As can be seen, DAFIF objects are very similar to ARINC objects.

Airspace Control Order (ACO) Objects With Time Effectivity



■ ***Figure 41—Multipoint ACO objects displayed in 3D***

FliteScene can display ACO symbology in 2D and 3D views, including:

- Circle
- Orbit
- Corridor
- Line
- Point
- RadiusArc
- PolyArc
- Polygon
- Track.

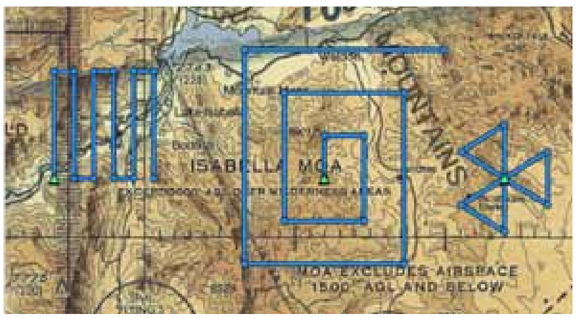
FliteScene can also apply Time Effectivity to ACO symbology to indicate if a symbol is currently active or inactive based on time parameters passed into FliteScene via the command interface. Figure 41 shows a multipoint ACO in 3D.

Search Patterns and Areas

FliteScene can display geographically referenced Search Patterns and Areas in 2D view. The number of Search Patterns and Areas is configurable. A Search Area is a circular expanding area which continues to increase (or decrease) in size based on a specified expansion rate. The initial location and radius of the Search Area is also specified.

FliteScene also supports the following Search Pattern types: Parallel Path, Expanding Square, and Sector Search. For each of these types, there are a number of user specified parameters, as shown below:

Parameters	Parallel Path	Expanding Square	Sector Search
Number of Tracks (Legs)	√	√	
Track Length	√		√
Track (Leg) Spacing	√	√	
First Turn Direction	√	√	√
Initial Position/Heading	√	√	√



■ ***Figure 42—Search patterns***
Left: Parallel path, Middle: Expanding square, Right: Sector search

Figure 42 shows an example of the various Search Pattern types.

User-Defined Symbols

User-defined symbols are based on user-commanded parameters. They consist of geographically referenced or screen-referenced lines, polygons, arcs, strings, and graphic symbols. User-defined symbols can be displayed in 2D or 3D view.

Text Boxes

Text Boxes support a variety of usages, including messaging, chat, and general text display with scrolling capability. The quantity, size, and appearance of text boxes are configurable. Other text box features include:

- Individual declutter
- Set/Retrieve text
- Word wrap
- Text cursor for easy text insertion or deletion

Figure 43 shows an example Text Box display.

■ ***Figure 43—Text box***

Bezel Key Symbols (Beta)

FliteScene provides an interface to simplify the display and use of symbology commonly associated with bezel key type displays. These symbols include bezel buttons, labels, and list boxes. They are screen referenced and can be displayed in any view. Users specify the screen location and image filename to use for each bezel button. Multiple filenames can be specified for a single button that has multiple states (e.g., selected, not selected). The interface is very flexible to support a wide variety of user display needs.

Figure 44 shows some example bezel key symbols.

■ ***Figure 44—Bezel key symbology***

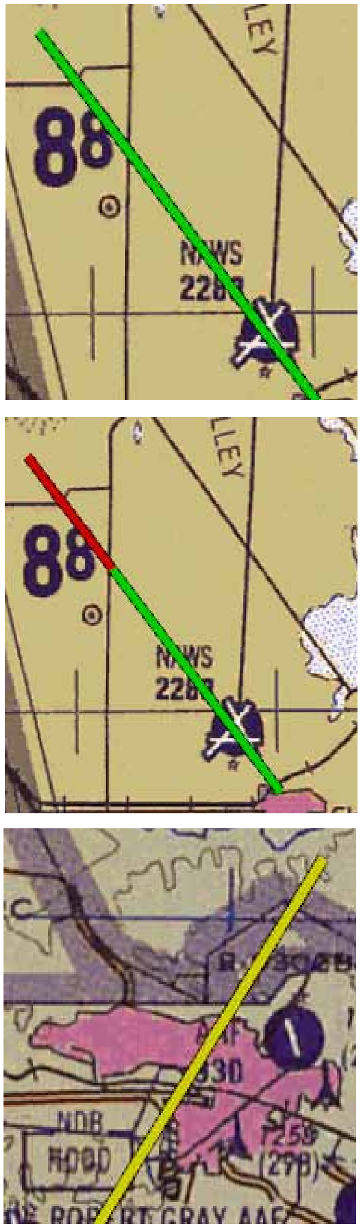
Cursor Symbols and Features

A cursor symbol and alternate cursor symbol can be displayed in 2D or 3D views and positioned as commanded via the command interface. The sprites representing these symbols are configurable. In 3D view, the cursor is primarily used to interact with screen referenced symbology (e.g., selecting bezel keys). In 2D view, the cursor can also be used to interact with georeferenced symbology and data queries.

FliteScene cursor features include the following:

- Return latitude, longitude, and elevation at cursor position
- Returning unique ID(s) associated with cursor selected object(s) (i.e., symbols) that are located within a specified range of the cursor position
- Return symbol information and metadata for a unique ID
- Highlight a symbol associated with a unique ID
- Render a screen referenced copy of a symbol associated with a unique ID
- Move a symbol associated with a unique ID
- Delete a symbol associated with a unique ID

These FliteScene cursor features provide a powerful and flexible interface for performing a wide range of user-to-map related interactions. For example, if multiple symbols are within the user-defined cursor range, the user can cycle through the returned unique IDs, highlight a specific symbol, query for symbol information, drag/drop a symbol to another location, or delete a symbol. FliteScene's Text Box feature could also be used to display queried information as shown previously in Figure 43.



■ ***Figure 45—CLOS symbology. Top: clear; Middle: blocked; Bottom: unknown***

Clear Line-of-Sight (CLOS) Symbol

The CLOS symbol can be displayed in 2D view. When enabled, the CLOS symbol is displayed following a CLOS Data Request (see Clear Line-of-Sight in the Data Requests section). Three configurable colors are used when displaying the CLOS symbol: Clear, Blocked, and Unknown. The Clear color is used when line-of-sight is clear. When line-of-sight is blocked, the Clear color is used up to the obstruction, and the Blocked color is used from obstruction to end point. When busy processing, or when the elevation data needed to compute is not available or is invalid, the Unknown color is used to draw the line between the two end points.

Figure 45 shows Clear, Blocked, and Unknown CLOS symbols

Clear Line-of-Sight (CLOS)—Pin to Ownship

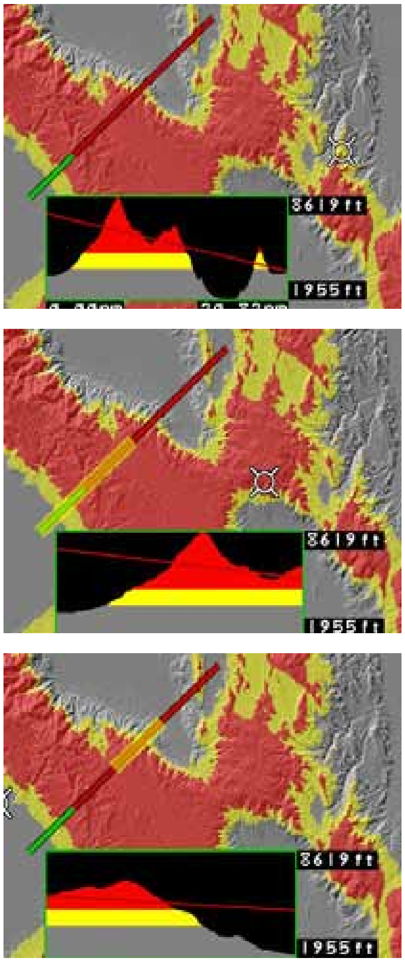
When enabled, FliteScene will automatically tie the CLOS starting point to the ownship location and periodically update the displayed CLOS. This creates a "rubber-band" effect where the CLOS starting point moves with the ownship. The update rate is configurable.

Elevation Profile

When enabled, FliteScene will display an elevation profile in 2D view corresponding to the displayed CLOS symbol. As shown in Figure 46, the elevation profile can be scaled to match any portion of the CLOS symbol as indicated by a slider highlighted on the CLOS symbol. This provides detailed 3D terrain awareness in a 2D view. The elevation profile colors match the terrain elevation banding colors set by the user. The X-axis label provides an indication of distance, and the Y-axis provides an indication of height.

Point of Intercept (POI) Symbol

A POI symbol can be displayed in 2D view. When enabled, the POI symbol is displayed following a POI Data Request (see Point of Intercept in the Data Requests section). The POI symbol is composed of a sprite symbol and a line as shown in Figure 48. The sprite symbol is a configurable symbol that is displayed at the point of intercept, if one exists. Two configurable colors are used when displaying the POI line: Clear and Unknown. When no point of intercept exists, a line is drawn in the Clear color from starting point to the end of the elevation scene. If the end of the elevation scene is reached, the Unknown line color is drawn from the end of the elevation scene to the edge of the display area as shown in Figure 47. When a point of intercept does exist, the Clear color is used up to the intercept, and a symbol is drawn at the intercept point. When busy processing, or when the elevation data needed to compute is not available or invalid, the Unknown color is used to draw a line from the starting point to the end of the display area as shown in Figure 49.



■ *Figure 46:* ***Elevation profile inset corresponding to CLOS line. Top: full line; Middle: half line; Bottom: quarter line***

■ ***Figure 47—No POI found***

■ ***Figure 48—POI found***

■ ***Figure 49—POI unknown***

Range/Bearing

A Range/Bearing line can be displayed in 2D view. When enabled, a Range/Bearing line is displayed between two points following a Range/Bearing Data Request (see Range/Bearing in the Data Requests section). The two points are provided via the command interface. A text box could be used to display the range and bearing information that is returned from FliteScene. The display parameters are configurable.

Figure 50 shows range/bearing from the ownship to a specified grid.

■ ***Figure 50—Range/bearing***

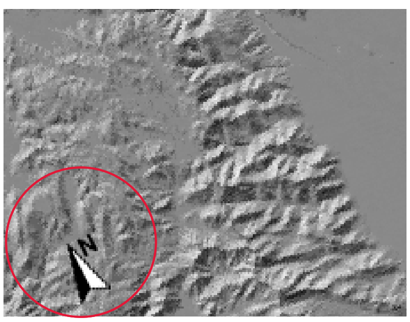
MGRS Grid (Beta)

When enabled, FliteScene will display an MGRS grid corresponding to a specified MGRS code. Displayed MGRS grid data includes:

- Grid box of the MGRS coordinate
- Label indicating the MGRS coordinate

North Indicator

When enabled, a north indicator symbol is displayed in 2D view as shown circled in Figure 51. The icon used for this symbol is configurable (e.g., a full compass rose icon could be used if desired).

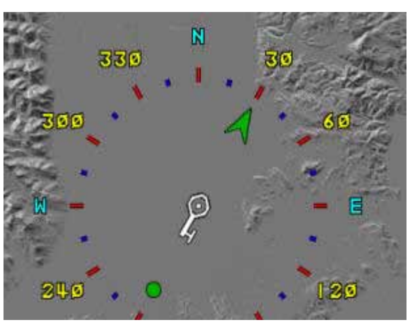


■ ***Figure 51—North indicator***

Compass Rose

When enabled, a Compass Rose is displayed about the ownship in 2D view as shown in Figure 52. There are 16 configurable Compass Rose patterns to choose from, and up to 16 configurable pointers can be displayed on the Compass Rose. Compass Rose display parameters (e.g., color, radius, tick separation, width, outline, etc.) can be changed via the command interface.

In addition, a magnetic north offset can be supplied via the command interface, which FliteScene will apply to both the Compass Rose and the North Indicator.



■ ***Figure 52—Compass rose***

Data Requests

DATA REQUESTS

Coordinate Conversions

In 2D and 3D views, a coordinate conversion request, given a latitude/longitude coordinate, provides a screen coordinate. In 2D view, given a screen coordinate, a coordinate conversion request provides a latitude/longitude coordinate. These conversion functions can be provided in a separate Projection Server library if desired.

Vertical Data Requests

A vertical data request, given a screen coordinate or a latitude/longitude coordinate, provides the applicable vertical data value (elevation if terrain or depth if bathymetry) at that location.

Clear Line-of-Sight

Clear Line-of-Sight can be determined in 2D and 3D views. The concept of Line-of-Sight (LOS) refers to a path connecting an observer and the point being observed (the target). CLOS uses elevation information to determine if the line-of-sight between two points is clear or obstructed. This request returns the latitude, longitude, and terrain elevation of the obstruction point, if it exists.

Point-of-Intercept

Point-of-Intercept can be determined in 2D and 3D views. POI determines the terrain intercept point for a defined line. This request returns the latitude, longitude, and terrain elevation for the first obstruction encountered along the defined line.

Range/Bearing

FliteScene returns range and bearing information via the command interface for any two specified points as described in the FliteScene ICD.

MGRS (Beta)

In 2D and 3D views, FliteScene supports Military Grid Reference System (MGRS) conversion requests. Requests can be for the MGRS code corresponding to a geo lat/lon or a screen X/Y coordinate. FliteScene can also return the geo lat/lon coordinate corresponding to an MGRS code.

Acronyms

ADRG	Arc Digitized Raster Graphics
ACO	Access Control Object
AGL	Above Ground Level
ARINC	Aeronautical Radio, Incorporated (standards)
CADRG	Compressed Arc Digitized Raster Graphics
CG	City Graphics
CHUM	CHart Updating Manual
CIB®	Controlled Image Base
CLOS	Clear Line of Sight
COTS	Commercial Off The Shelf
DAFIF	Digital Aeronautical Flight Information File
DBDD	Database Design Document
DBDB-V	Digital Bathymetric Data Base – Variable Resolution
ECHUM	Electronic CHart Updating Manual
ECRG	Enhanced Compressed Raster Graphics
ESRI	Environmental Systems Research Institute, Inc.
FAA	Federal Aviation Administration
FARP	Forward Area Rearm/Refuel Point
FQT	Formal Qualification Test
FV	FalconView®
GEO	Geographic
GNC	Global Navigation Chart
HAT	Height Above Terrain
HMI	Human Machine Interface
ICD	Interface Control Document
ID	Identification
JMPS	Joint Mission Planning System
JNC	Jet Navigation Chart
JOG	Joint Operations Graphics
JPEG	Joint Photographic Experts Group

(continued next page)

Acronyms *(continued)*

LFC. . . . . Low-Flying Chart
LOS . . . . Line-of-Sight
LZ. . . . . Landing Zone
MGRS. . . . . Military Grid Reference System
MSL . . . . Mean Sea Level
NGA. . . . . National Geospatial-Intelligence Agency
ONC. . . . . Operational Navigation Chart
PDF . . . . Portable Document Format
PNG . . . . Portable Network Graphics
POI. . . . . Point of Intercept
PZ. . . . . Pick-up Zone
SAFIRE . . . . Surface-to-Air Fire
TFC. . . . . Transit Flying Chart
TIFF . . . . Tagged Image File Format
TIV . . . . Threat InterVisibility
TLM . . . . Topographic Line Map
TPC . . . . Tactical Pilotage Chart
UAV . . . . Unmanned Aerial Vehicle
VO . . . . Vertical Obstruction
XML. . . . . eXtensible Markup Language

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