Software for Space, Defense & Intelligence

Defense Seminar

Using Commercial Software for Defense Engineering & Operations

Introductions

- **Matt Halferty**
  - Director, International Business
  - US Army Officer - West Point
- **Nate McBee**
  - Manager International Systems Engineers
  - Masters Aerospace Engineering - Univ. of Tennessee
- **Daniel Honaker**
  - Senior Systems Engineer, Asia Pacific
  - Masters Aerospace Engineering - Univ. of Colorado
- **Melissa Honaker**
  - Aerospace Systems Engineer, Asia Pacific
  - Bachelors Aerospace Engineering - Univ. of Colorado
- **Alex Ridgeway**
  - Aerospace Systems Engineer, Asia Pacific
  - Bachelors Aerospace Engineering – Pennsylvania State Univ.

Agenda

- **Introductions**
  - Company Overview
  - STK basics and product offering
- **Defense Operations**
  - Pre-mission planning
  - Real-time operations
  - Post-mission analysis
- **Engineering Defense Systems**
  - Model Based System Engineering
  - Test and Evaluation
  - Hardware in the loop simulation
- **Q&A and Wrap Up**

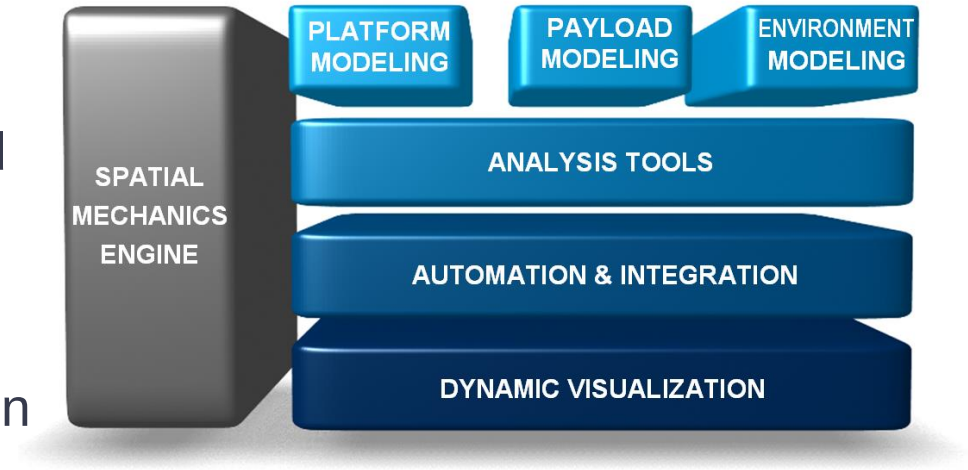
AGI Global Overview

- **Analytical Graphics, Inc. (USA): a global aerospace standard**
  - 45,000+ global software installs
  - 700+ user organizations worldwide
- **Provider of COTS software since 1989**
  - Space mission design & engineering
  - Satellite operations
  - Space situational awareness
- **Validated astrodynamics, 16 patents, 75+ developers**

Australian Government
Department of Defence
Defence Science and Technology Organisation

DSTA
Defence Science & Technology Agency

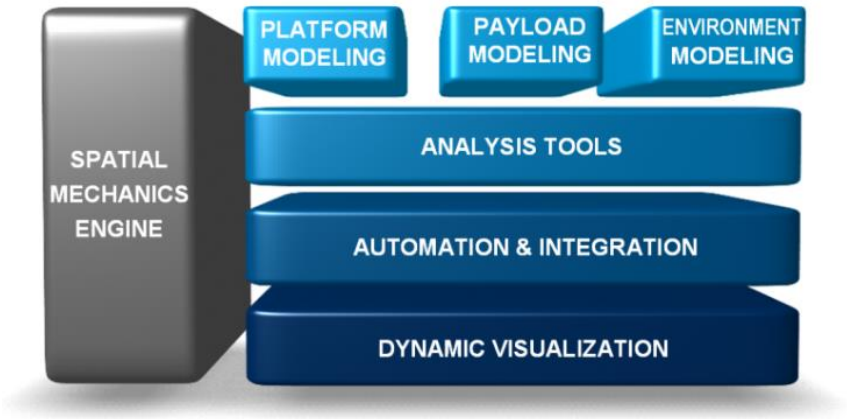
AGI Software Building Blocks

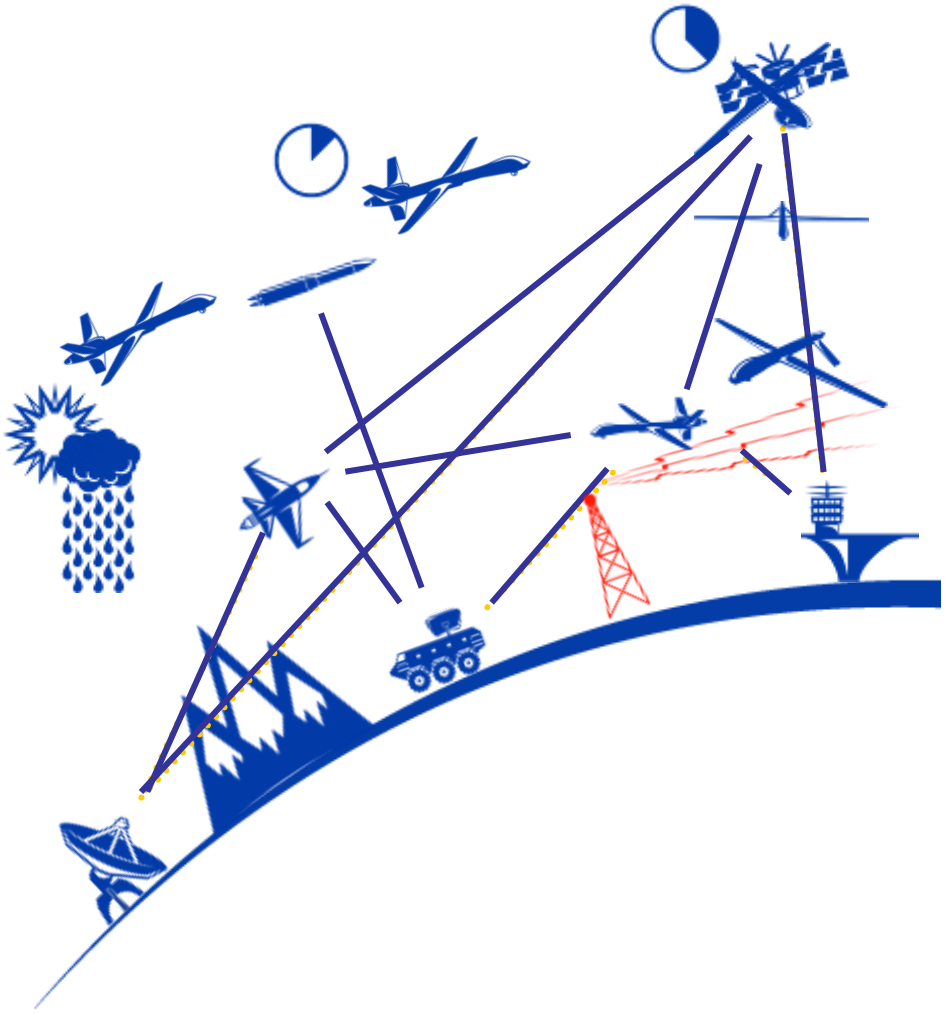


- **Spatial Mechanics Engine**
  - Precision mapping of time and space
- **Advanced Vehicle Motion**
  - Advanced platform propagation
- **Payload and Environment Modeling**
  - Configure sensors, communications, terrain, buildings, atmosphere
- **Analysis Tools**
  - Analyze the relationships of objects over time
  - Evaluate quantitative and qualitative measures
- **Display**
  - Visualize complex system mechanics in dynamic 3D

Systems Tool Kit Summary

- **COTS software for space, defense, and intelligence**
- ***Model*** **your system**
- ***Analyze your mission***
- ***Convey*** **your results**





AGI Solutions – *software in any form*

Desktop applications

Stand-alone or integrated:

- **System and mission design**
- **Analysis**
- **Simulation**
- **Operations**

Application engine

Mission-specific applications and work flows

Software components

Modular capability libraries:

- **Enterprise integration**
- **Thin clients**
- **Servers**
- **Web Services**

Form factor analogy

Products

Solutions

Desktop applications

- Out-of-the-box solution
- User has access to a predefined set of solutions
- STK, ODTK, CHARISMA

Application engines

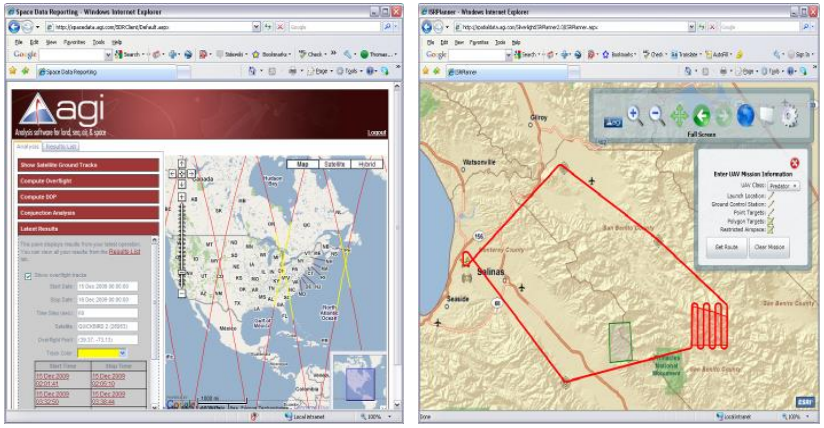
- Unfinished solution
- Developer can manipulate the workflow to get at the same or slightly different solution
- STK Engine, ODTK Engine

Software components

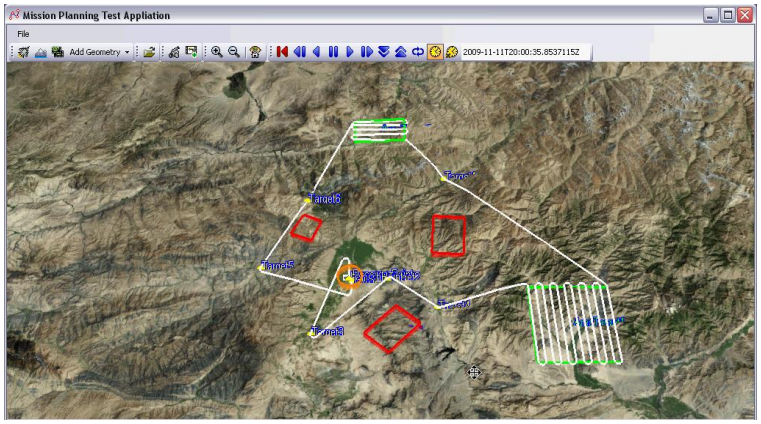
- Raw pieces needed for solution
- Developer assembles pieces to build larger components or entire solutions
- Well suited for Web Services

SDK's Example implementations

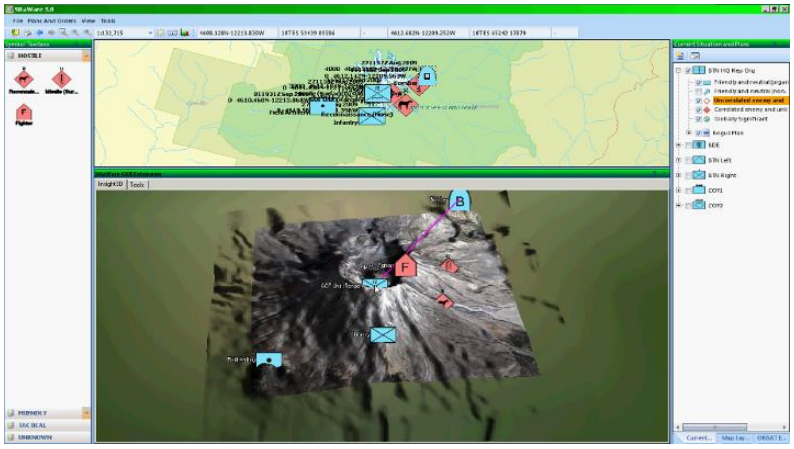
Web services



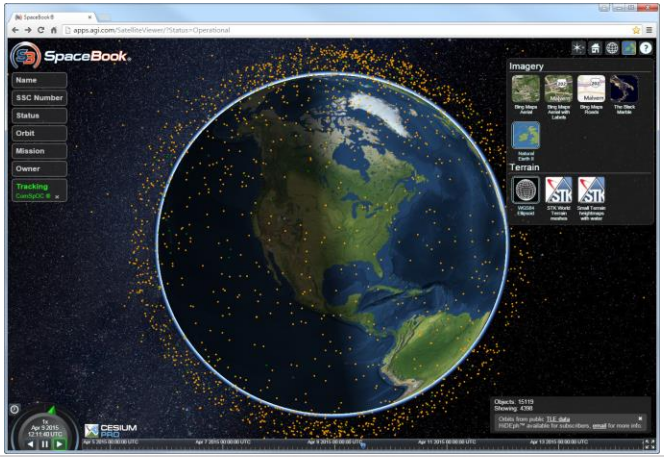
Custom applications



OEM



Cesium

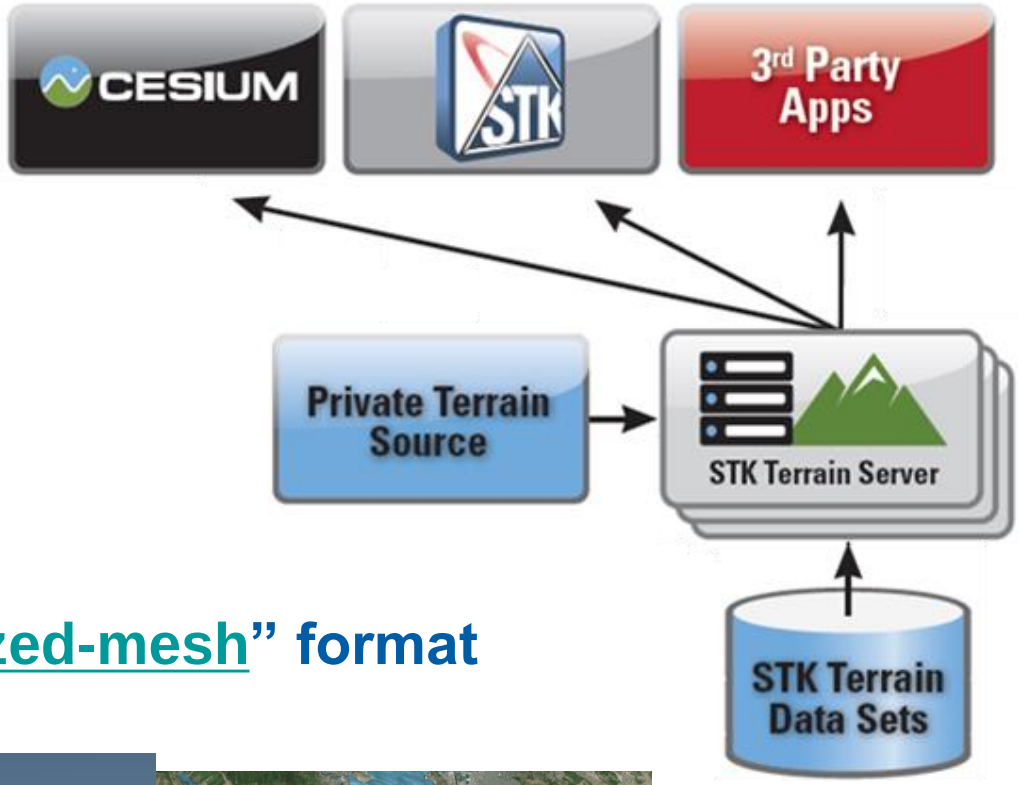


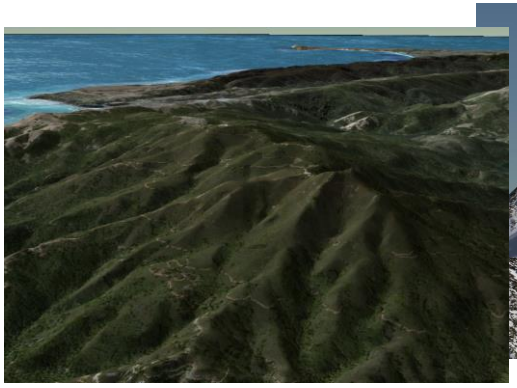
What is Cesium?

- JavaScript library for 3D globes and 2D maps
- Built using WebGL and HTML5 standards
- Runs almost anywhere
- Apache 2.0 License
- Tuned for time-dynamic data
- Founded by agi, supported by community

Terrain Server

- **Performance**
  - Optimized for AGI clients
  - I/O bound not CPU
- **Accuracy**
  - Mesh vs. Height map
- **Clients**
  - Cesium
  - CesiumPro
  - STK
- **Non-proprietary "Quantized-mesh" format**





STK validation & verification

- **Internal V&V each time we produce a software build**
  - Manual and automated processes
  - Test against customer applications
- **Aerospace Corporation conducted an independent V&V**
- **Over 40,000 people using our products worldwide**
  - Many of whom have conducted their own V&V's
    - Including the ISS Power Group at NASA JSC
- **DII/COE Level 5 compliant**
- **Accredited to run on various gov't networks**
  - NRO, NSA, CIA
  - JWIC network (JDISS)
  - DODIIS framework (JDISS/CMMA)
- **AGI has a development staff of over 70 people who add new functionality, maintain, validate, verify, document, etc.**
- **AGI holds many patents that have been incorporated into our software technology**
  - AGI encourages employee innovation

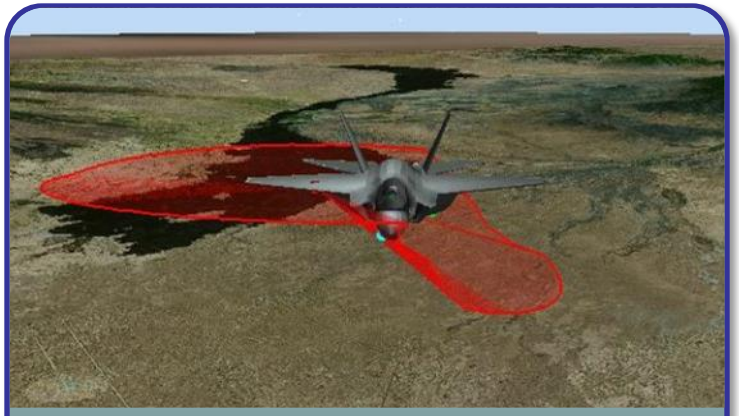
Software for Space, Defense & Intelligence

Defense Operations: Pre-Mission Planning

Models

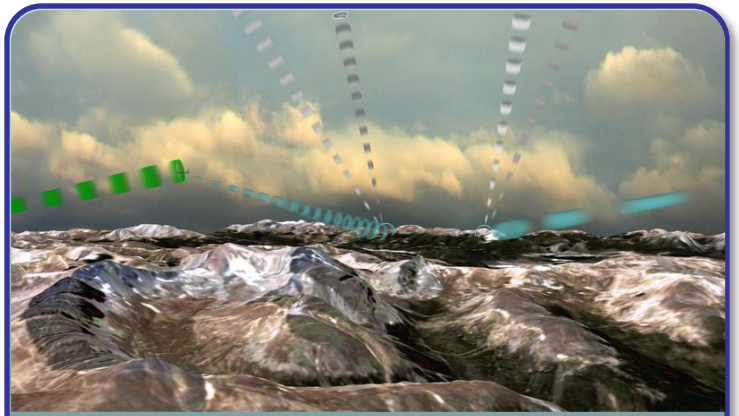
Vehicle Motion Models

Model vehicle position and attitude



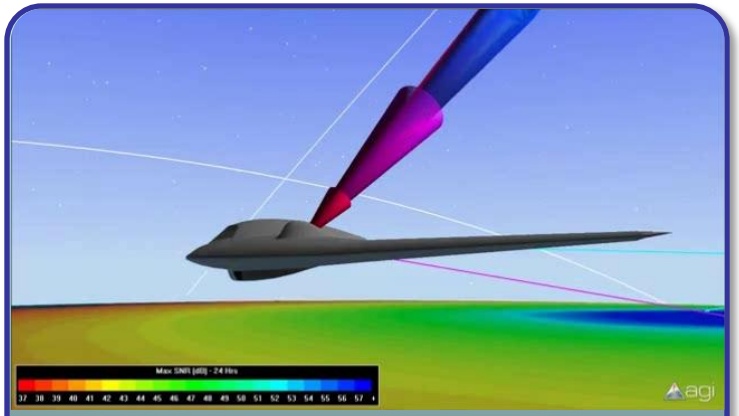
Sensor Models

Model sensor geometry & pointing



Environment Models

Model terrain, atmosphere & space



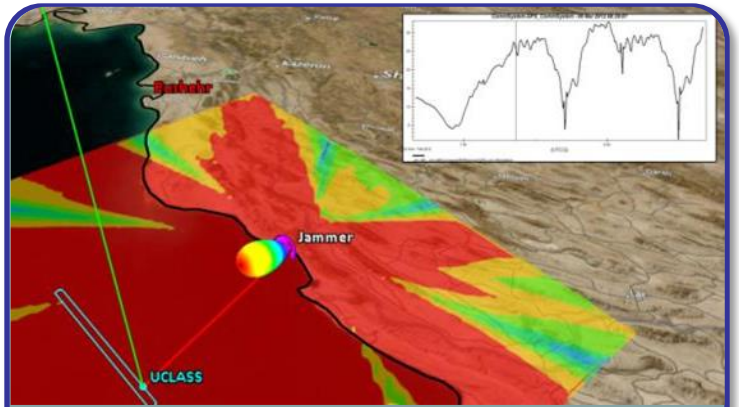
Comms & Radar Models

Model RF propagation & interference

Simulate

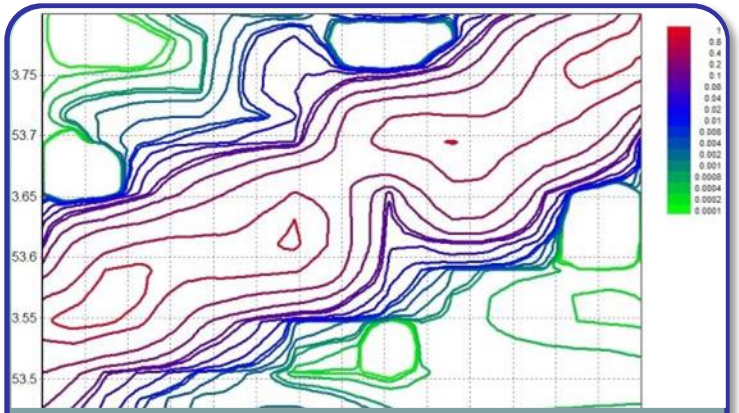
Simulate mission

Analyze system behavior in theater



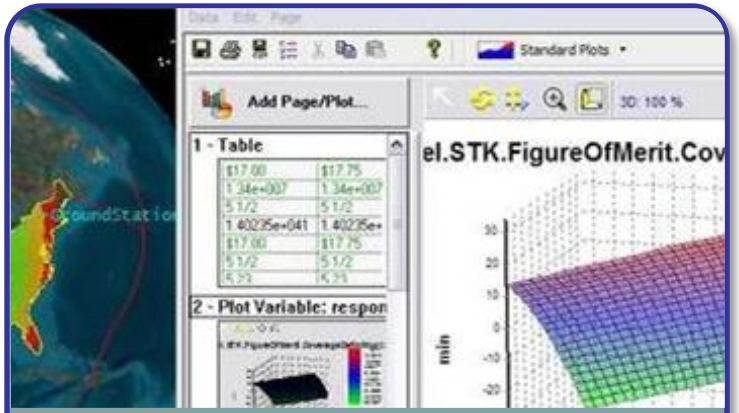
Calculate system performance

Measure against mission objectives



Evaluate system relationships

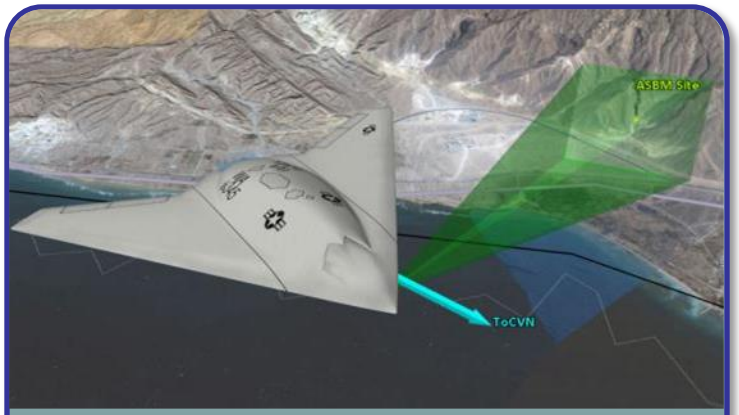
Measure system impact



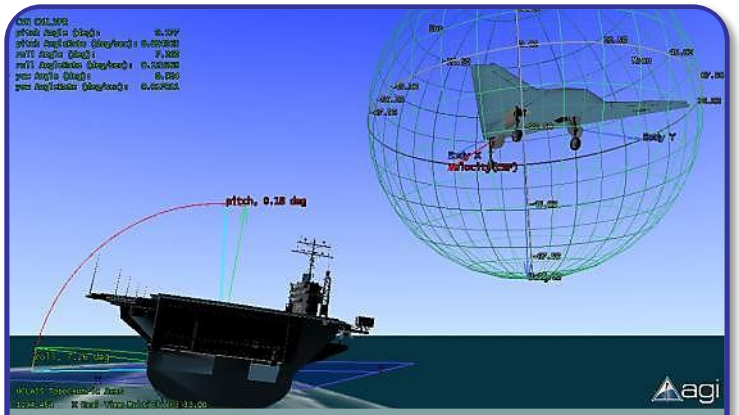
Explore trade space

Analyze system design

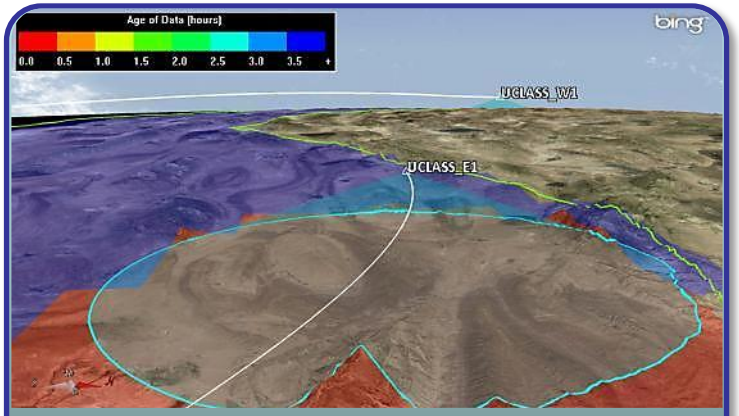
Analyze



2D and 3D visualization
Vehicles, routes, sensors & analysis



3D object representations
Position, orientation & articulation



Mission environment
Terrain & imagery

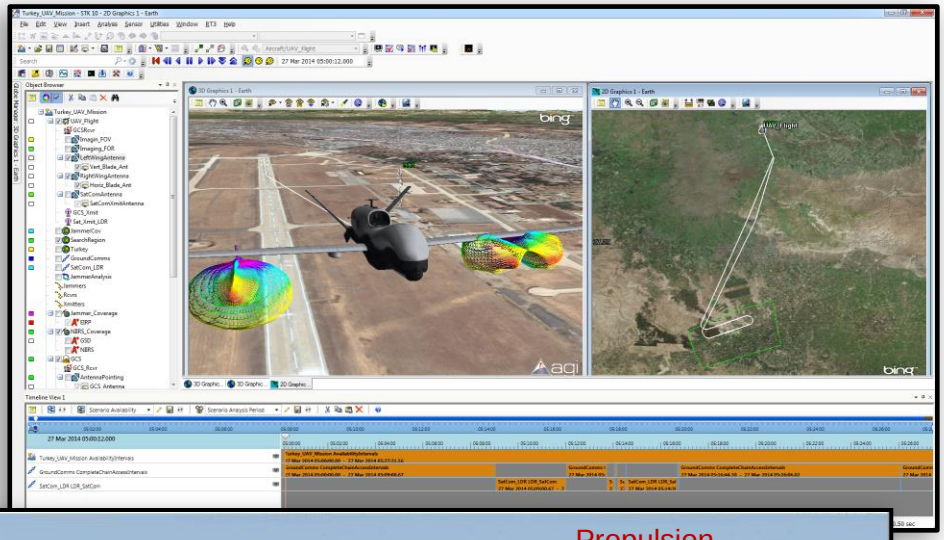
Analyze results
Graphs, reports, images & videos

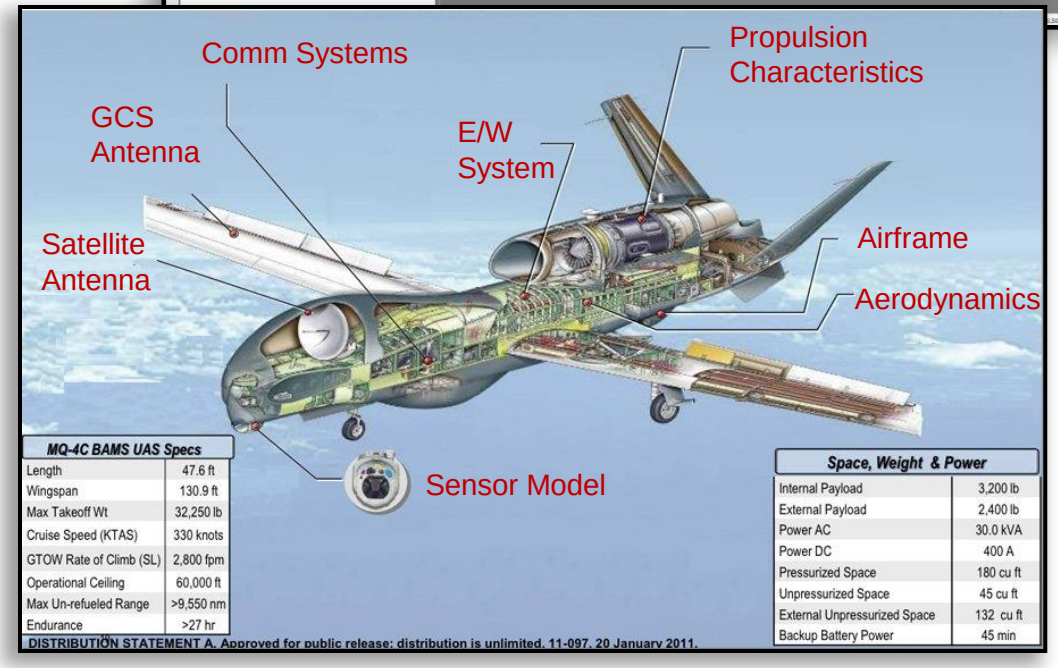
Software Demonstration

- **Mission Design**

  Operation: Turkey/Syria Border Surveillance

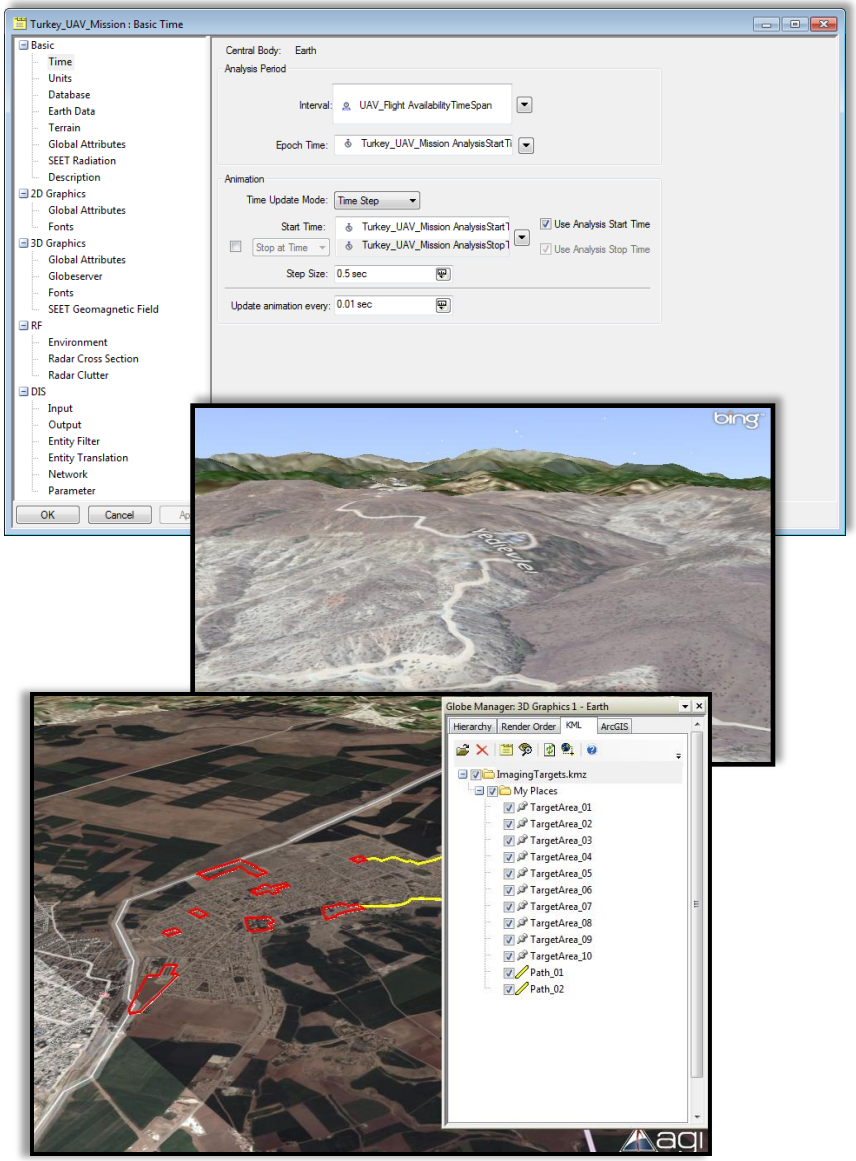
  – GlobalHawk UAV Flight
    - Flight Characteristics
    - Route Modeling
    - 3D Model
    - Antenna Designs
  – Communications Systems
    - Ground Communications
    - Satellite Relay Communications
    - Modulation/Filtering Models
  – Onboard Payloads
    - Imaging Sensors
    - Custom Scripted Imaging Quality Performance





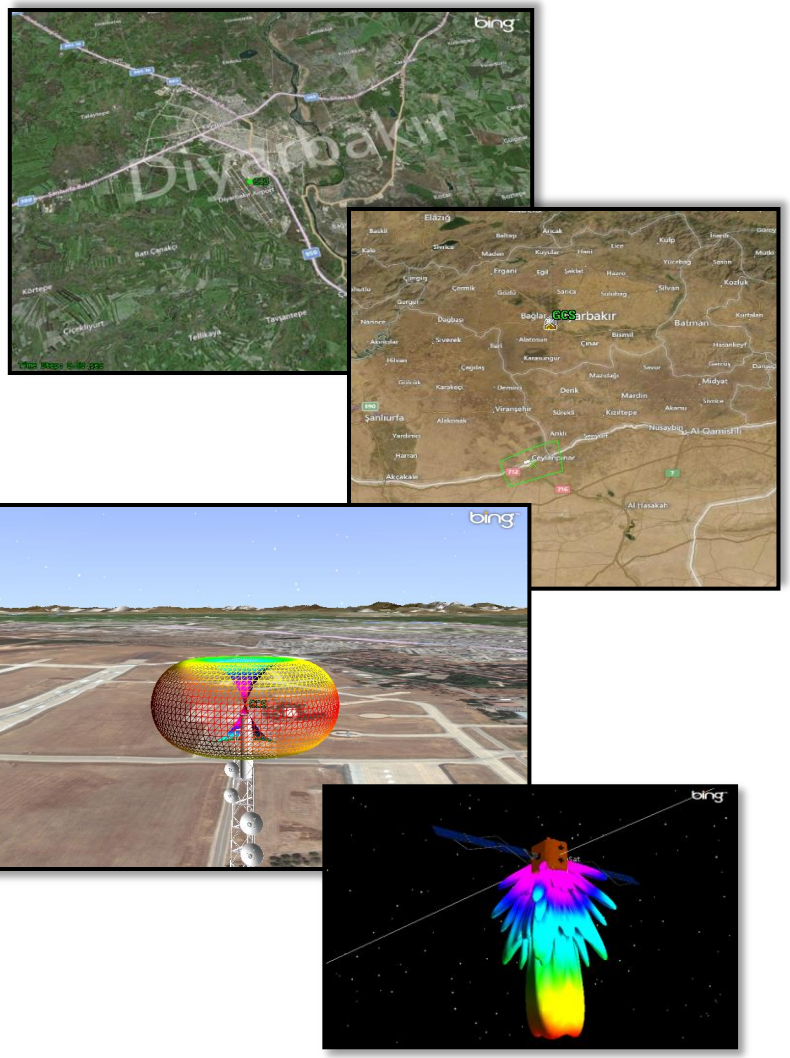
STK Scenario Setup

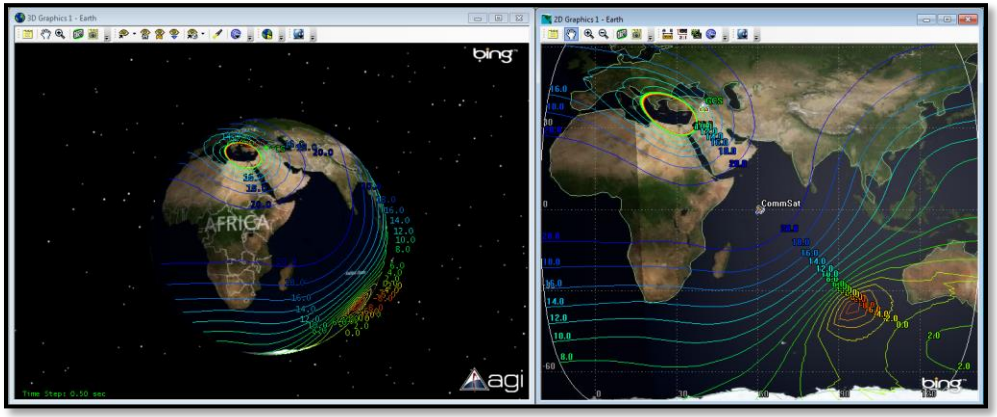
- **Time Period**
  - Analysis conducted over this time interval
- **RF Environment**
  - Models for atmospheric effects & RF propagation loss
- **Imagery/Terrain**
  - Import data sets for terrain
  - Stream imagery (WMS, Bing Maps, Etc)
  - Local imagery tiles
- **Areas of Interest/Places/Targets**
  - Shapefile data (ESRI MXD/Google KMZ)
  - Browse AGI's database for facilities/places/targets



Theater of Operations

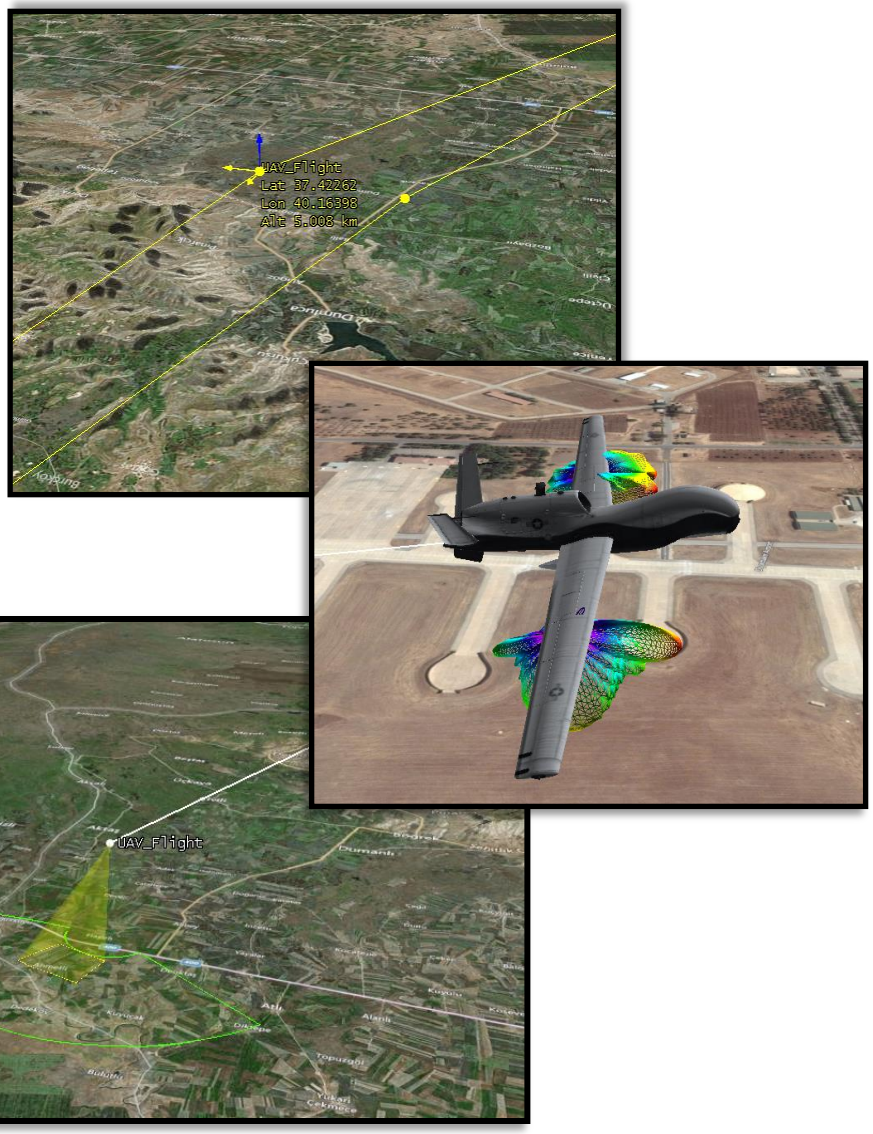
- **Airports/Runways**
  - Takeoff/Landing airport runway locations
- **Ground Control Station**
  - Location of GCS
  - Antenna modeling (STK Provided Model)
- **Satellite Relay**
  - Define satellite location/orbit regime & propagate for duration of mission
  - Antenna modeling (External Model File)





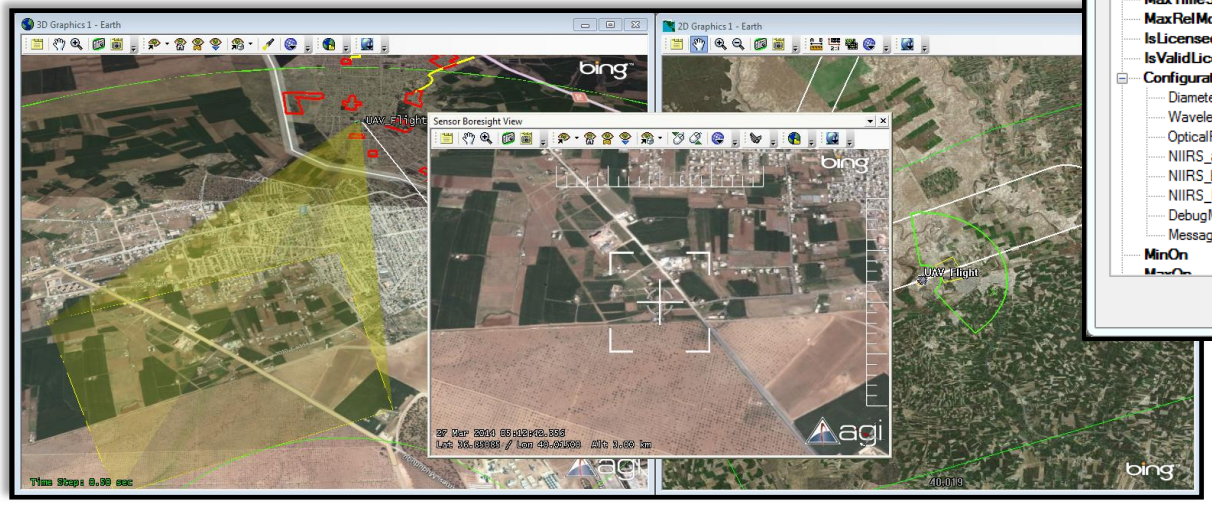
Flight Planning

- **Interactive Flight Path Modeling**
  - Vehicle performance characteristics
  - Library of procedures
  - Intuitive 3D interface
- **3D Airframe Model**
  - Accurate/Realistic model representation
  - Attach points for subsystems (Antennas/Sensors/Etc)
- **Onboard Payloads**
  - GCS Antennas
  - Satcom Antenna
  - Optical Sensors/Cameras



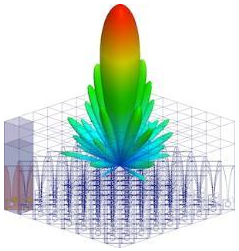
Sensor Performance

- **Optical Sensor Properties**
  - Field of View
  - Field of Regard
- **Custom Script (Image Quality)**
  - Script Defined NIIRS Image Quality Scale
  - Custom Algorithm Plugin Point
- **Sensor Coverage Results**
  - Gridded Coverage Results (Heat Map)
  - Statistical Metrics



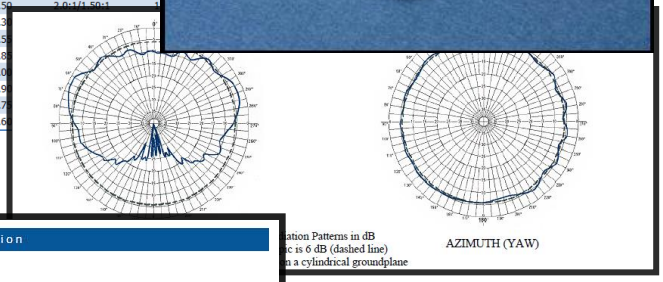
Antenna Modeling

- **Antenna Considerations**
  - Which design best supports the current mission plan
- **Antenna Data**
  - Manufacturer data
  - Test chamber data
  - Software representation of antenna designs



Communications Model

Round Blade P/N	Straight Blade P/N	Frequency Range GHz	VSWR MAX/TYPICAL	5KW¹ ALTITUDE	PEAK² POWER	Height Inches [mm]	Weight (SMA) OZ [grams]
6107	6007	1.060 ± .030	2.0:1/1.50:1	116	160 W	2.30 [58.4]	1.0 [28.3]
6108	6008	0.9165 ± .025	2.0:1/1.50:1	116	160 W	2.30 [58.4]	1.0 [28.3]
6109	6009	1.35 – 1.54	2.0:1/1.50:1				
6110	6010	1.43 – 1.54	1.5:1/1.25:1				
6110-2	6010-2	1.425 – 1.525	1.5:1/1.25:1				
6110-3	6010-3	1.45 – 1.65	2.0:1/1.50:1				
6110-4	6010-4	1.50 – 1.80	2.0:1/1.50:1				
6115	6015	1.60 – 1.70	1.5:1/1.25:1				
6120	6020	1.71 – 1.85	1.5:1/1.25:1				
6125	6025	2.00 – 2.10	1.5:1/1.25:1				
6125-1	6025-1	2.00 – 2.30	2.0:1/1.50:1				
6130	6030	2.20 – 2.30	1.5:1/1.25:1				
6130-1	6030-1	2.30 – 2.40	1.5:1/1.25:1				
6130-2	6030-2	2.40 – 2.50	1.5:1/1.25:1				
6130-3	6030-3	2.20 – 2.40	1.5:1/1.25:1				
6130-4	6030-4	2.30 – 2.50	1.5:1/1.25:1				
6130-6	6030-6	2.20 – 2.50					
6135-1	6035-1	3.10 – 3.3					
6135-2	6035-2	3.45 – 3.5					
6135-3	6035-3	3.65 – 3.8					
6140	6040	4.50 – 5.0					
6150	6050	5.40 – 5.9					
6150-1	6050-1	5.27 – 5.7					
6150-2	6050-2	6.40 – 6.6					

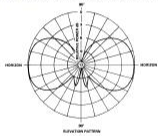


product specification

Broadband Omnidirectional Antenna
For L- Through S- Band

Type 58200-14 discone antenna provides omnidirectional azimuth coverage for the frequency ranges L through S bands.

The unit offers light weight, extreme ruggedness, and highly reliable operation. Corrosion-resistant materials and stainless steel or bronze hardware are utilized in the construction of this antenna. It is ideally suited for monitoring applications or as a base station antenna for ground to air communications and telemetry.



Characteristics of type 58200-14

Frequency range, MHz	1435-2300
Gain, nominal, dBi	2.0
VSWR, maximum	2
Polarization	Vertical
Azimuth beamwidth, degrees	360
Elevation beamwidth, degrees, nominal	75
Input power, watts, CW	400
Input connector	Type N Jack (female)
Windload rating, mph, (km/hr)	200 (320)
Maximum diameter, inches (mm)	360
Maximum length, inches (mm)	12.5 (320)
Weight, lbs (kg)	1.5 (0.7)
Mounting to pipe diameter, inches (mm) clamps included	1.062 (27)

ANDREW. Connecting the Wireless World

Andrew Corporation
10500 W. 153rd Street
Orland Park, IL 60462 USA

Customer Support Center
From North America:
Telephone: 1-800-255-1479
Fax: 1-800-349-5444
International:
Telephone: +1-708-873-2307
Fax: +1-708-349-5444

Internet
www.andrew.com

Fax-On-Demand
From North America:
1-800-861-1700
International:
+1-708-873-3614

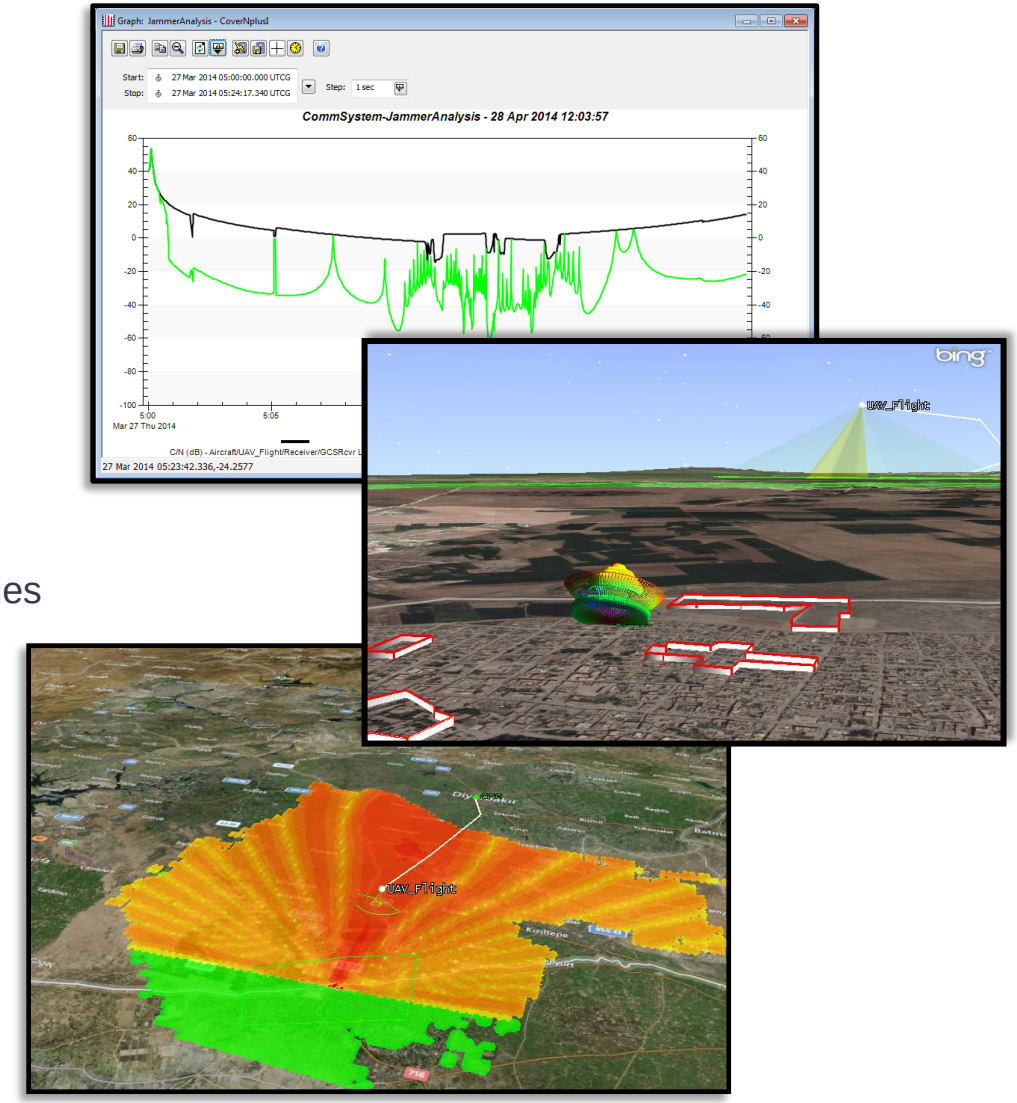
All designs, specifications and availabilities of products and services presented in this bulletin are subject to change without notice.

Bulletin 1320 (Rev6 07/03) Copyright © 2003 Andrew Corporation, Orland Park, IL 60462 USA

Printed in USA

Communication Analysis

- **Ground Communication Link**
  - Link Budget Calculations
  - Antenna Considerations
  - Communication Windows/Timeline
- **Satellite Communication Link**
  - Communication Windows
  - Decreased Data Rates
  - Amount of Data Relayed
- **Jamming Analysis**
  - Theoretical Jammer Location/Capabilities
  - Jammed Signal Degradation
  - Mitigate Jamming (Filtering)
  - Spectrum Analysis

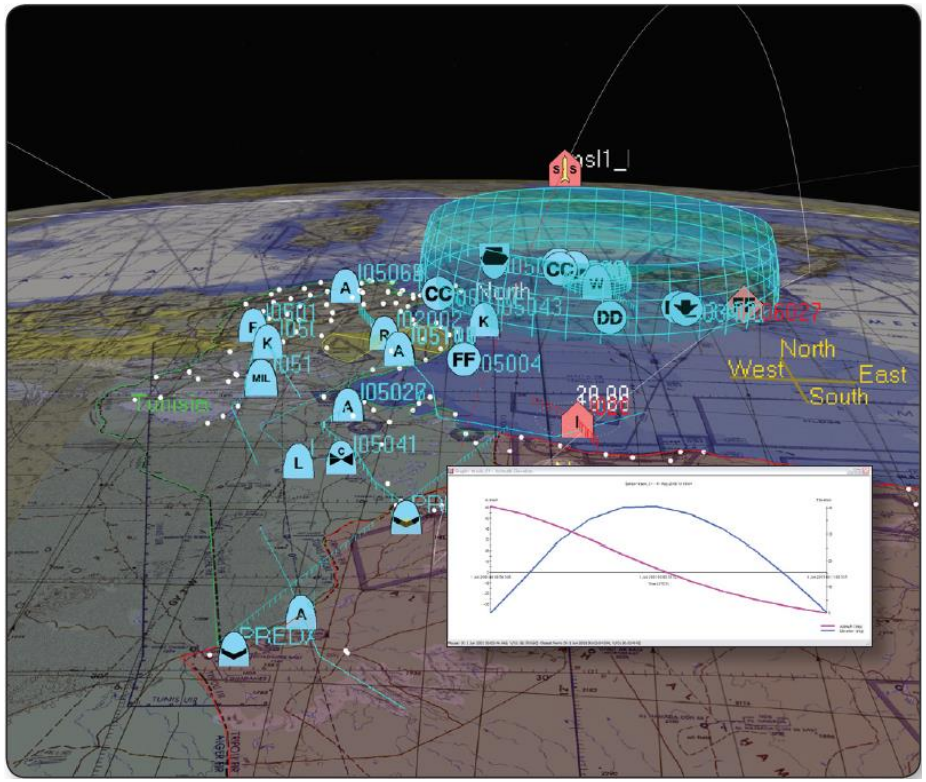


Software for Space, Defense & Intelligence

Defense Operations:
Real-time Operations

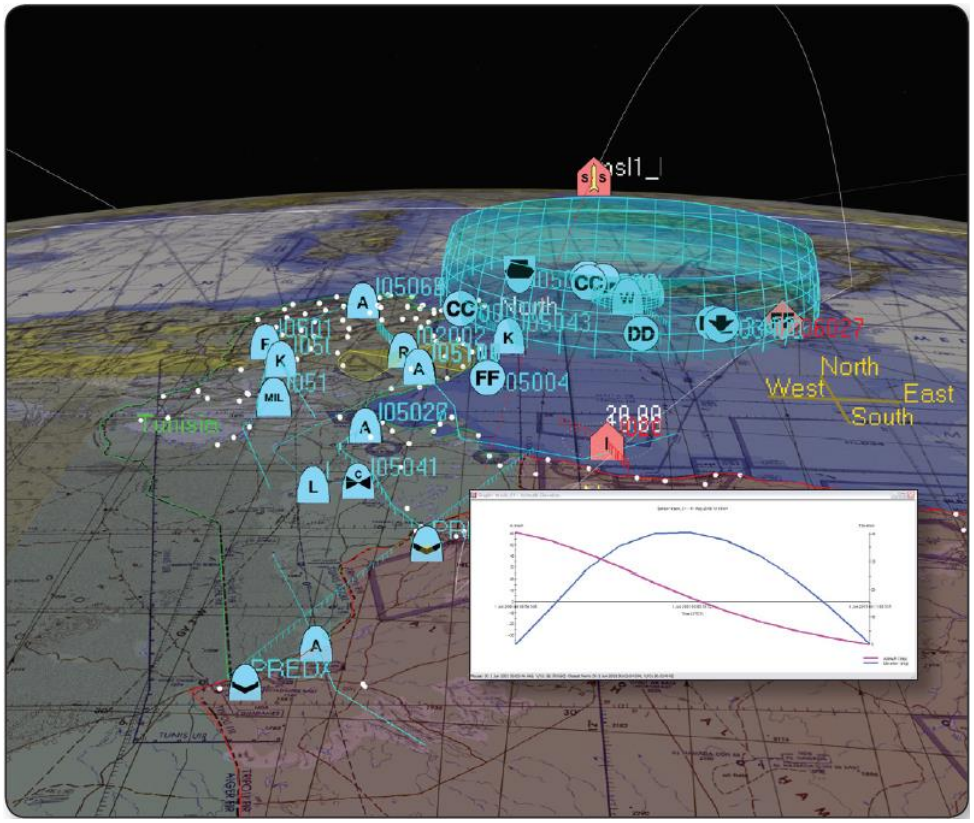
AGI solutions for real-time data

- **COTS software for display and analysis of live data**
- **Applications**
  - Decision support displays
  - Common operating pictures
  - UAV operations software
- **Products for all solution architectures**
  - Stand-alone applications
  - Service oriented architectures



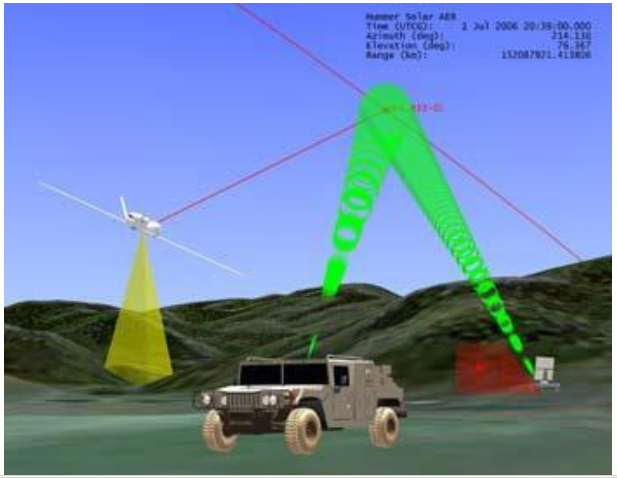
Real-time tracking (RT3)

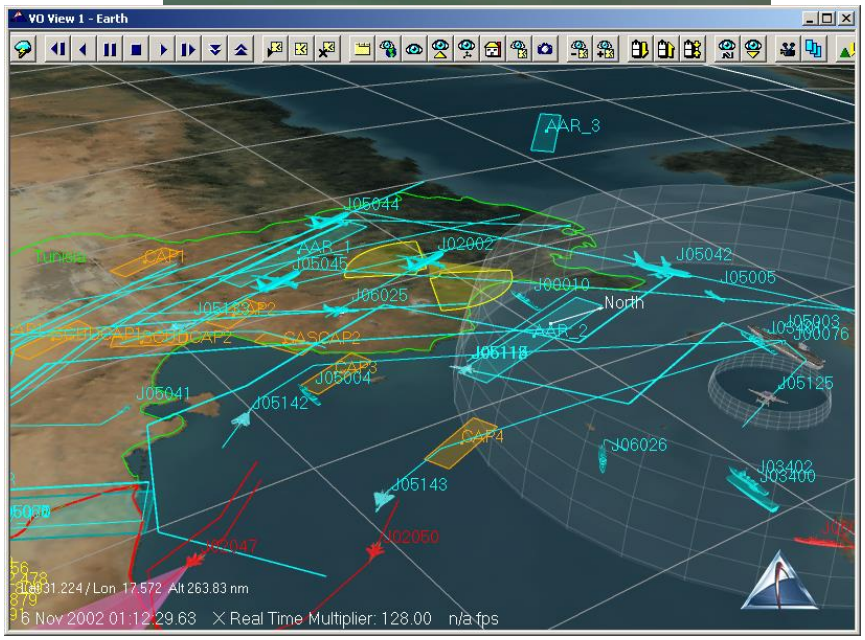
- Display and analyze multiple simultaneous data feeds
- Compatibility with common feed formats
- Automated event monitoring
- Automated actions on events
- Archiving and playback capability
- Data analysis



Distributed simulation

- **Includes all of the Real-time tracking capabilities plus:**
  - MÄK's VR-Link toolkit for interfacing with the most common network simulation standards
  - Interoperable interface that provides easy integration with modeling and simulation environments
  - Interoperate with simulation protocol standards (DIS, HLA)



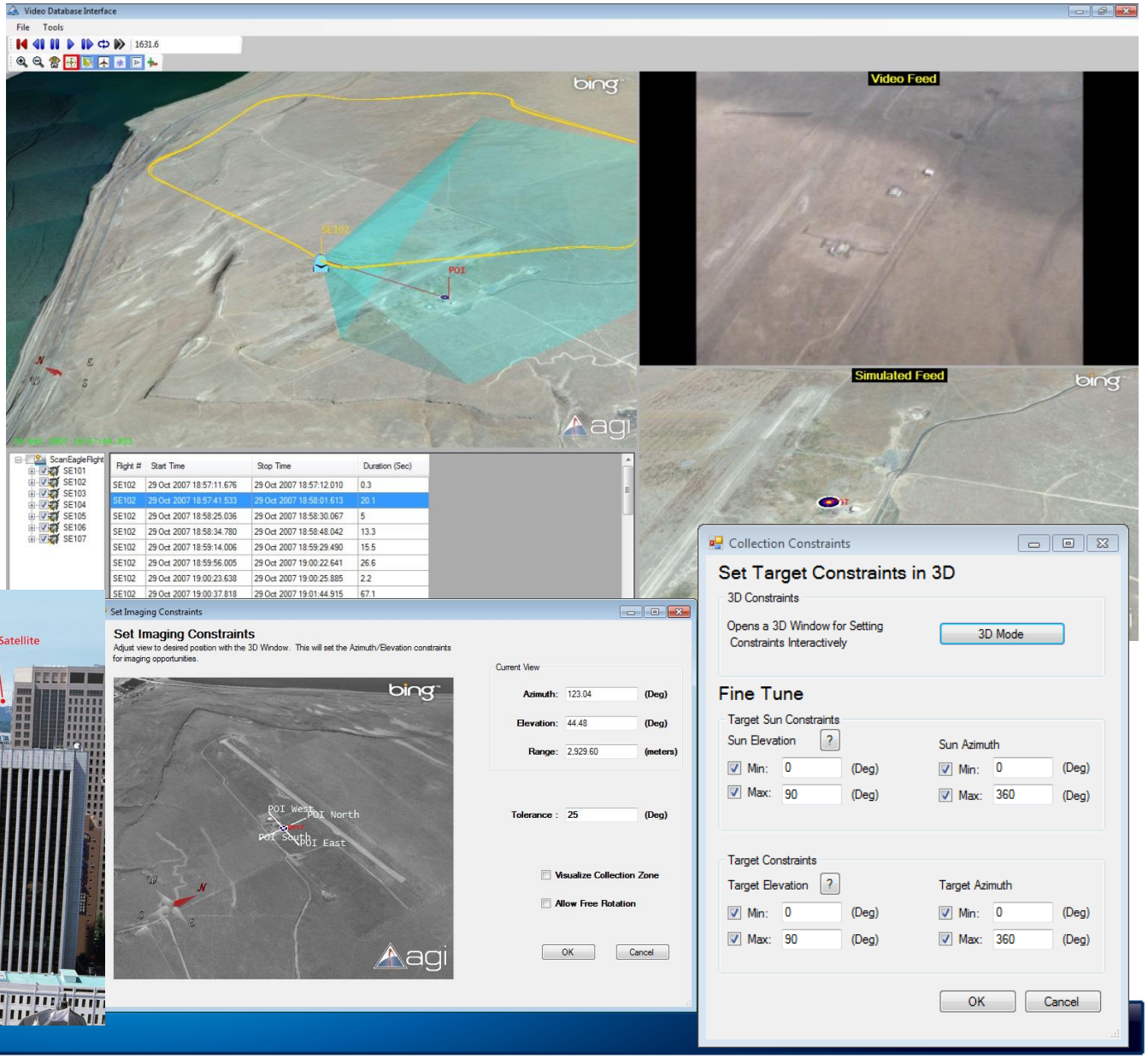


Software for Space, Defense & Intelligence

Defense Operations: Post-Mission Analysis

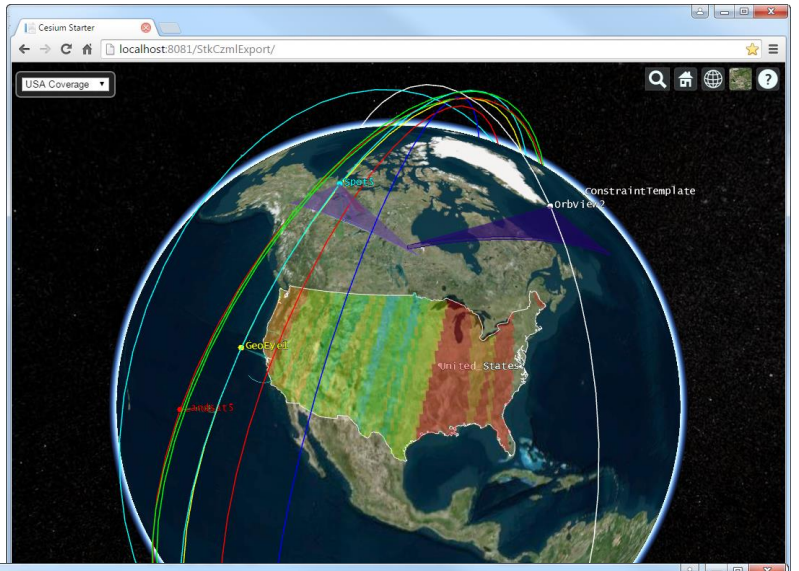
Video Exploitation / Demo

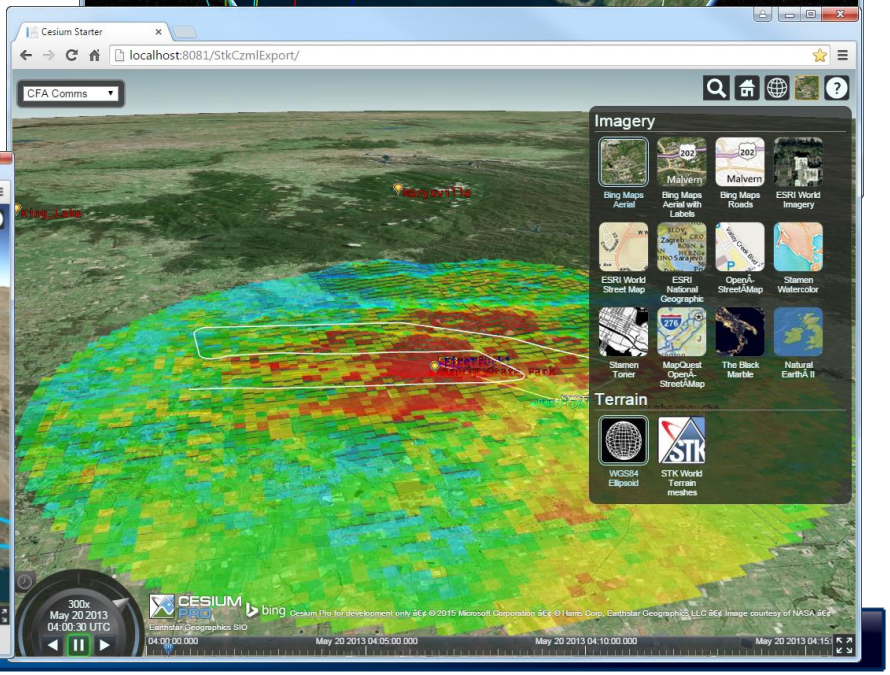
- **Data Fusion**
  - Quick Search for Desired Video
  - Custom Interface
  - Easy to Use!!
- **Interoperable**
  - Imagery Data
  - Video Data
  - GIS Information

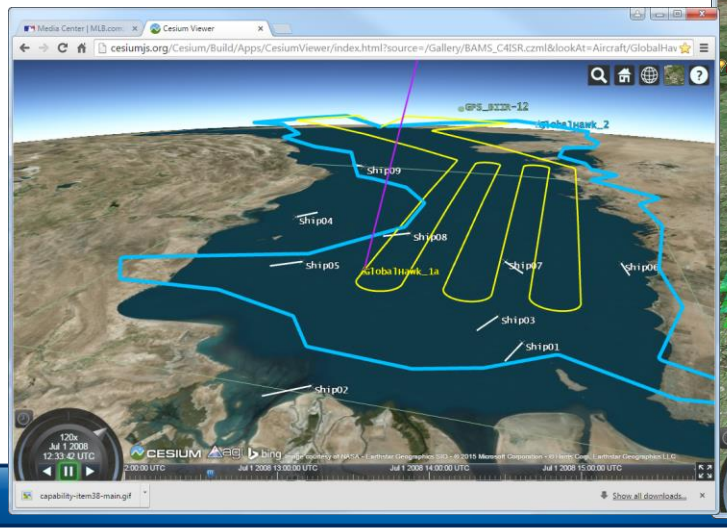


Share results in Cesium

- Publish post mission data for visualization in Cesium
- No install or plugin required
- Streaming terrain, imagery, video







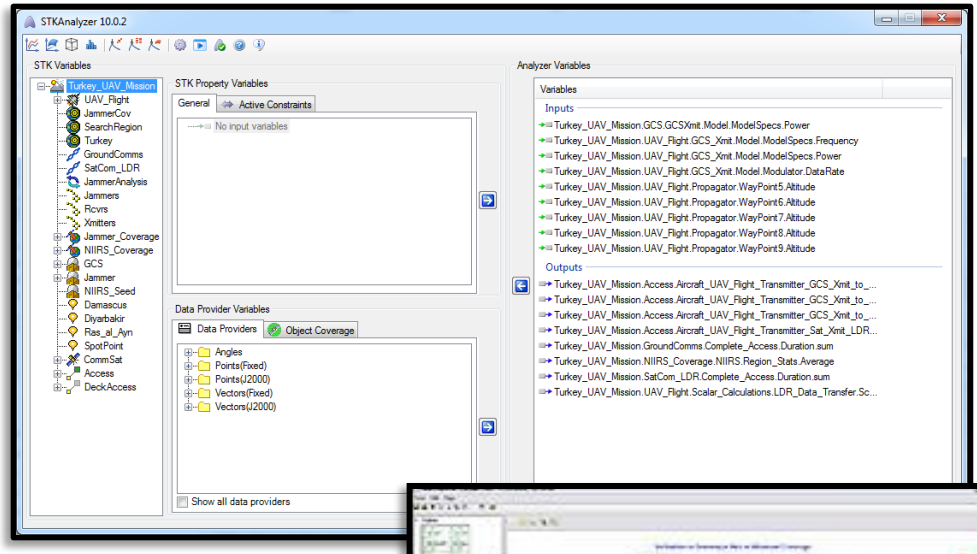
Break

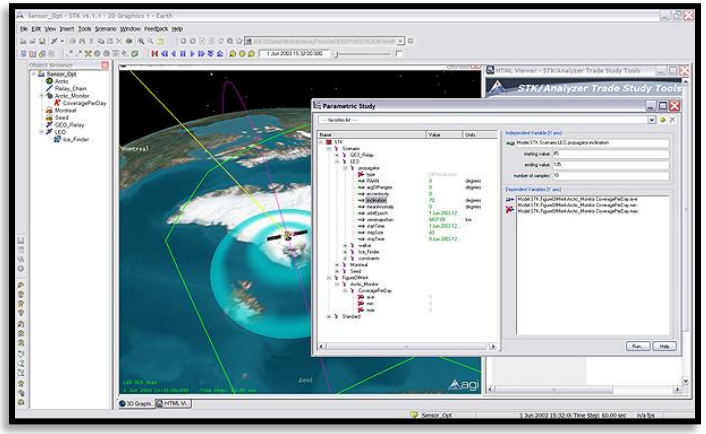
Software for Space, Defense & Intelligence

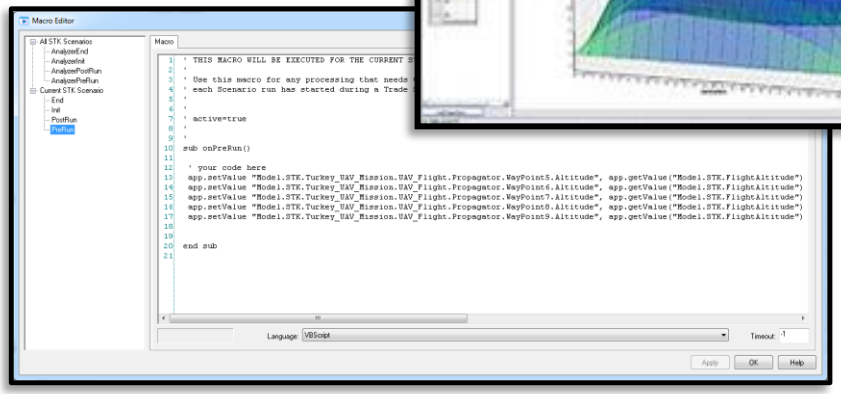
Engineering Defense Systems: Model Based System Engineering

Trade Studies

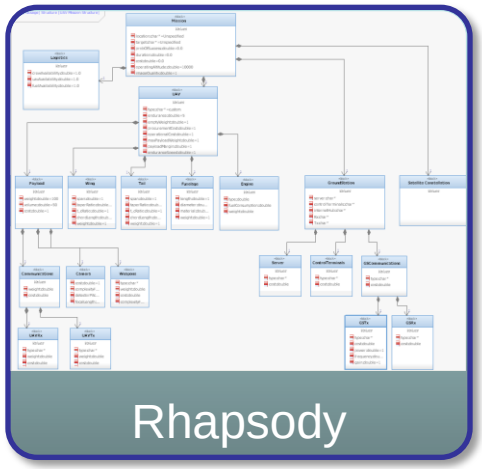
- **STK Analyzer Product**
  - Automated Trade Study Tool
  - Many Studies to Choose
  - Drag/Drop Interface
  - Directly Ingest STK Properties & Analysis
  - Vary One/Many STK Parameters & Identify Results of Interest
  - Macro Scripting Interface

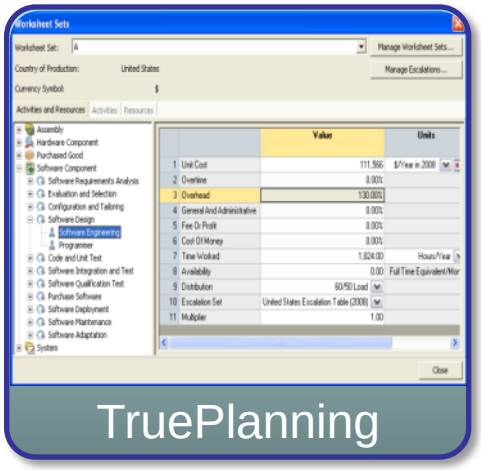


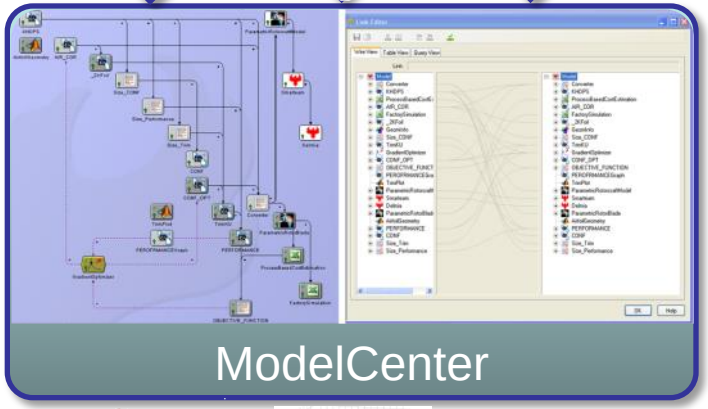


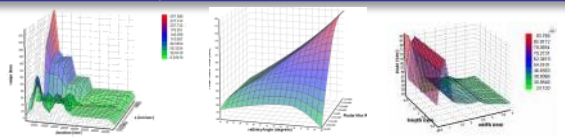


ModelCenter

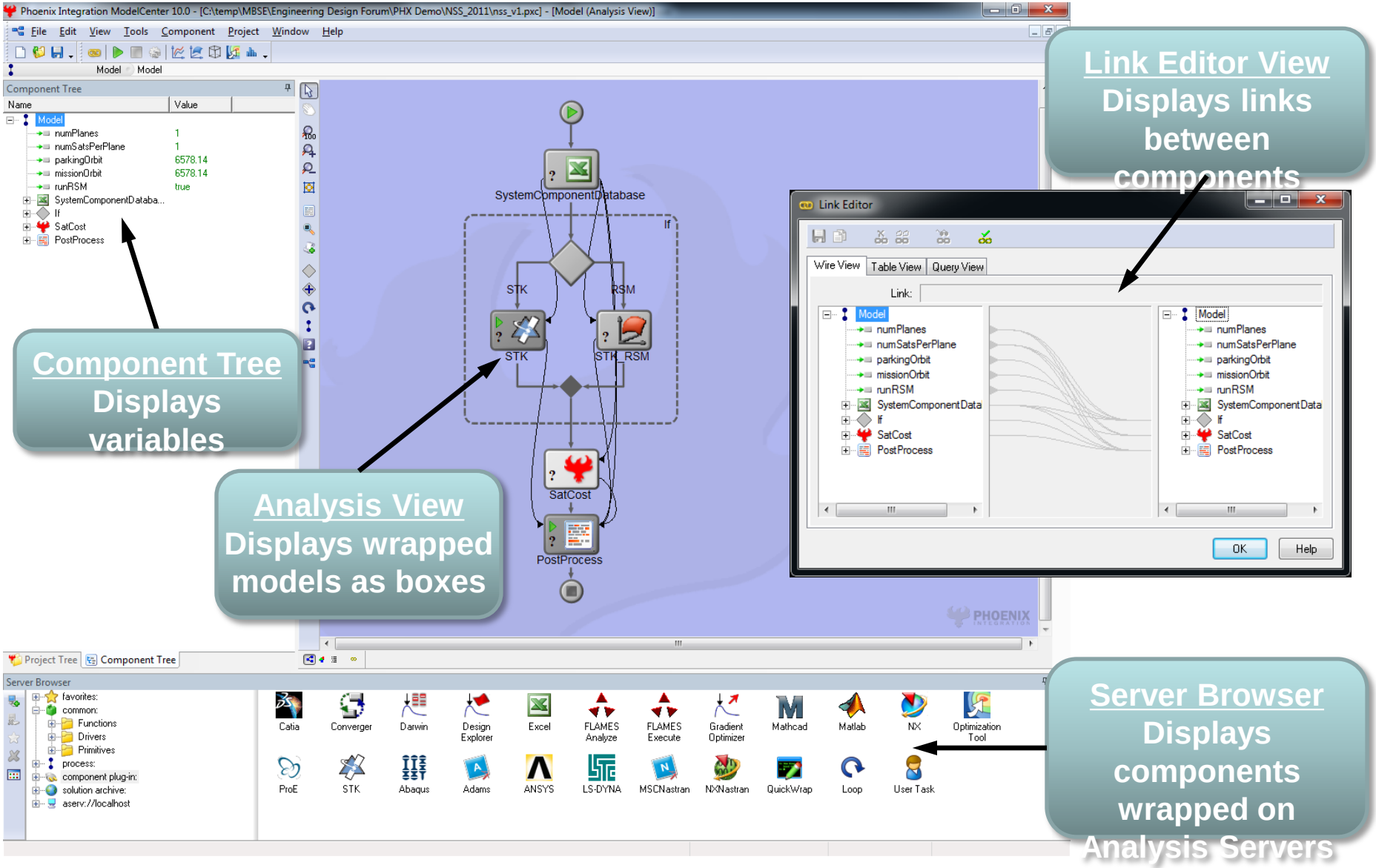








ModelCenter Interface



Component Tree
Displays variables

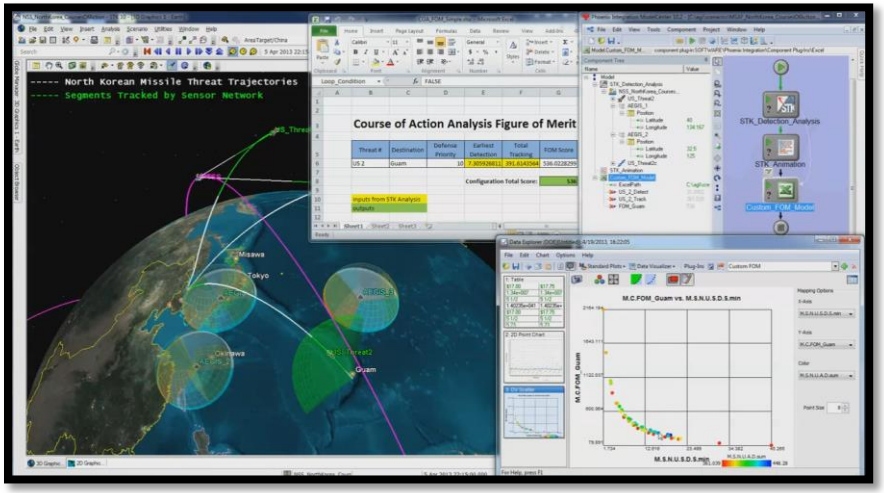
Analysis View
Displays wrapped models as boxes

Link Editor View
Displays links between components

Server Browser
Displays components wrapped on Analysis Servers

Missile Defense COA Analysis (Korea)

What is the best location to position defensive assets to detect a number of potential threat missiles?



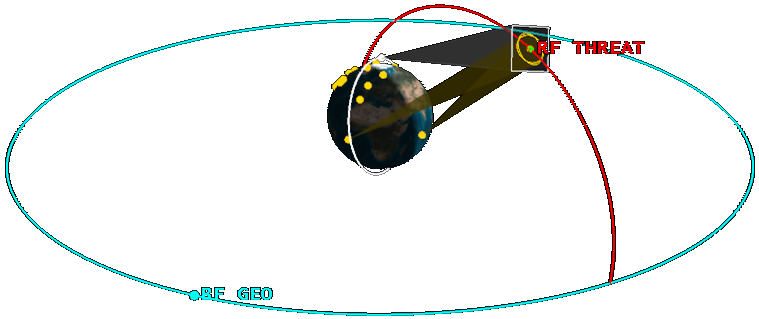
Models linked

- Threat Flyouts (external trajectories)
- Space-based detections (STK)
- AEGIS Radar Detections(STK)
  - Earliest detection
  - Longest tracking
- Engagement FOM (Excel)
  - Threat priority
  - Overall FOM value

Multiple asset location parameters changed over Design of Experiments (DOE) to provide informed decisions of asset deployment

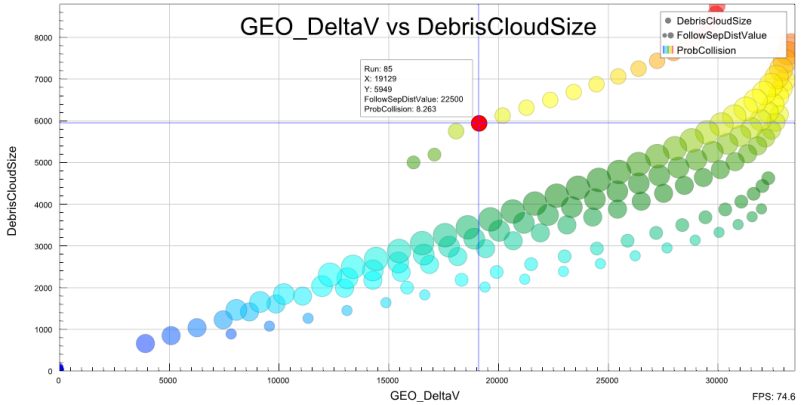
GEO Kinetic Defense Assessment

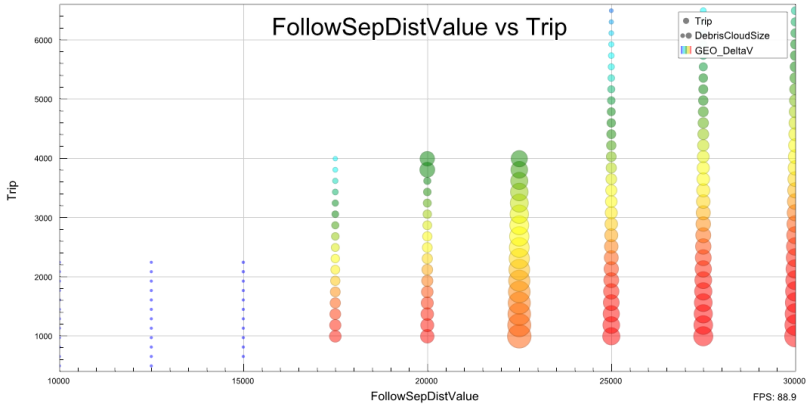
Assess potential for a co-located defensive payload to protect Geostationary assets from LEO based threat profiles



- **Control Variables**
  - Defensive Launch Time
  - Flight time of KKV

- **Evaluated Parameters / Models**
  - Range at impact
  - Time from impact to GEO crossing
  - KKV DeltaV required (Astrogator)
  - Cost/sizing of KKV (Excel)
  - Debris cloud size (MATLAB)
  - Probability of Collision (CAT)





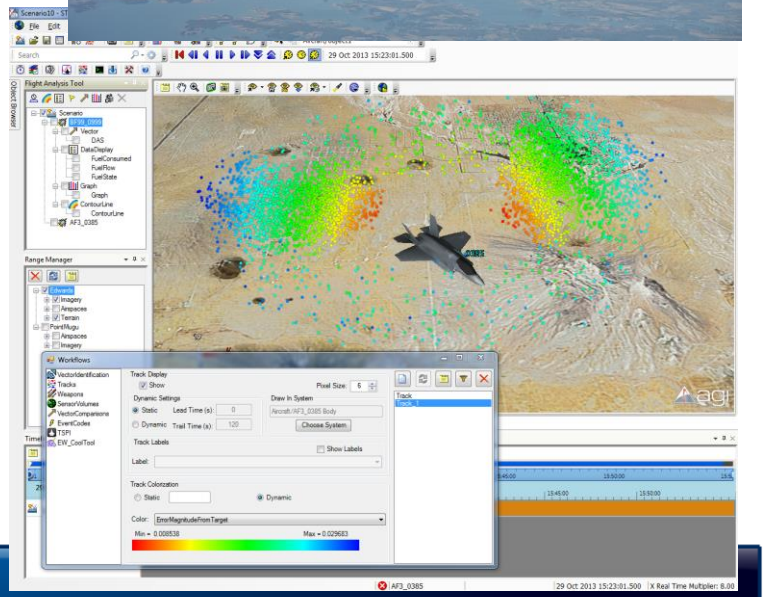
Video of Demo SDF Location

Software for Space, Defense & Intelligence

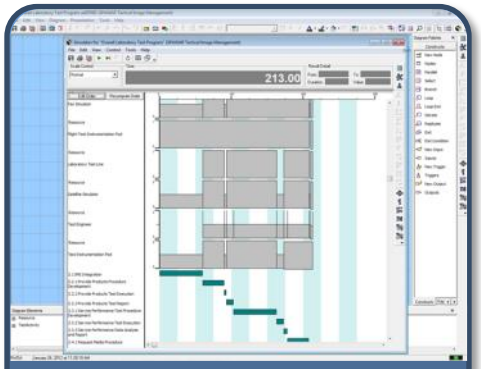
Engineering Defense Systems: Test and Evaluation

AGI's Test and Evaluation Toolkit

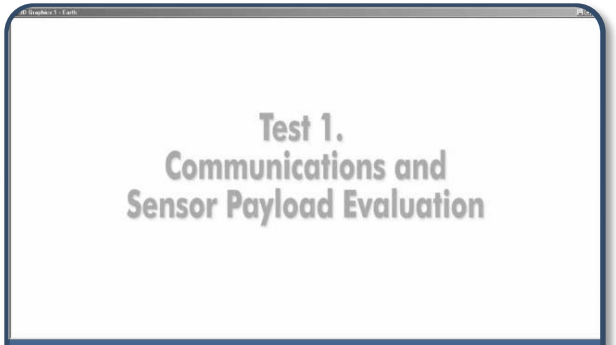
- **AGI Software Selected for F-35 Lightning II Program**
  - IMPROVE
    - Flight test plan and execution robustness
    - Test point density
    - Post-flight forensics analysis
  - ACCELERATE
    - Flight test process efficiency
    - Post-flight quick-look and anomaly resolution
    - Communications and test briefings
  - REDUCE
    - Re-planning cycle time
    - Re-fly rate
    - Test program costs and schedule



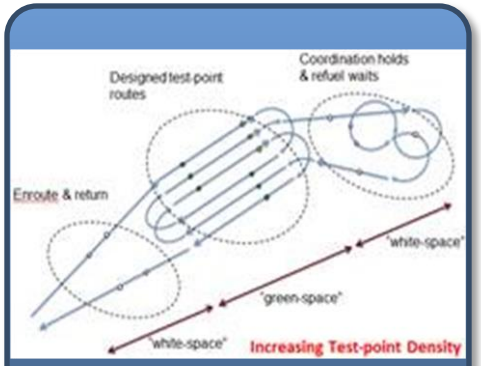
STK Impact Across Test and Evaluation Process



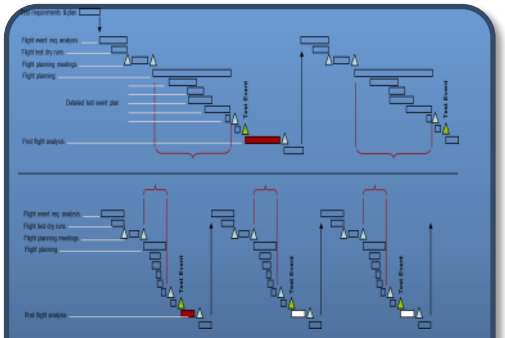
Test scheduling



Test event simulated in STK

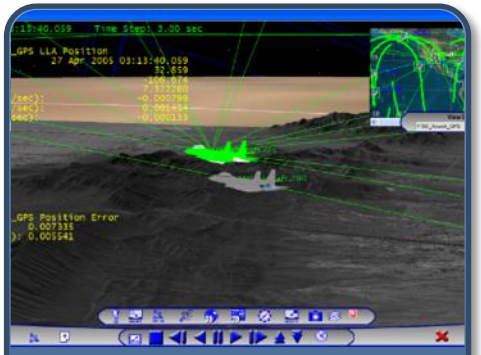


Test route optimization



Schedule compression using new processes

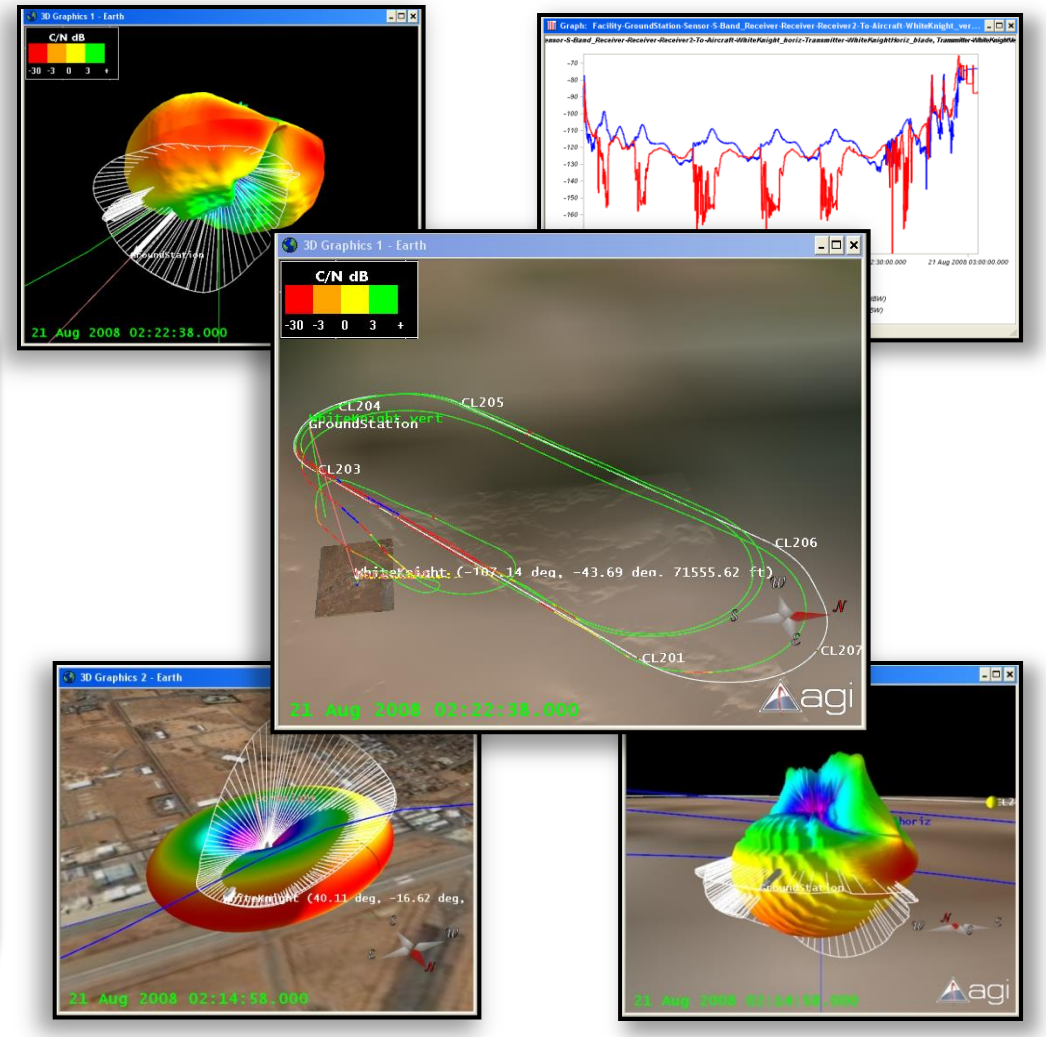
Test event monitored in real time



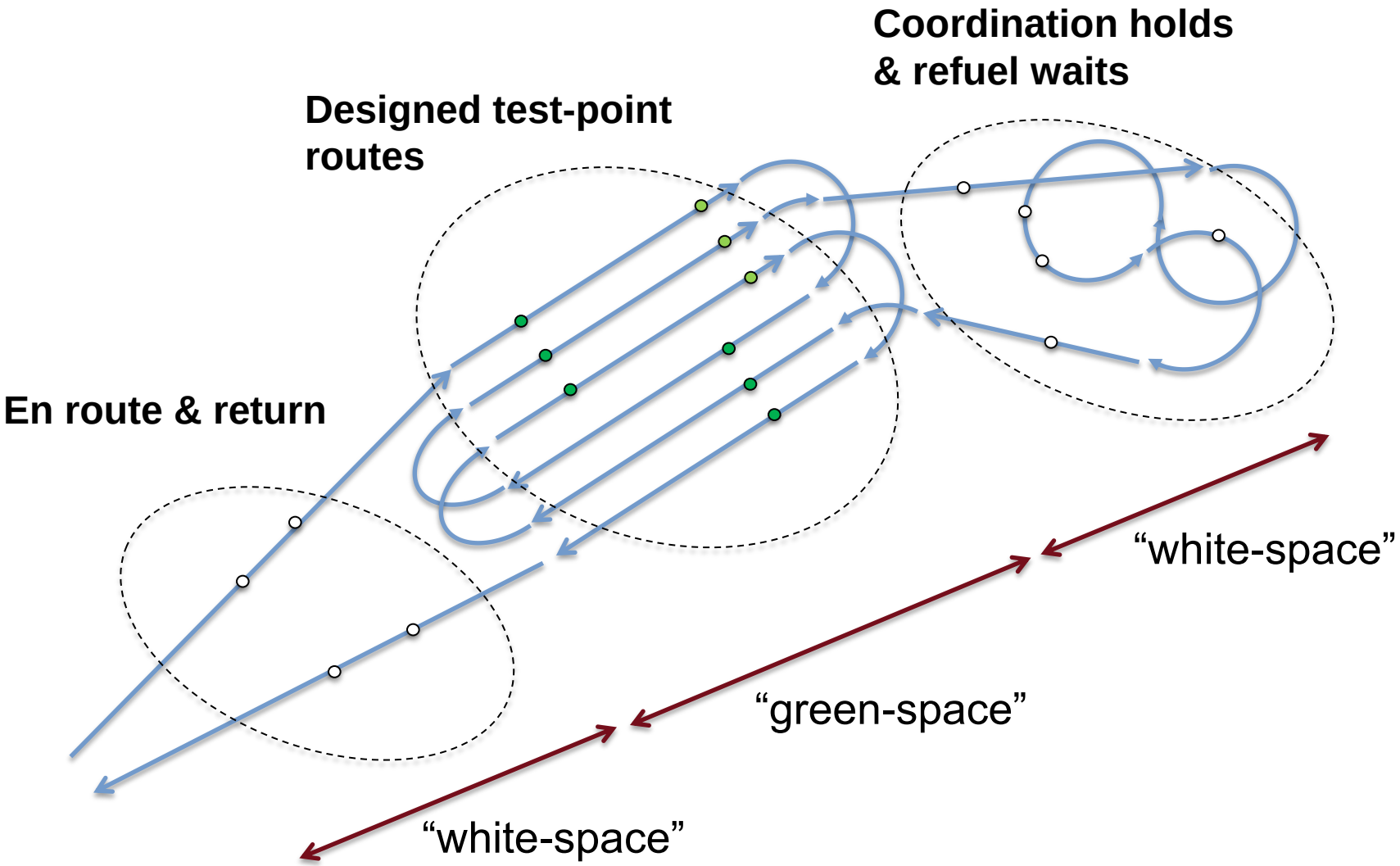
Quick-turn post-flight analysis

Develop Test Plan

- Create “Scenario” in STK
  - Time Period
  - Terrain
  - Imagery
  - RF Environment
- Create “Objects”
  - Aircraft
    - Aircraft System Models
    - Sensors/Comms/Etc
  - Targets
    - Radar Cross Section
  - Areas of Interest
  - Test Point Locations
- Data Sources
  - GIS/KML/Shapefile/Etc.



Increasing Test-point Density per Flight



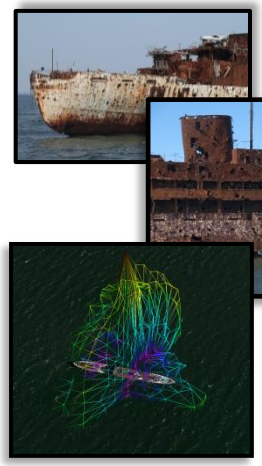
Software Demonstration

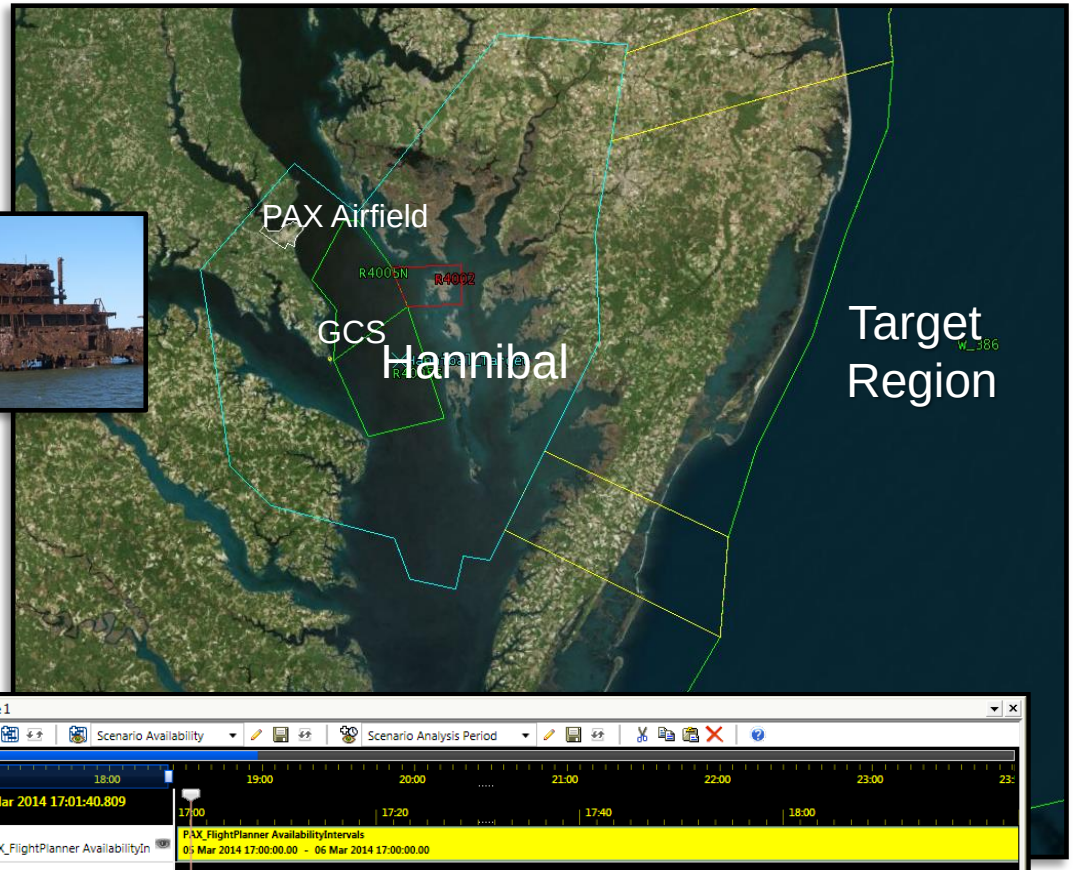
PAX River Flight Test

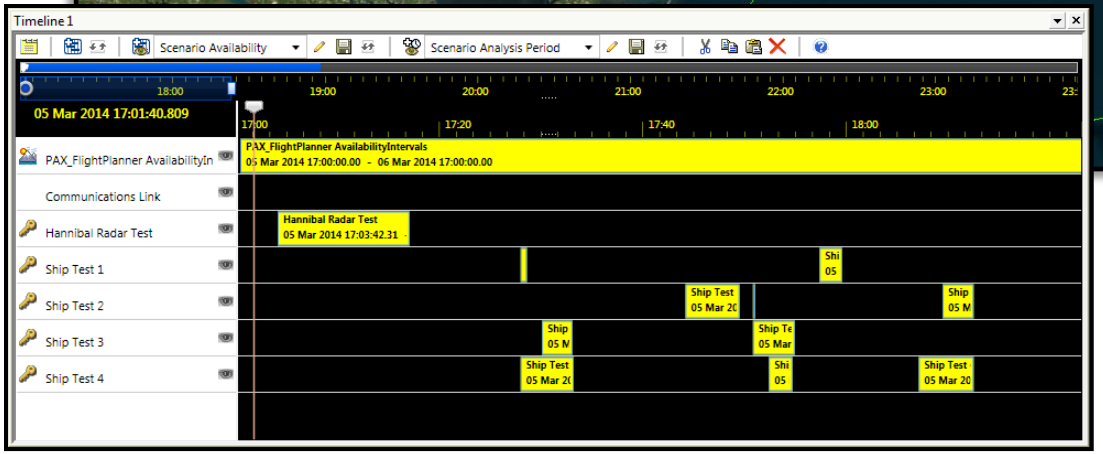
- **Radar System Test**
  - Flight pattern around "Hannibal" target
  - Model "Hannibal" in STK for radar test
- **Comm System Test**
  - Ground comm systems test
  - Model xmit/rcvr in STK
- **Target Acquisitions**
  - Various ship detection tests
  - Model ship targets & detection criteria

Challenges

- Test Event Coordination
- Timing
- Fuel Considerations







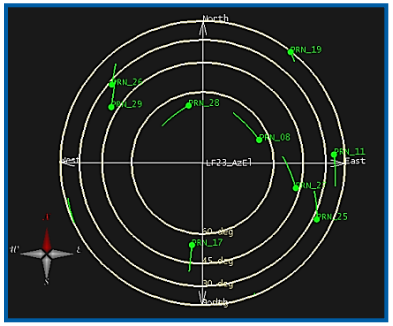
STEPAL

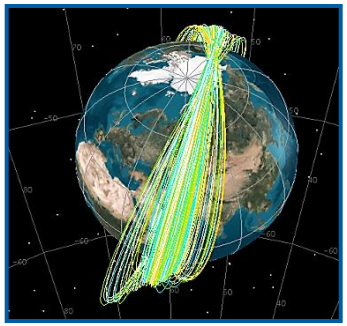
Missile Flight-test Planning and Analysis

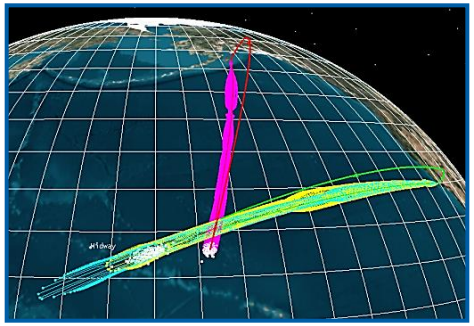
Problem: Constant, high-pressure tasks requiring complex, unique analysis approaches. Clearly communicate results to decision-makers.

Solution: STK out of the box and custom workflows via STK's open APIs. 3D animations convey complex dynamics.*

Outcome: Seven years of high customer satisfaction and increased contract support to Missile Defense Agency.







*"*Much of STEPAL's work went to the President, essentially unchanged."* - LTG Obering, former director MDA

'STK's off-the-shelf capability and flexibility allows STEPAL to successfully execute challenging analysis tasks.'

—Frank Grose, senior space systems analyst, SAIC

Software for Space, Defense & Intelligence

Engineering Defense Systems: Hardware-in-the-loop Simulation

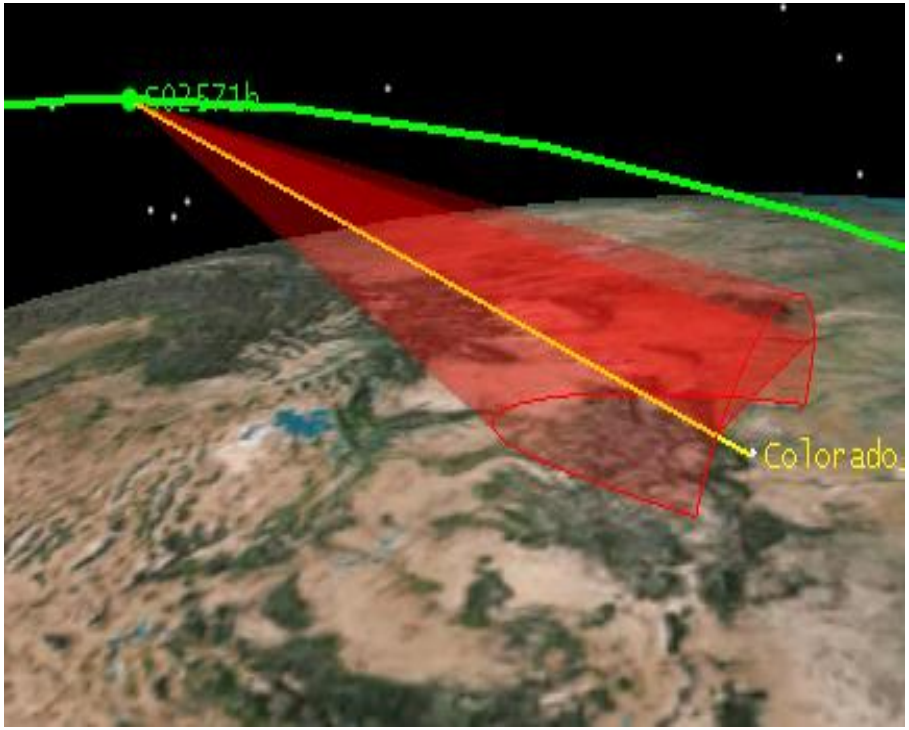
What is a Channel Simulator?

Key feature of product:

Re-creating signals that *precisely* reflect those encountered in nature:

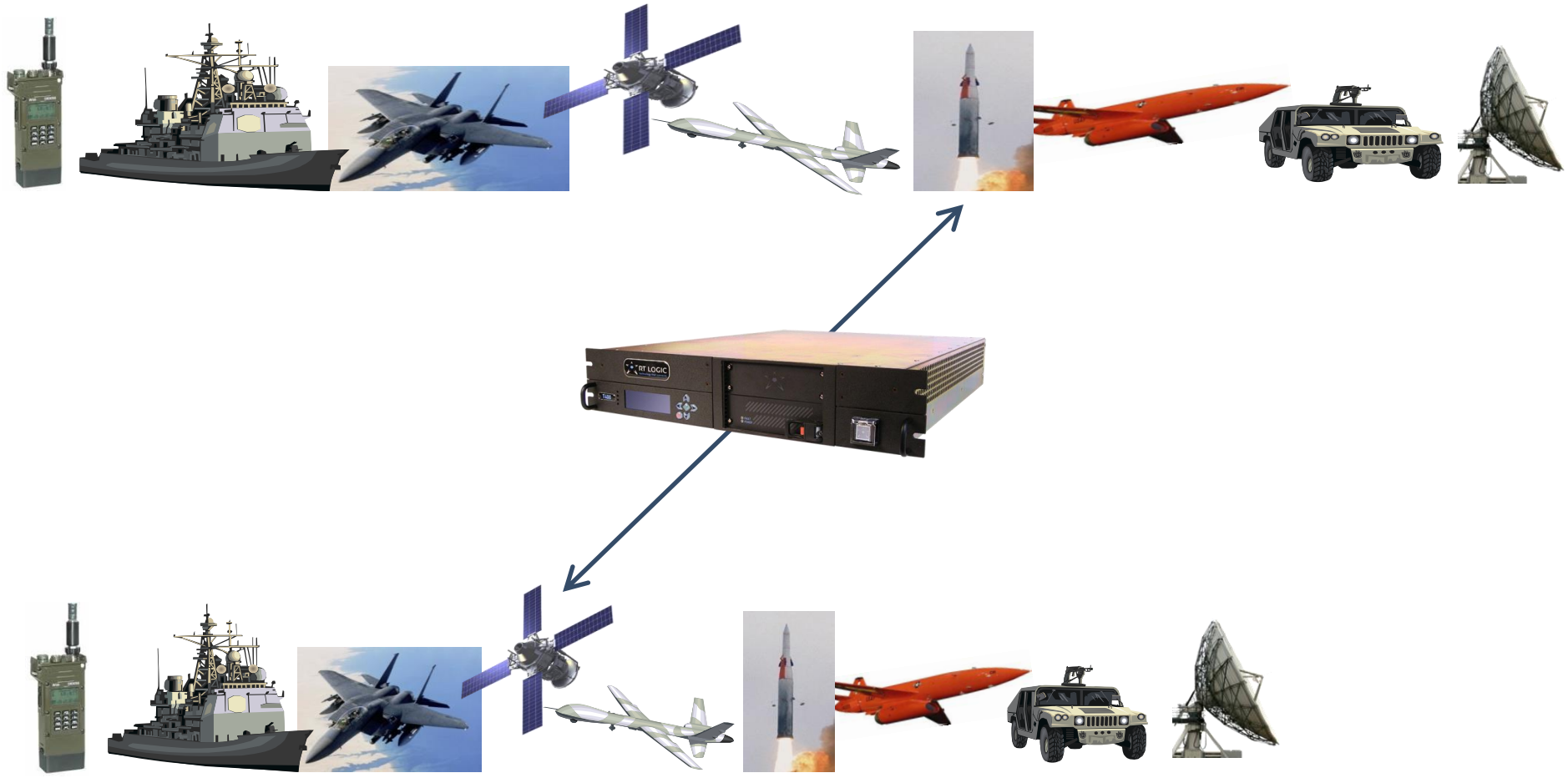
- **Dynamic, real-time testing**
  - Physics compliant
  - Phase continuous

Relative motion and flight paths relate to most of the difficult conditions that need to be tested against
Realistic testing saves time and money, assures data integrity, increases credibility, reduces risk



RT Logic Channel Simulator

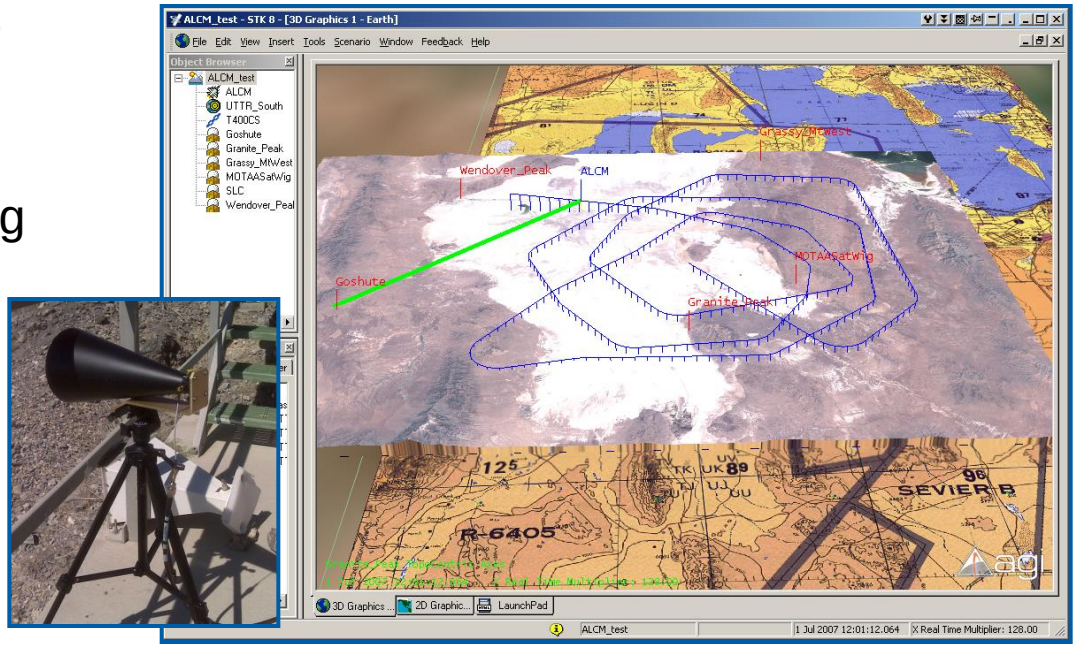
The Channel Simulator can model paths between *any* RF comm devices



Improved Test Range Operations

Problem: Precisely replicate RF signals as they would appear in nature to support range planning and rehearsal.

Solution: Drive RF channel simulator using STK Engine.



Outcome: Integrated mission model and accurate wireless communication that allows range operators to model all aspects of range.

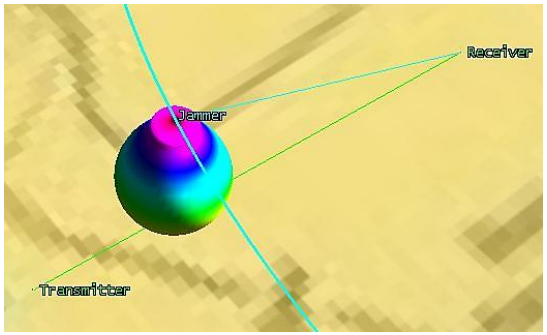
HWIL Simulated signals that are indistinguishable from live test events.

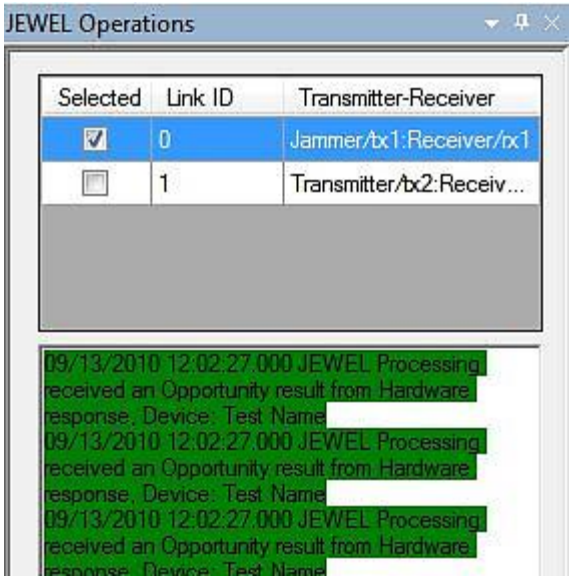
JEWEL HWIL Simulator

Problem: *Simulate RF environment with jammers, transmitters and receivers to test radio hardware. Pass RF data in real time to hardware systems to determine jammer effectiveness for IED deterrence.*

Solution: *Customize STK with a user interface plugin that communicates with the JEWEL hardware systems*

Outcome: *Simple UI allows for simulation of electromagnetic environmental effects (E3) to determine how hardware will respond prior to open air testing, thereby reducing costly required open air tests.*





STK saves lives and money by reducing open air test exercises

Resources

AGI Website

- White Papers
- Case Studies
- Software Resources
- Blogs
- Forum
- Events

www.agi.com

Software for Space, Defense & Intelligence

Thank You!!

www.agi.com

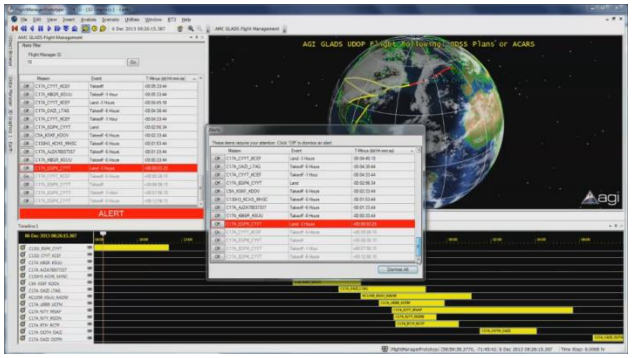
Case Studies

CASE STUDY

Air Mobility Command 618th AOC GLADS

Problem: Unable to find a solution to meet 2012 Mobility Air Forces C2 Campaign Plan Need to Collaborate with All Mission Partners Across Warfighting Domains

Solution: AGI technology integrated with web services from legacy enterprise system and other GOTS technologies rapidly delivered new capabilities and workflows.



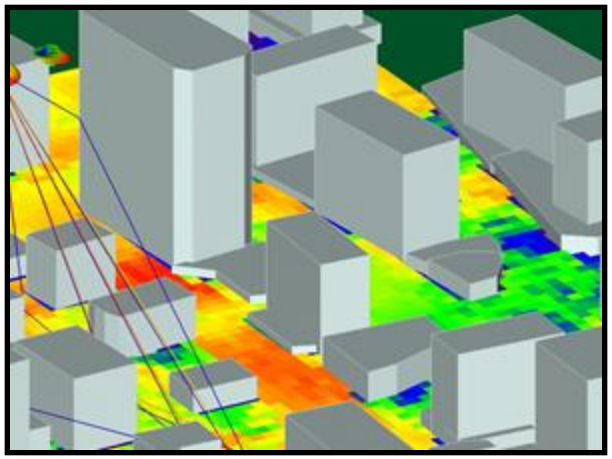
Outcome: GLADS Phase I supports daily TACC – 618th AOC operations as well as General Officer desktop UDOPs delivering situational understanding of Mobility Air Forces missions. GLADS Phase II enables TACC Flight Managers and mission partners with same visibility across SIPR & NIPR.

GLADS GENERATES KNOWLEDGE AT THE POINT OF DECISION MAKING
Man-Hour Costs Saved Using GLADS = $3.4M Per Year

SPAWAR - Joint Tactical Radio System (JTRS)

Problem: Customer wants to run parametric analysis studies on a HWIL network simulation for JTRS. The simulation is fed from live tests that measure link budget metrics. Live testing is slow and expensive.

Solution: Use STK to stimulate the network simulation using simulated routes, terrain and 3D buildings. TIREM and Uprop used for high fidelity comms.



Outcome: STK eliminates the need to perform live radio tests and gives the JTRS program the ability to investigate the trade space.

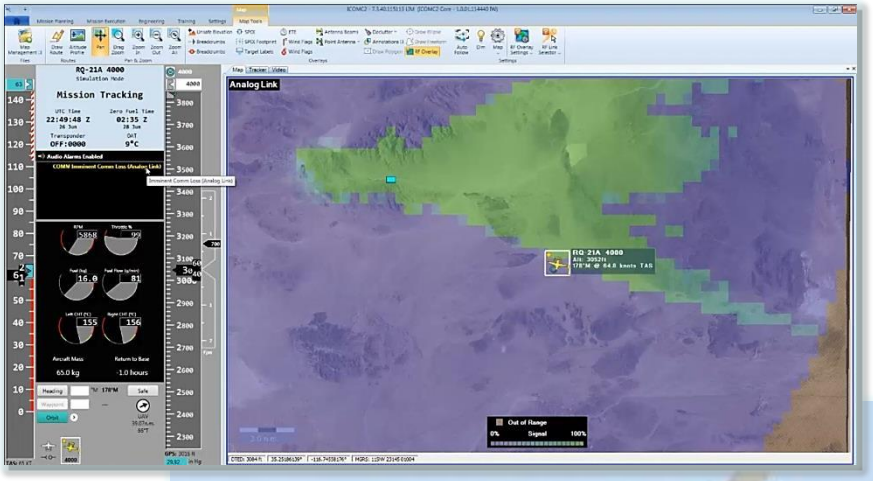
The JTRS program is saving $20K for each JTRS test and is able to run more tests in less time!

STK Components integrated into Insitu ICOMC2 system

Problem: A need to perform pre-mission planning and real-time RF analysis in a UAS Control System

Solution: Integrated STK Components software into ICOMC2 for dynamic prediction of radio frequency communication and relays

Outcome: Improved situational awareness and mission effectiveness to aid critical ISR decision making



"The ability to show predictive RF link coverage from our ground station to the air vehicle… will be of great benefit to all our ICOMC2 customers" ***Andrew Hayes, Insitu Prog. Mgr. of Advanced Ground Architectures***

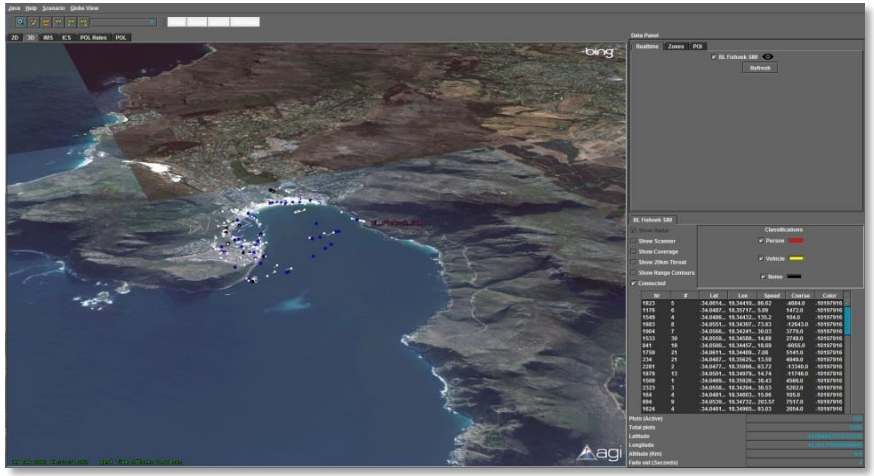
Business Partner: Suritec

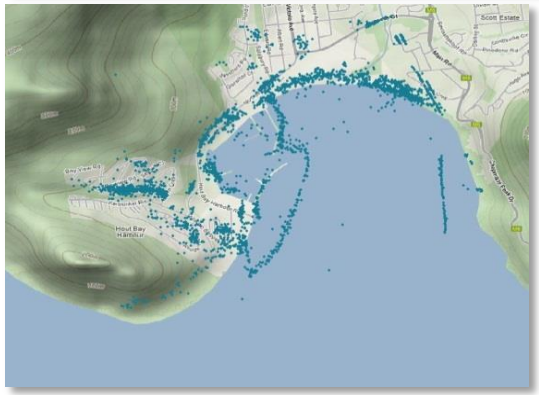
Activity Based Intelligence and Patterns-of-Life Analysis

Problem: Need for a multi-INT fusion framework to support intelligence and operational theatre analysts in ABI and patterns-of-life analysis.

Solution: STK Engine integrated to fuse multi-sensor data and analyze stored sensor data along the mission timeline.

Outcome: Flexible, multi-INT solution enables nodal and geospatial pattern analysis of vehicular and personnel entities of interest.





"Using STK Engine has saved us a year of development and resources worth $700K" ***Ryno Goosen, Director, Suritec***

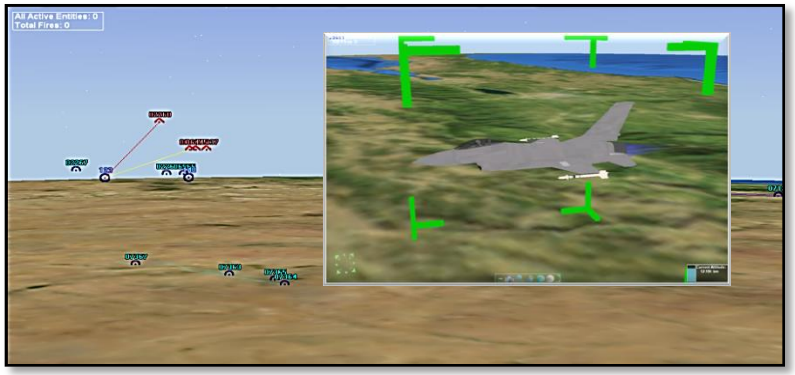
CASE STUDY

Märzen Group TDACS Situational Awareness Option

Problem: Märzen's proven COTS *Tactical Data Analysis and Connectivity System* required enhanced Situational Awareness: i.e a 3D visualization Option.

Solution: Utilize AGI's similarly proven development libraries* to embed a capability for theatre wide, real-time depiction and analysis of tactical data feeds.

Outcome: A low cost, fast time to market, and necessary enhancement of TDACS. TDACS now ships with 3D.



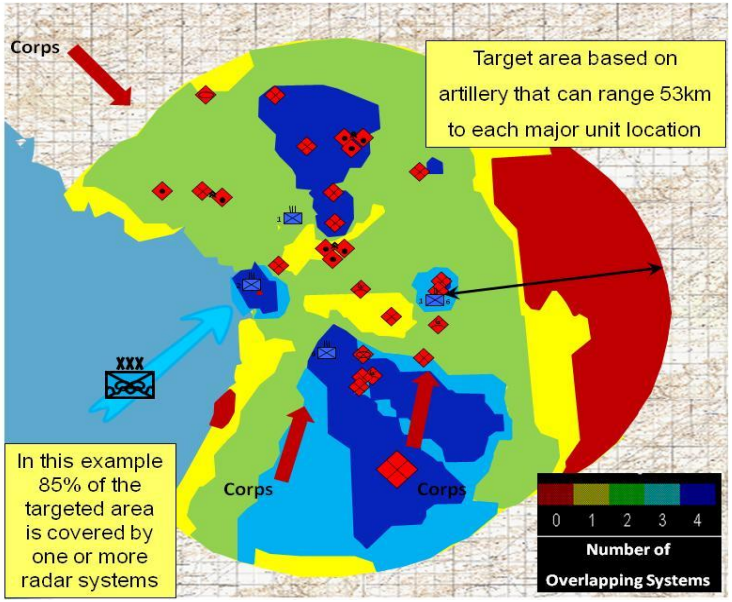
Commercial Technology insertion saved months in development time and provided a dramatic improvement in 3D Situational Awareness.

*AGI's *Insight 3d* , *Dynamic Geometry Library* and *Tracking Library*

Counter Battery Radar (CBR) Study

Problem: Force Structure Review Group (FSRG) tasked CBR study team with assessing proper deployment of G/ATOR increment II radars for Target Acquisition Platoons.

Solution: CBR team used STK to model G/ATOR radar deployments and assess system coverage and performance capabilities



Outcome: Study found fewer radars needed to perform the mission. Approved Acquisition Objective (AAO) adjusted from 38 to 28 systems resulting in significant acquisition savings and reduced manning requirements

G/ATOR acquisition savings of $295M based on improved analysis of radar system mission effectiveness

ITT Exelis

Airborne MASINT Mission Planner

Problem: Multi-sensor mission planning complex and time-consuming; existing system not operationally relevant.

Solution: Build Airborne/MASINT Mission Planning (AMMP) Tool using AGI software.

Outcome: Delivered AMMP for flight test in 90 days; mission planning reduced from 2 days to 2 hours.

AMMP

AIRBORNE MASINT MISSION PLANNER

Portable, "Roll-on, roll-off" Customized Mission Planning and 3D Visualization System

Core Capabilities	Primary Components
Automatic waypoint generation	Rugged GETAC laptop
3D/2D Visualization Environment	(MIL-STD 810F compliant)
Sensor coverage analysis and display	AGI Satellite Toolkit 8.0
Multi-variable optimization and analysis	500 GB External Hard Drive
Mission management tools	Portable printer
Customized user workflows	Garmin GPSMAP 296 aviation GPS
Situational Analysis tools	Garmin GPSMAP 76 handheld GPS
Mission preview and playback capability	Pelican storage case

ITT PAR RR agi

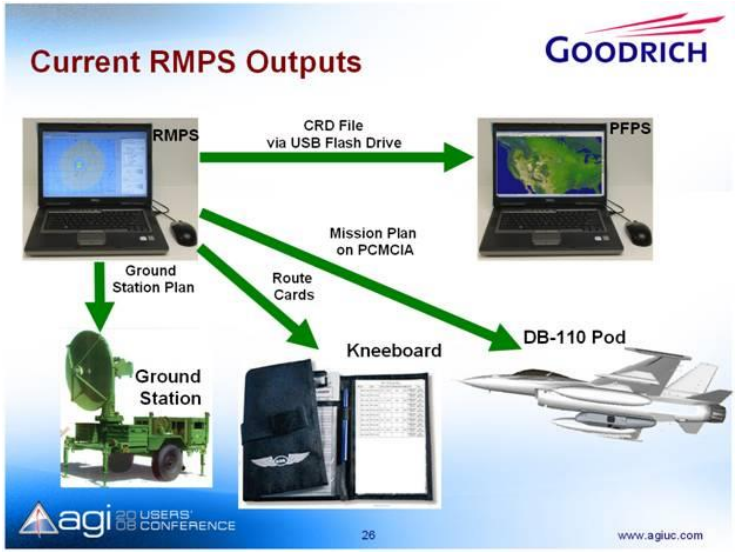
24X process improvement / operationally effective

UTC ISR- Reconnaissance Mission Planning System

Problem: *Costly Recurring Software Upgrades to existing F-16 system (i.e. $750K for two months enhancement contract)*

Solution: *Develop a system in-house using STK Engine and other COTS software combined with existing expertise*

Outcome: *Software Upgrade Cost Savings for one upgrade cycle were $300K*



$1.6 Million in Cost Savings over a five-year period and, "The growth path for future features with AGI is very clear."
UTC - Lead Software Engineer

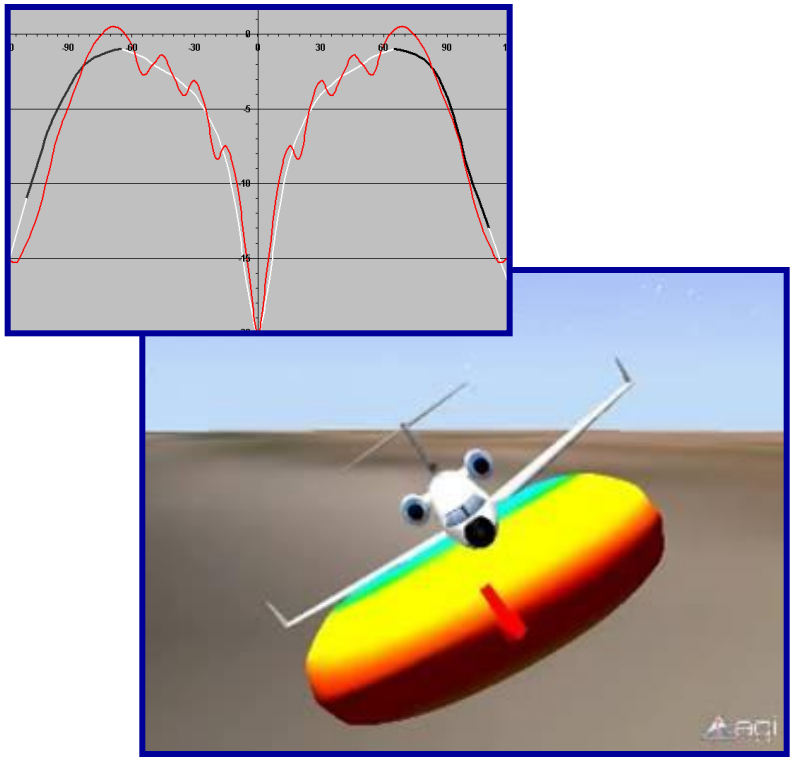
NORTHROP GRUMMAN INTEGRATED SYSTEMS

Aircraft communications

Problem: Determine antenna coverage and blockage from aircraft keel.

Solution: "As installed" antenna patterns analyzed with multiple flight profiles for coverage.

Outcome: Millions of dollars saved in reduced required flight tests and reduced schedule risk.



"Valid flight testing at your desk" – Bruce MacDougall, NGC

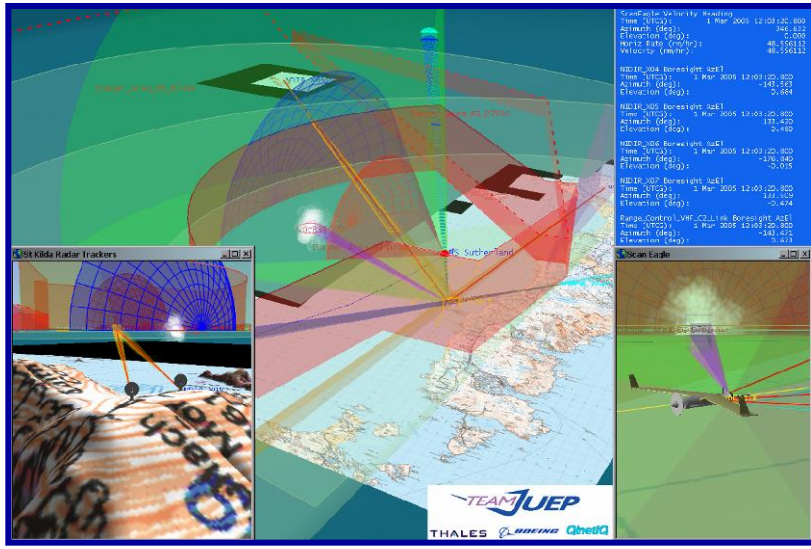
THALES AEROSPACE DIVISION

Test and evaluation for UAV trials

Problem: Operational analysis and planning required prior to live trials.

Solution: STK analyzed “what-ifs?” faster than in real-time.

Outcome: Cost and time savings designing T&E plans with the customer. Requirement changes on the fly.



Operations, T&E planning and post-trial analysis.

Use in UAV systems/BAMS program

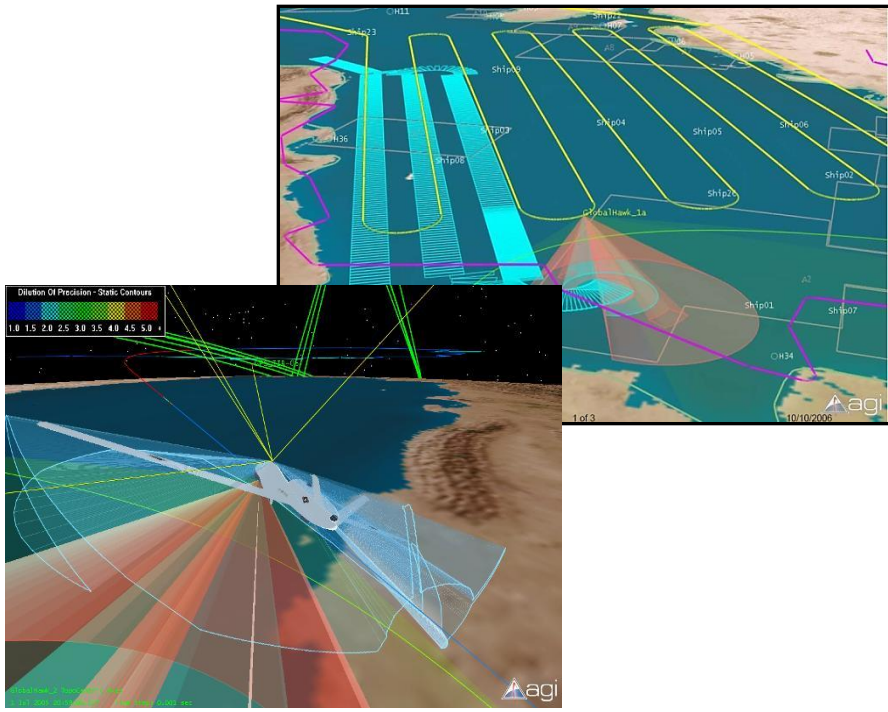
BAMS Program

Naval Air Warfare Center – IBAR Lab

Problem: Needed ISR mission planning and analysis tool that was “above and beyond the typical.”

Solution: Modeling various UAV platforms, sensor coverage, satcomms and flight plans.

Outcome: Quick turnaround of sensor platform and ISR analysis.



Measure surveillance effectiveness of UAV systems in a single integrated environment.

Better comms; less cost

Problem: P/EP-3 Orion aircraft lost SatCom link in flight tests.

Solution: Flight data in STK showed aircraft was obstructing the signal at some flight angles.

Outcome: Fewer flight tests needed, better antenna placement on aircraft.

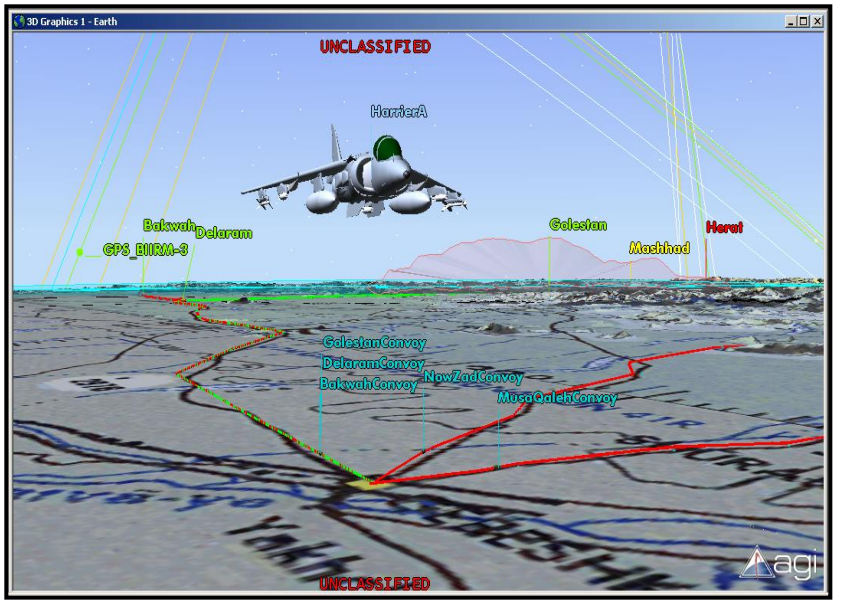
Avoided costly, excessive design margins.

UNITED STATES MARINE CORPS

STK fielded in Afghanistan

Problem: Urgent need for pre-mission planning tool to optimize expensive combat assets (UAVs, planes) and protect warfighters in Afghanistan's physically challenging terrain.

Solution: AGI desktop software installed in ruggedized computer. Used in field by staff-level Marines with reach-back support to analysts in U.S.



Outcome: Tool built and fielded in six weeks. Supports commander's decision-making through data visualization, ISR effectiveness, risk mitigation and communication effectiveness.

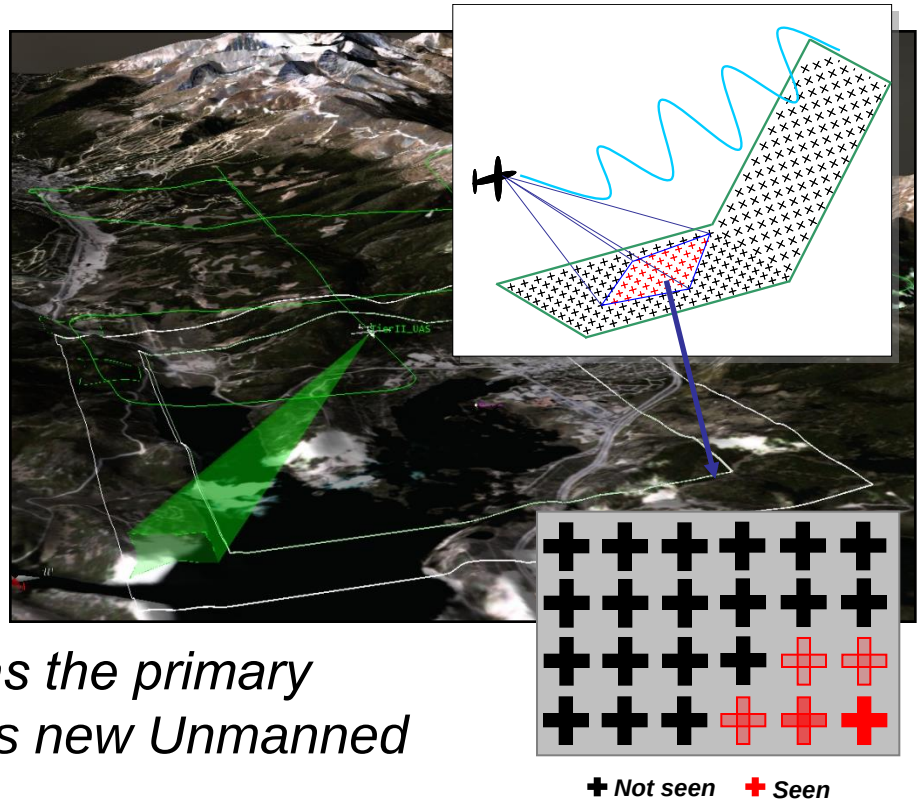
Essential operations decision-support tool built and deployed in six weeks.

USMC Tier II UAV Study

UAV System Evaluation and Design

Problem: *Develop a method for quantitatively evaluating both a mix of UAVs and Sensors*

Solution: *STK and integrated probabilistic EO/IR detection simulation*



Outcome: *"First truly joint UAS"; STK was the primary software used to formulate this new Unmanned Aircraft System*

Simulated future system effectiveness to procure the right system for the mission

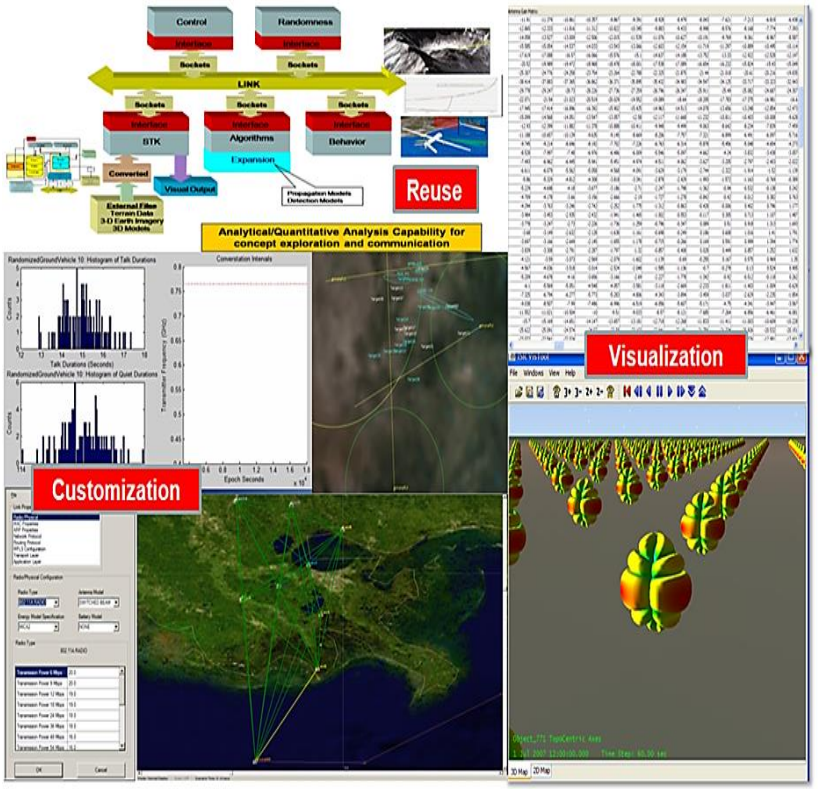
L-3 COMMUNICATIONS

C4ISR operational and concept analysis

Problem: Develop modeling, simulation and operations analysis products to support analysis and presentation of operational activities, system integrations and design concepts.

Solution: Combine AGI desktop products with variety of COTS/GOTS tools and legacy code.

Outcome: Initial capability delivered 14 months ahead of schedule. Reduces analysis time by as much as 80%. Adds credibility to proposals and shapes early phase program development.



Accelerated support to business development activities.

HEADQUARTERS U.S. AIR FORCE A9

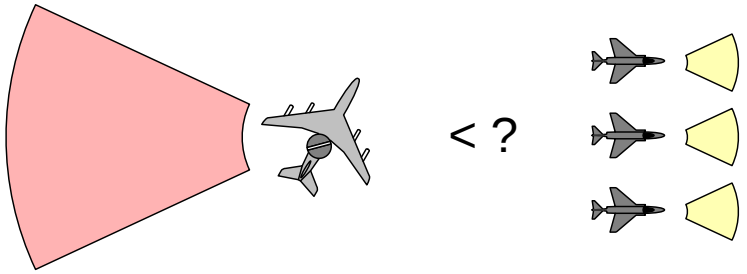
Airborne ISR study

Problem: Determine optimal mix of airborne assets to improve kill-chain effectiveness.

Solution: STK sensors, platforms, scenarios, visualizations combined with in-house models via MATLAB and Ruby.

Outcome: Reduced typical study time from one year to one month.

What ISR investments should the Air Force make?



"STK has enabled A9 to quickly respond to some of the most challenging questions in the DoD."

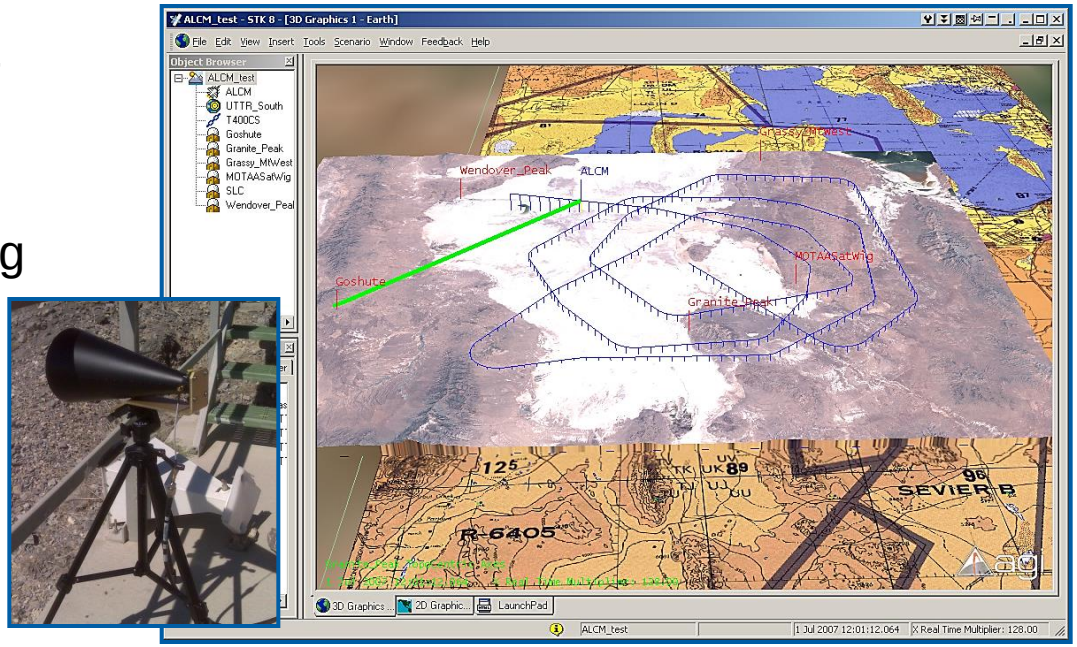
—Timothy Booher, senior analyst, USAF

RT LOGIC

Improved test range operations

Problem: Precisely replicate RF signals as they would appear in nature to support range planning and rehearsal.

Solution: Drive RF Channel simulator using STK Engine.



Outcome: Integrated mission model and accurate wireless communication that allows range operators to model all aspects of range.

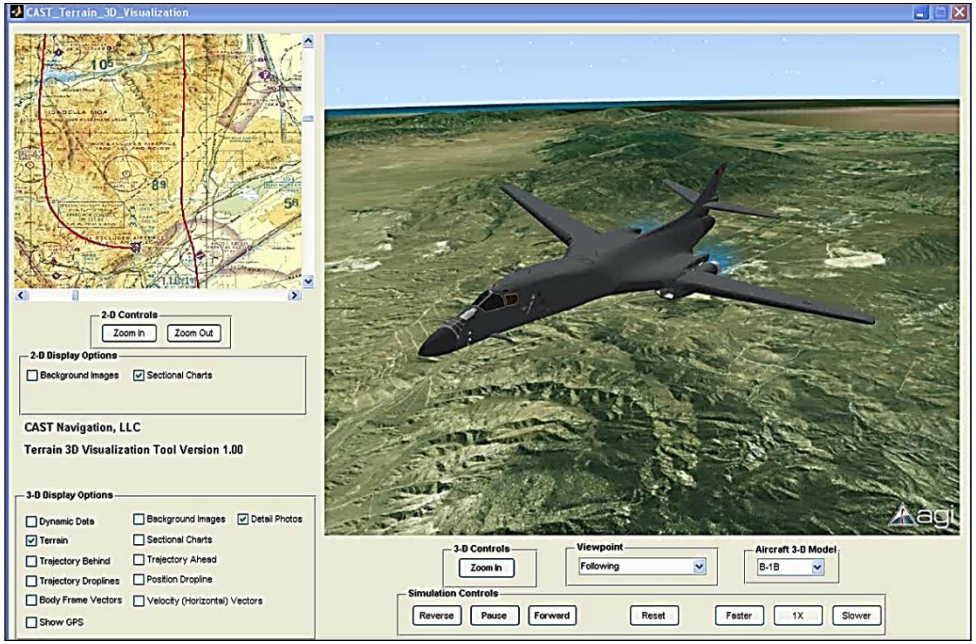
Simulated signals that are indistinguishable from live test events.

CAST NAVIGATION

Creating a state-of-the-art GUI

Problem: GPS/INS test-equipment software needed upgrade to high-quality visualization in 3 months to satisfy new customer's requirements.

Solution: STK Engine 2D and 3D controls added to legacy software GUI.



Outcome: On-time delivery of expanded product that exceeded customer expectations; reduced development from man-years to months; potential for increased business.

"AGI software allowed CAST to expand its product offerings and capture new business."

—Bob Addiss, senior software engineer, CAST Navigation

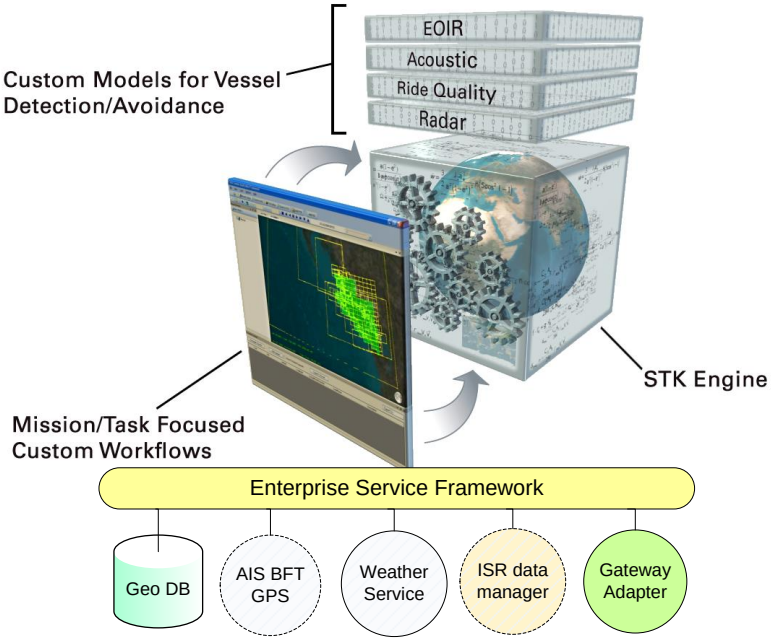
GENERAL DYNAMICS CANADA

Custom mission-planning application

Problem: Six months of a 10-month schedule lost to contract delays—no deadline relief.

Solution: STK Engine with custom work flows, visualization, and integration of existing tools.

Outcome: On-time delivery in four months, under budget. Capabilities exceeded expectations and led to follow-on funding.



"Huge schedule risk mitigated by using STK!"

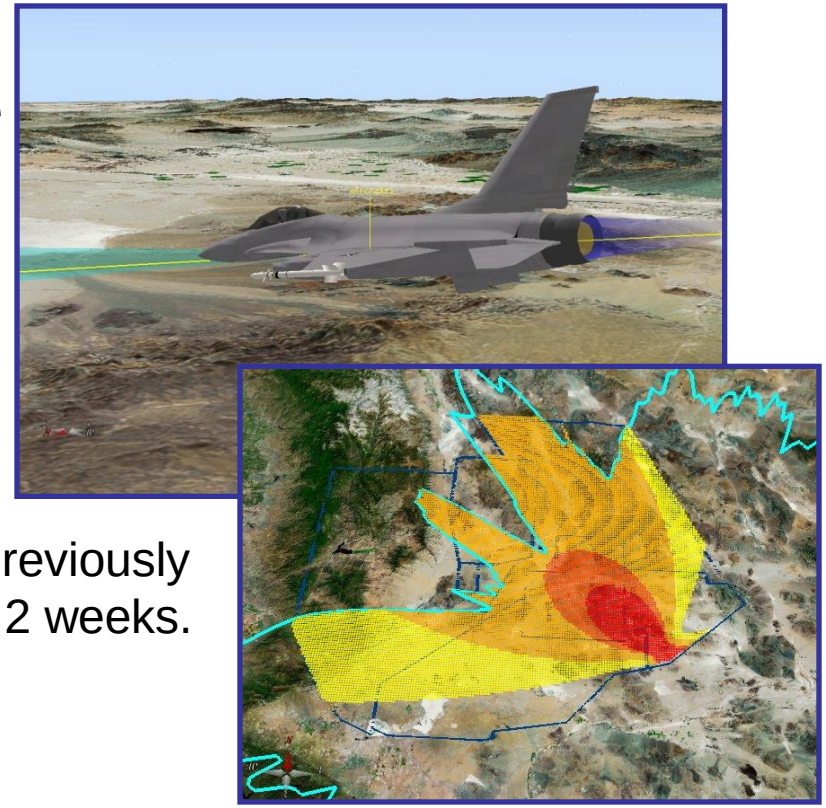
—Mike Gingell, principal engineer, General Dynamics Canada

EDWARDS AIR FORCE BASE

Wind Turbine Airborne Radar Model

Problem: Had no way to analyze impact of proposed wind turbines on airborne radars, needed quick-turn analysis tool.

Solution: Modeled predicted noise and Doppler shift affects in STK, verified against flight test measurements.



Outcome: STK provided analysis model that previously did not exist, Analysis completed in 2 weeks.

$1 million saved in reduced need for flight tests.

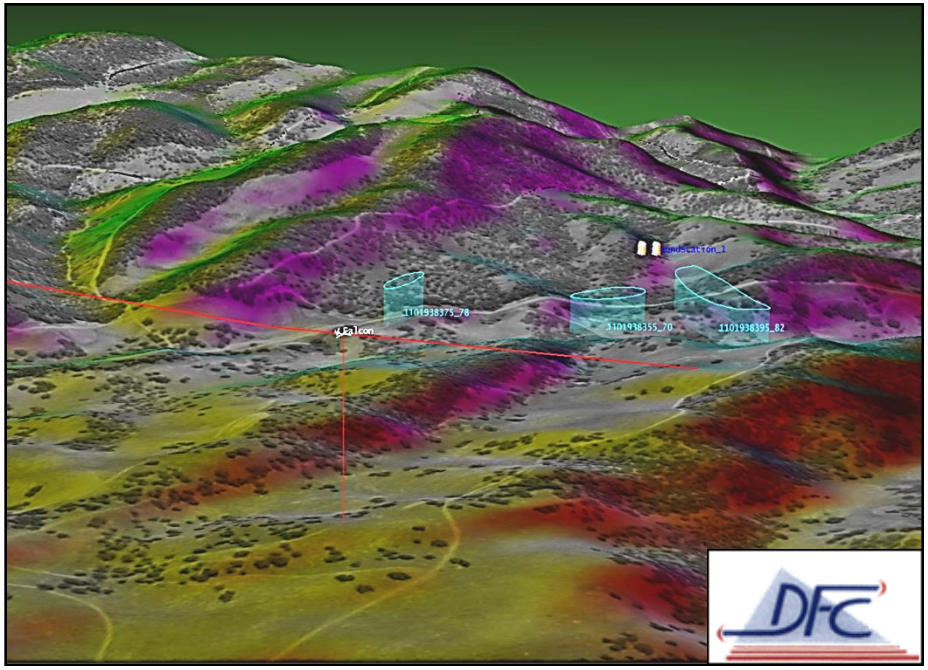
U.S. DOD

SIGINT operations tool

Problem: Execute complex Signals Intelligence (SIGINT) missions from planning to real-time to post-mission review.

Solution: Data Fusion Corporation (DFC) delivered an STK-based ISR-logic solution for live operations support.

Outcome: "Mission Minder" solution delivered to DoD end-users for end-to-end SIGNT operations.



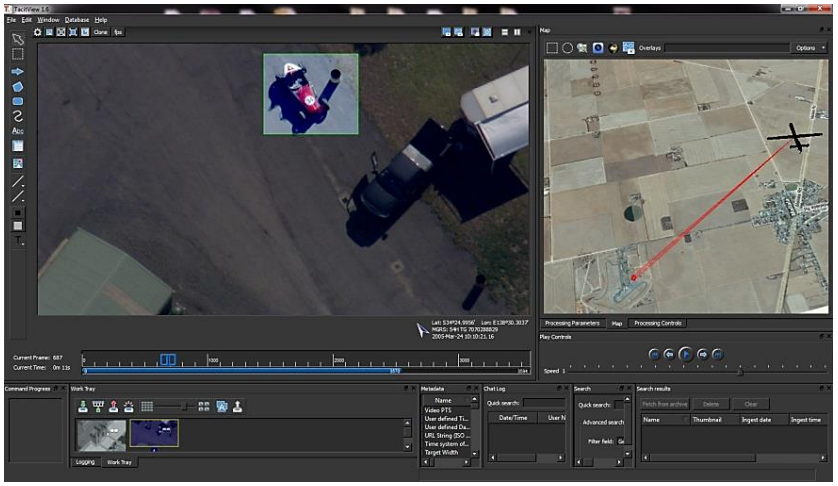
"STK software not only provides Mission Minder with superior analytics and visualization in support of ISR operations, it is an ideal setup when you are dependent on real-time, net-centric support."

-George Krasovec, Data Fusion Program Manager

2d3

Integrating STK Components and TacitView

Problem: 2d3 wanted to add a 3D component to TacitView that would provide users a geospatial interface to create geo-queries, view geospatial imagery and platform sensor metadata and view other map products.



Solution: Integrated AGI capabilities into TacitView using Insight3D.

Outcome: Users gain a rich, interactive 3D globe for easily navigating through geospatial data.

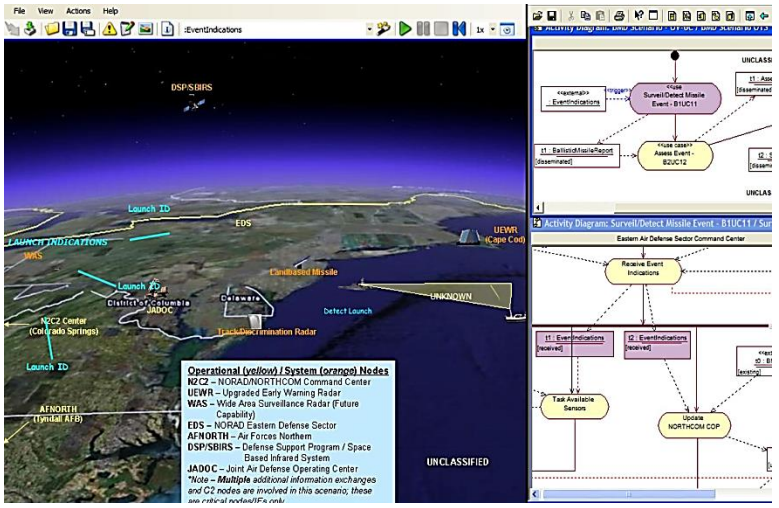
Using AGI Components saved the company time, money and risk.

Enhanced system architecture design and evaluation

Problem: DoD Architecture Framework's (DoDAF) Operational View Level 1 limited in ability to model and visualize physical environment and interaction with architecture.

Solution: Serco's UML Animator drives physics-based 3D graphics using STK as the simulation framework.

Outcome: The UML Animator is the cornerstone for capabilities-based assessments, exercise planning and mission area CONOPS development and refinement.



AGI software brings Serco and its government customer 3D capability that they didn't have and couldn't develop.

Case Study – UAV Operations

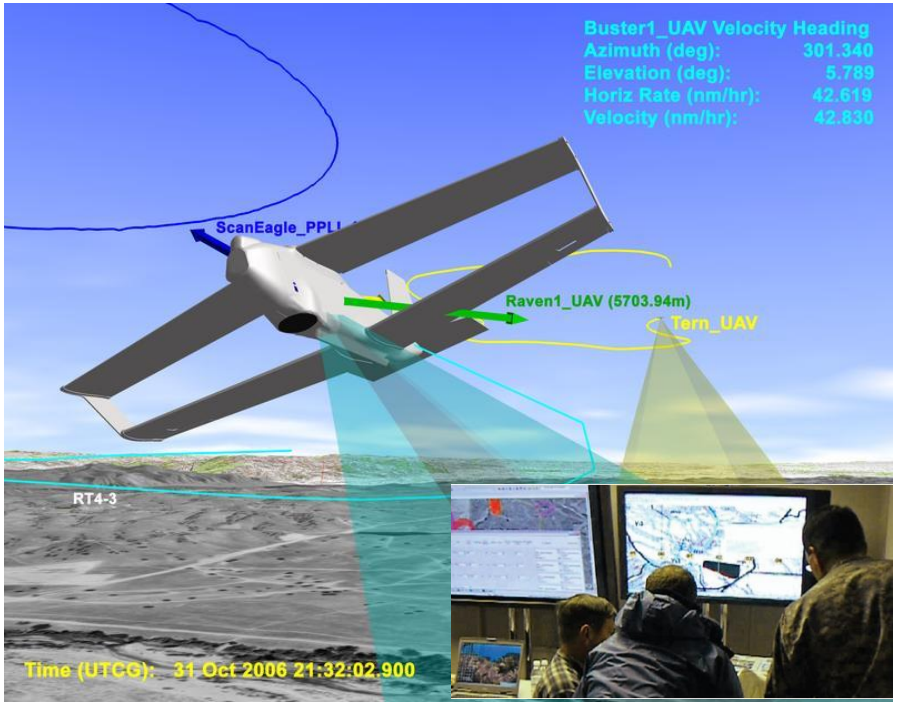
Naval Postgraduate School UAV Trials

UAV Decision Support

Problem: US Special Operations Command required advanced UAV situational awareness and mission analysis

Solution: STK ingested real-time data and computed sensor footprint, coverage, and UAV proximity

Outcome: Real-time decision support and post-mission analysis provided dramatic improvements to the operations



"I truly believe the potential benefit is enormous since the ability to visualize the sensor footprint is critical to commanders' understanding of the battlefield."

Dr Nita Lewis Miller, NPS Human Systems Integration

Case Study – Maritime ISR

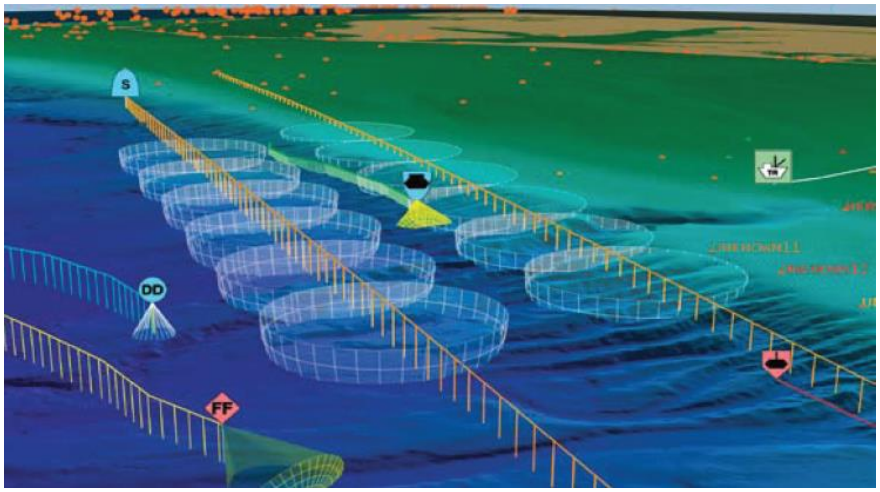
CONOPS and Maritime and Air Littoral Operations (MALO) Tactics Analysis

Defence R&D Canada

Problem: Needed to study effectiveness of numerous naval ISR assets in littoral operations.

Solution: STK was customized to include acoustic models and streamlined analysis workflows for the users.

Outcome: Rapid simulation, analysis and visualization was performed for complex naval operations , avoiding expensive live trials.



DEFENCE R&D DÉFENSE
DRDC–RDDC

"It would have taken us more thank a year to develop these capabilities internally."

- Dr Dawzi Hassaine, DRDC

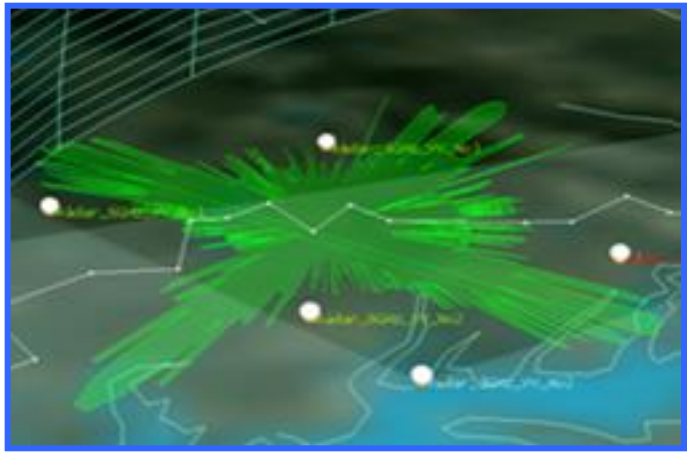
CASE STUDY

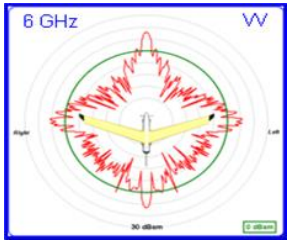
US D.o.D – Radar Planning for UAVs

Problem: Radar threat modeling required in existing planning system. When would aircraft be detected by enemy radar?

Solution: STK Engine and DoD radar models use dynamic RCS to rapidly identify detections in a mission plan

Outcome: Expanded analysis capability with COTS software enabling predict and avoid solution





Rapid delivery of a technically accurate solution for radar prediction performance in existing mission planning system

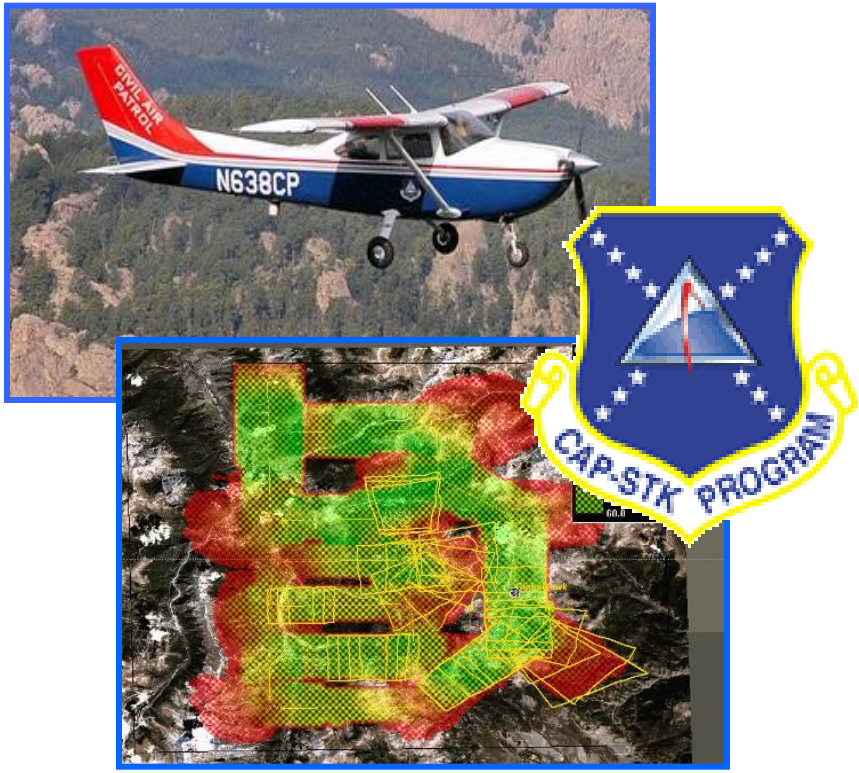
Customer case study

Civil Air Patrol
US Air Force Auxiliary

Problem: Planning and tracking needed for recon, disaster relief and counter-narcotic operations

Solution: AGI-CAP Search Tool: Streamlined workflow for operators

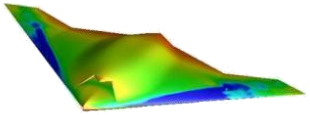
Outcome: Quick, easy planning and search area coverage tool



AGI software was operational solution for CAP: responsible for 85% of American inland search and rescue operations

Backup Slides

Creating a Complete Representation



Aircraft Model

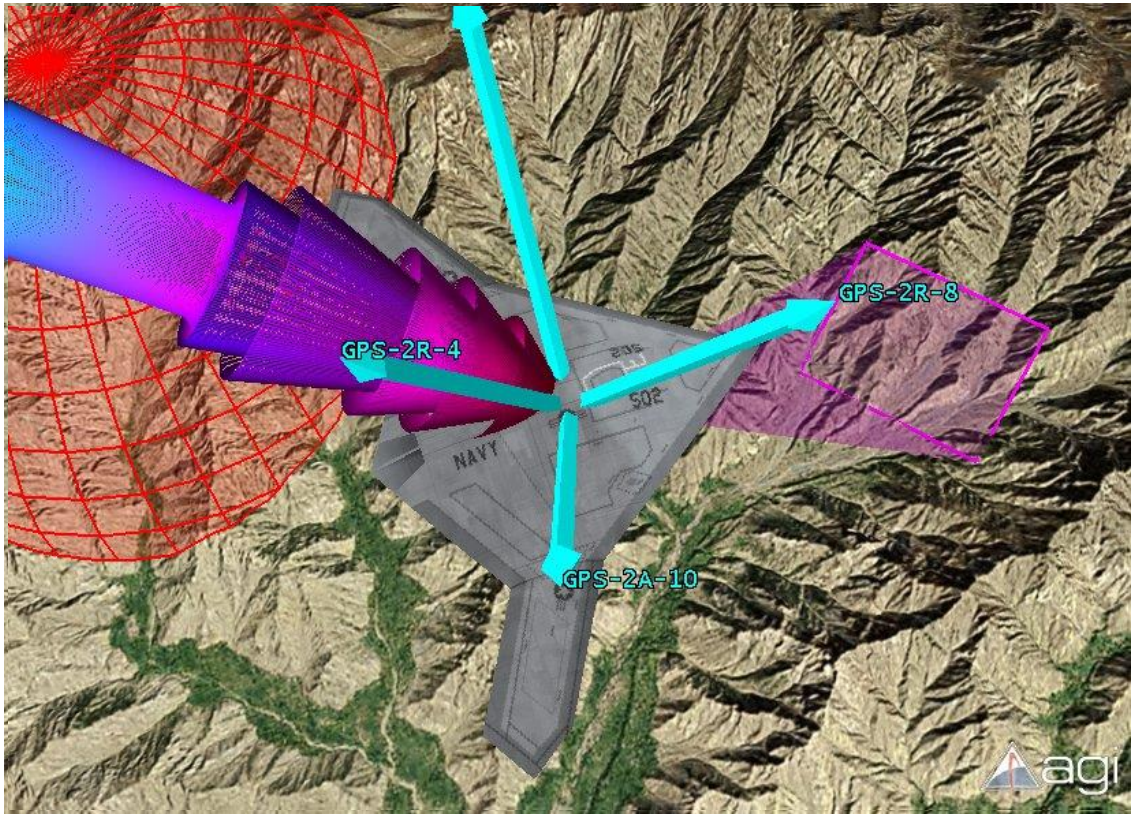
Sensor Model

Environment Model

Navigation Model

Communications Model

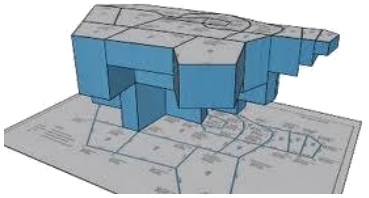
Threat Model



Acoustic Model

Radar Model

Line of Sight



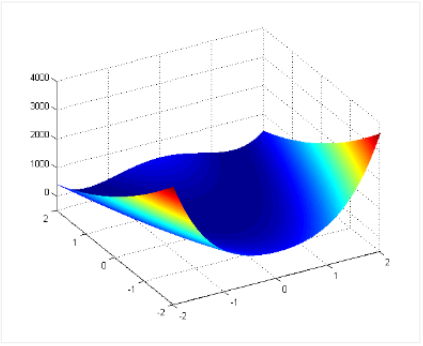
Airspace Geometry

ModelCenter Outputs

PHOENIX INTEGRATION | Rosenbrock Problem

Home | Eval

Function Shape



Description

This is an unconstrained problem with two continuous design variables. There is only one optimum point.

Minimize:

f = 100 * (x1^2 - x2)^2 + (x1 - 1)^2

With a search space:

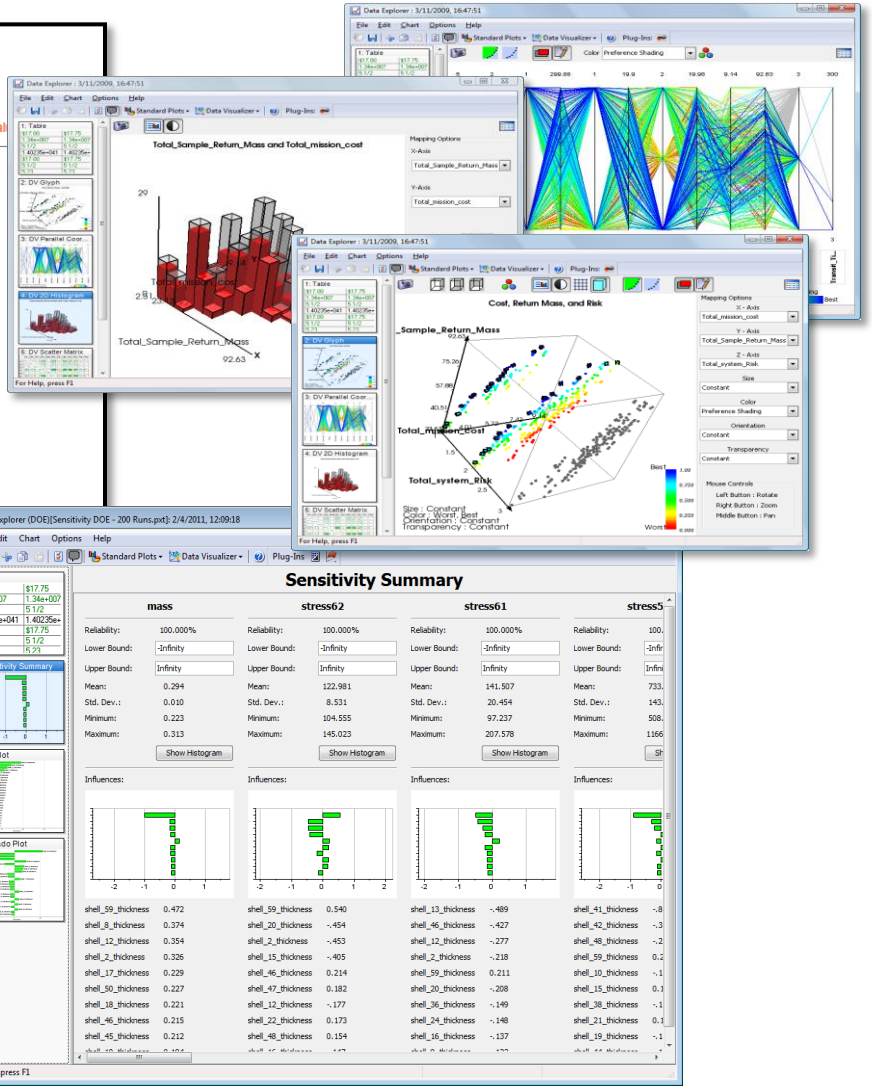
-2 <= x1, x2 <= 2

The optimum is:

f* = 0 at x* = (1, 1)

Test Results

Algorithm	Average Error in Objective	Average Number of Function
Darwin	0	3660
SwarmOps JDE	0	951
SwarmOps DESuite	0	439
SwarmOps MOL	0.1092	490
SwarmOps DE	0.0065	721
SwarmOps PS	1.789	524
SwarmOps PSO	0.0771	441
SwarmOps LUS	0.4469	349



ModelCenter Off the Shelf Plug-ins

Product Design

- Given design parameters, predicts performance characteristics:
  - How much will it weigh?
  - How high can it fly?
  - What will it cost?
- Useful for designing hardware
- Wrap your code or use plugins:

- Matlab
- Mathcad
- Excel
- Fluent
- Nastran
- ANSYS
- LS-DYNA
- Price
- Seer
- CAD

System/Mission Simulation

- Given performance characteristics, predicts how a system will react to various stimulus over time:
  - Hit rate?
  - Access times?
  - Throughput?
- Useful for designing systems
- Wrap your code or use plugins:

- Flames
- Magic Draw
- OpNet
- ProModel
- Rhapsody
- STK
- Extend
- Vensim
- Aceit
- Arena

Development options

Application

Engine

Components

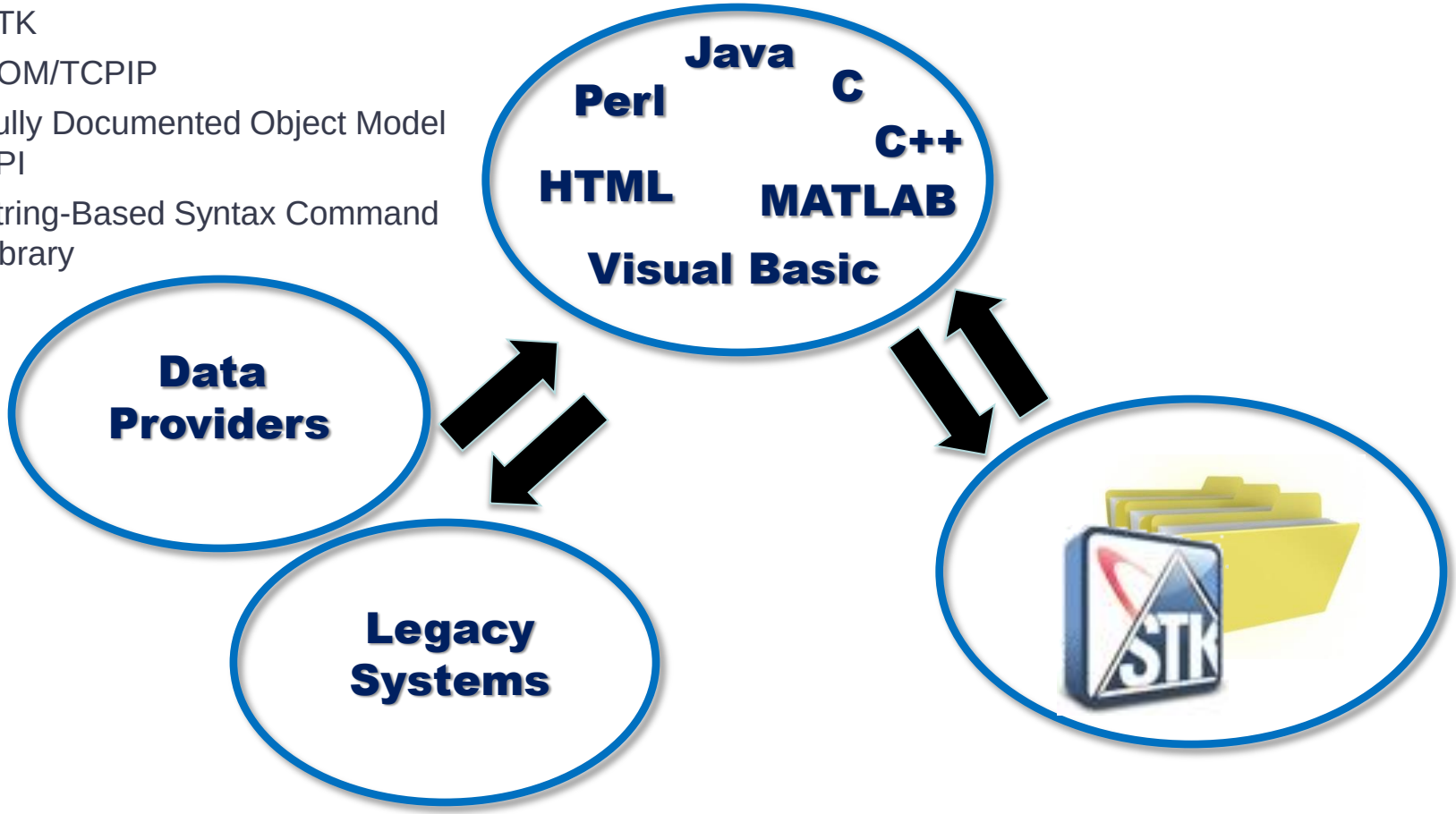
Full, unlimited access to programming interface

Prototype solution before investing

.NET & Java

STK Integration

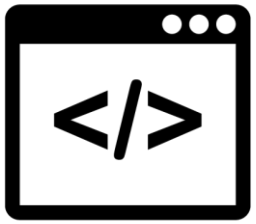
- **Integration Layer**
  - Share Data Access To/From STK
  - COM/TCPIP
  - Fully Documented Object Model API
  - String-Based Syntax Command Library



STK Engine Application Design

STK Engine Libraries

Custom Algorithms



Custom GUI Design

Custom Application

Deploy Application

AGI Components

- **AGI technology in the form of isolated functions**
- **A collection of developer libraries**
  - Use components as needed
- **Build applications that are:**
  - Scalable
  - Developed for internationalization
  - Built in native 64-bit architecture
  - Multi threaded
  - Suitable for thick-client, thin-client, or server deployment
  - Cross-platform compatible
- **For users who**
  - Need only a piece of AGI technology
  - Need to serve out AGI technology
  - Need web services that write directly to Cesium

AGI Components – High level

A collection of .NET or Java assemblies

- **Dynamic analysis based on high-precision JulianDate type time**
- **Precise platform positioning and orientation**
  - Orbit and waypoint propagation
  - Sensor geometry modeling
- **Accurate earth, moon, and planet modeling**
- **Complex numerical and geometry algorithms**
  - Manipulate points, axes, vectors, and reference frames
- **High-fidelity, time-based, intervisibility algorithm**
- **Terrain masking**
- **Dilution of precision, navigation accuracy, and RAIM outage algorithms**
- **Figure of merit analysis for both platforms and grids**
- **Signal propagation accounting for hardware and environment**
- **Process, visualize, and analyze dynamically acquired data**
- **Precision 3D rendering**

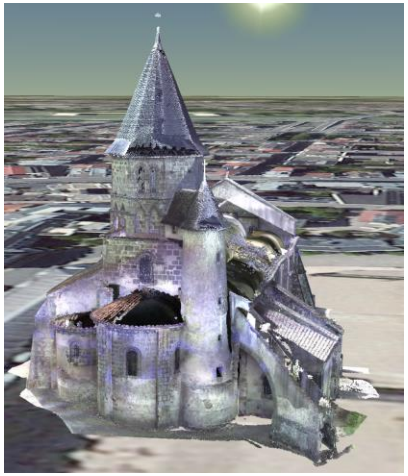
AGI Components – by product

A collection of .NET or Java assemblies

- **Dynamic Geometry Library**
  - Complex numerical and geometry algorithms
    - Model vehicles and payloads geospatially over time
- **Navigation Accuracy Library**
  - Dilution of precision, navigation accuracy, and RAIM outage algorithms
- **Terrain Analysis Library**
  - Terrain masking
- **Spatial Analysis Library**
  - Figure of merit analysis for both vehicles and grids
- **Communications Library**
  - Signal propagation accounting for hardware and environment
- **Insight3D Visualization Library (Java coming soon)**
  - Precision 3D rendering
- **Tracking Library**
  - Process, visualize, and analyze dynamically acquired data
- **Routing Library**
  - Routes based on waypoints and procedures accounting for vehicle behaviors

Coming Soon

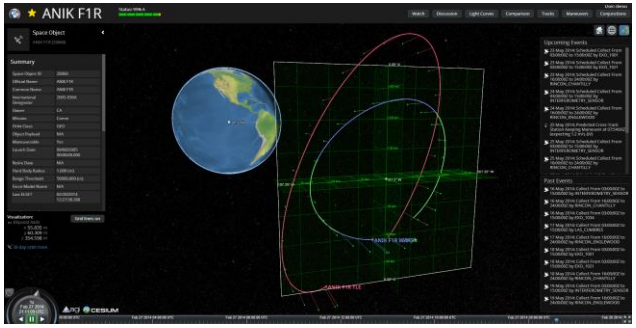
Terrain and Imagery



Point clouds

Cities

Vector data



Time-dynamic

Also foliage, stars, traditional 3D models, etc.

Data Standards

- CZML
- GeoJSON
- TopoJSON
- simplestyle
- KML
- quantized-mesh
- glTF
- Lots of streaming imagery standards

Imagery in Cesium

- Web Map Service (WMS)
- Tile Map Service (TMS)
- OpenGIS Web Map Tile Service (WMTS)
- OpenStreetMap
- Bing Maps
- ArcGIS Server
- Google Earth Enterprise
- Single image tiles

CZML

- Short for Cesium Language
- A streamable JSON scene description for data-driven visualization.
- Developed alongside Cesium but can be implemented in other projects.
- CZML Guide: http://git.io/czml