AGI Software and Solutions for Test and Evaluation (T&E)
Agenda

- **Introductions**
  - Company Overview
  - Current Industry Test & Evaluation Challenges

- **AGI Software Support of T&E Workflow**
  - Typical Test & Evaluation Processes
  - Software Simulation/Coordination Efforts

- **Pre-Mission Planning Design**
  - Using Commercial Software for Planning/Analysis/Simulation
  - Test Event Rehearsal & Replanning

- **Testing Operations**
  - Real-Time Visualization & Support
  - Data Analysis & Situational Awareness

- **Post Flight Analysis**
  - Flight Reconstruction
  - Analyze Test Data
  - Refine Procedures & Testing Processes

- **Q&A Wrap Up**
AGI Asia Introductions

- **Matt Halferty**
  - Director, Asia Pacific
  - US Army Officer - West Point

- **Jim Head**
  - Partner Manager, Asia Pacific
  - Masters Degree Strategic Studies – RSIS Singapore

- **Nate McBee**
  - Systems Engineer Manager, International
  - Masters Aerospace Engineering - Univ. of Tennessee

- **Dan Honaker**
  - Aerospace 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.
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
Test & Evaluation Challenges

Current Approach
Current Test & Eval Challenges

- Current planning tools are labor intensive and error prone
  - Inefficient test tools/methods
  - Long and iterative testing cycles
  - Unsophisticated modeling tools

- The costs to physically test are very high
  - Military aircraft operating costs can vary from $7500/hour to $1.2M/day*
  - Physical flight testing cycles can be reduced significantly
  - More tests can be performed during a single flight with proper planning

* - Actual F-35 testing cost for 4-ship (4 aircraft) test in an instrumented test range environment
Current Test & Eval Challenges

- Increasing Complexity of Onboard Mission Systems
  - (EW, EO/IR, Comms, Radar, IFF, Nav, LO, etc)

- Inefficient Test Flights (Low test-point density)

- High re-test/re-fly Rates (as Much as 50%!)  

- Challenge of Communicating Capability Attainment Along With Test-Point Completion
Using Computer Aided Engineering (CAE)

Product design, engineering and lifecycle disciplines take advantage of well established computer aided engineering (CAE) methods.
Addressing Current Methods

- **Current Methods**
  - Microsoft (MS)Excel
  - MS PowerPoint
  - MS Word
  - Custom MATLAB
  - “Planes-on-sticks”
  - “Flying wrist watches”

Great opportunity in the T&E discipline to reap similar benefits by using Computer Aided Engineering (CAE) methods in test-event design, execution & post-flight analysis.
AGI Systems Tool Kit Modeling

Build/Import Models

- Characterize System
- Performance models
- Environment models
- Mission specific data

Define measures of mission effectiveness

Iterative design & analysis

Run Simulations & Evaluate Performance

Test Planning

Combine into system model

Convey Results

- Reports & graphs
- Video
- Mission results or status

Evaluate mission performance

Build/Import Models

AGI Systems Tool Kit Modeling

Iterative design & analysis

Test Planning
AGI Software Overview

Model Based Engineering Approach
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*
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 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*
Create Systems Models

- Build Representative System Models
- Model Payloads (Sensors/Radars/Comms/Etc.)
- Dynamic Depiction of Systems in Theatre
- Expose Unforeseen Problems
Evaluating Mission Success

- Increase Fidelity With Updated Models
- Convey Complex Concepts
- Flexible Modeling Options
- Mission Design/Planning/Re-Planning and Optimization
Creating a Complete Representation
Mission Execution

- Conduct “What-If” Analysis
- Allow Operators to Focus on Mission
- Enhance Mission Situational Awareness
- Easily Evaluate Mission Success

Aircraft Model
Sensor Model
Environment Model
Threat Model
Communications Model
Example: Mission Planning

- Incorporate layers that represent mission effectiveness
- Display results in a format already familiar
- Allow for flexibility in tactical mission planning
- Apply automation to suggest mission plans
STK Modeling Environment

- Navigation Model
- Communications Model
- Aircraft Model
- Airspace Geometry
- Acoustic Model
- Sensor Model
- Environment Model
- Threat Model
- Automation
- Line of Sight
- Radar Model
**Systems Tool Kit Interoperability**

**COTS Tools**
- Scalable Networks – Qualnet
- Mathworks - Matlab
- Anark Core – data file exchange
- Opnet - NG using HLA
- Lightwave – IGES,STEP conversion
- SystemVue by Agilent
- LabVIEW
- DOORS
- IBM Rational
- HFSS – antenna models
- Xplane
- Real Flow – Importing wave motion
- RTLogic - Channel Simulator
- Elekrobit - PropSim
- Rhode & Schwartz – RF Channel Simulator
- Spirent – GNSS Simulator.
- CAST - Navigation
- MSoft Excel, PowerPoint
- Harpoon 3 Naval Warfare sim.
- Virtual Sim Tasker - VirtualSim CGF
- FuzzyTech. Fuzzy Logic Engine Controller
- Sharepoint - collaboration
- Pheonix Integration - Model Center
- ESRI.
- TruePlanning – Cost estimation system
- CARPET - a radar simulation tool that generates radar parameters

**GOTS Analysis and Operations Tools & Data**
- FalconView - comms analysis
- DCGS-AF
- EADSIM
- Navy’s Missile Planning Tool by APL
- JMPS - by Gnostech
- Naval Sim System by Mectron)
- NETWARS - Cyber Hacking
- SEAS ( http://teamseas.com/)
- NASA SPICE and CCDS
- GPS Almanacs
- TLE data
- BVI - BattleSpace Visualization tool
- GDM (INSCOM )
  *coming soon....*
- ESAMS – by Booz Allan Ham
- HF RAD - OTH Radar model
- NORAD - Operational Risk Assessment tool.

**Data Providers, formats and Imagery**
- Scribe Workbench
- Simulize - Flight Control
- JP2, NITF, etc
- DTED, DEM...
- Navteq - urban data
- ITU - satellite payload data
- OCG
- NMEA
- AIS Data
- Shapefile import/export

**Hardware/Software/Protocols**
- Touch Table
- Next Computing
- Scalable Display Technologies
- Max Vision
- MS Surface
- Droid OS
- Sys ML
- Magnolia Forge.
- Google Earth - KML import/export
- MS Virtual Studio - through JAVA, Com,.NET APIs
- TCP/IP API - network based interactions
- DIS/HLA/TENA

**Third Party Applications**
(also sold as a separate product by the source company)
- Remcom – Urban comms modeling
- Alion - TIREM
- VT Mak – SimMetrics
- AER – Weather Data
- SDL – Electro Optic Sensor Modeling
- Satsoft – Antenna Design
- ASI - Satellite Simulation
- SAIC – Missile modeling
STK Modeling Tools

Detailed Look At STK Modules
Aircraft Mission Modeler

Aircraft Model

- Performance Driven Models
- 3D Edit Flight Paths on the Fly
- Common Procedure Library
- Holding Patterns
- Takeoff/Landing & VTOL/Hover
- Fuel Management
System Design – Sensors

**Sensor Model**

- **What can your systems see?**
  - Dynamic environment
  - Number/type of platforms
  - Number/type of sensors
  - Target constraints
    - Terrain
    - RCS

- **Complex detection**
  - Visual
  - IR (GSD)
  - RF
  - Search/Track Radar
  - Synthetic Aperture Radar (SAR)
  - GMTI (flexible constraints)

- **Use the right sensor for the mission**
Imperfect RF Environment Analysis

Environment Model

- Terrain blockage
- Rain, clouds, fog
- Gaseous absorption
- Foliage / Urban
- Custom loss plug-ins
Communications Model

- **What is my Comm Environment?**
  - Modelling Comm Effects
  - Specify the RF environment model

- **Number of Nodes**
  - Transmitters / receivers
  - Multi-hop links

- **Predicting the link quality**
  - Detailed emitter patterns, modulators, spectral filters, etc.
  - Link budget (BER, Eb/No, C/N, etc.)
  - Interference / jamming
  - Link performance over large areas

- **Evaluate Alternate Asset Usage**
Radar Modeling

- Pulsed & Continuous Wave
- SAR
- Filters
- Gaseous absorption
- Polarization
- Custom Antennas
- Radar Cross Section
STK for Model Based Systems Engineering

Aircraft Model

Sensor Model

Communications Model

Mission Specific Analysis
STK for Model Based Systems Engineering

Aircraft Model

Sensor Model

Communications Model

End-to-End System Design
Quick Overview of STK for Modeling Systems
AGI Software – Test & Evaluation Timeline
<table>
<thead>
<tr>
<th>Develop Test Plan</th>
<th>Test-Event Design</th>
<th>Event Rehearsal</th>
<th>Pre-Test Re-Plan</th>
<th>Test Execution</th>
<th>Post-Test Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Test scenario development</td>
<td>- Selection of test points for specific objectives</td>
<td>- Use of pre-flight briefing materials</td>
<td>- Pre-test adaption to last minutes changes</td>
<td>- Test event situational awareness tools</td>
<td>- Rapid production of “quick-look”</td>
</tr>
<tr>
<td>- Timing of test events</td>
<td>- Flight plan design to match test point goals</td>
<td>- Nominal test scenario run through</td>
<td>- Flexibility to bring up nominal test plan in M&amp;S environment and quickly make changes</td>
<td>- Real-time visualization of test event</td>
<td>- Actual flight path –vs– nominal</td>
</tr>
<tr>
<td>- Gross system trades</td>
<td>- Coordination of test resources</td>
<td>- Scheduling check</td>
<td>- Airspace changes impact assessment &amp; adaption</td>
<td>- On-board aircraft</td>
<td>- Actual test points achieved comparison to plan</td>
</tr>
<tr>
<td>- Detailed system trades</td>
<td>- Multiple aircraft</td>
<td>- Coordination of test resources</td>
<td>- Wind direction impact assessment &amp; adaption</td>
<td>- Local to test range</td>
<td>- Visualization of test geometry history correlated with collected test data</td>
</tr>
<tr>
<td>- Determine objectives – given &amp; derived</td>
<td>- Multiple sensors</td>
<td>- Quick reaction test plan modifications</td>
<td>- Weather conditions changes impact assessment &amp; adaption</td>
<td>- Remote to contractor facility or customer facility</td>
<td>- M&amp;S supplement to actual test results</td>
</tr>
<tr>
<td>- Determine essential elements of analysis and MOEs</td>
<td>- Air &amp; ground</td>
<td></td>
<td>- Provides a means to allow for changes with low impact to test objectives achievement</td>
<td>- Monitoring of test points achievement versus nominal plan</td>
<td>- Use of STEP process approach to validate M&amp;S models as part of the feedback loop within the test series</td>
</tr>
<tr>
<td>- Identification of variables for control and measurement</td>
<td>- Design &amp; planning of specific test</td>
<td></td>
<td>- Quick reaction to real-time changes in actual flight paths versus planned nominal and impact on test points and objectives</td>
<td>- Quick reaction to real-time re-planning to adapt to changes and to execute secondary objectives and test points</td>
<td>- Test point trade space extrapolation</td>
</tr>
<tr>
<td>- Gross trades of schedule of objectives</td>
<td>- Scheduling</td>
<td></td>
<td>- Real-time re-planning to adapt to changes and to execute secondary objectives and test points</td>
<td>- Remote real-time SA of test events and participation in real-time re-plans</td>
<td>- Variations of parameters to aid in the design of next test event</td>
</tr>
<tr>
<td>- Design of Experiments</td>
<td>- Planning &amp; analysis of infrastructural items</td>
<td></td>
<td>- Remote real-time SA of test events and participation in real-time re-plans</td>
<td>- Post test briefing material production</td>
<td>- Specific test point geometry depictions and animations</td>
</tr>
</tbody>
</table>

- Telemetry systems
- Test range radars
- Comm systems
- Pre-flight briefing material production - animations, snap shots, event schedules
- Nominal test scenario run through
- Scheduling check
- Coordination of test resources
- Quick reaction test plan modifications
- Pre-test adaption to last minutes changes
- Flexibility to bring up nominal test plan in M&S environment and quickly make changes
- Airspace changes impact assessment & adaption
- Wind direction impact assessment & adaption
- Weather conditions changes impact assessment & adaption
- Provides a means to allow for changes with low impact to test objectives achievement
- Quick reaction to real-time changes in actual flight paths versus planned nominal and impact on test points and objectives
- Real-time re-planning to adapt to changes and to execute secondary objectives and test points
- Remote real-time SA of test events and participation in real-time re-plans
- Post test briefing material production
- Animation of entire test event
- Specific test point geometry depictions and animations
STK Impact Across Test and Evaluation Process

1. Test scheduling
2. Test event simulated in STK
3. Test route optimization
4. Schedule compression using new processes
5. Test event monitored in real time
6. 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.
Example: Mojave Flight Test

Downlink Communications Test

**Issue**
- Loss Of Signal During Aircraft Ground Taxi to End of Runway
- Loss of Signal at Northeast Part of Flightpath; Particularly in the Turn and At Max Altitude of 50Kft

**Fixes**
- Moved Receive Antenna Location On Building Roof – Fixed Taxi Issue
- Adding Low Noise Amplifier to the Receive Antenna Produced Much Improved Signal at Northeast Part of Flightpath
- Narrowed Bandwidth on Receiver to Improve Signal-to-Noise Ratio
Model The Problem

Flight Path
- Aircraft Mission Modeler
- External Ephemeris
- 3D Aircraft Model

Antenna
- External Data
- Built in Models
- Plugin Models

RF Environment
- Propagation Loss Models
- Weather
- Terrain
- Custom Plugins
System Design Considerations

Antenna Choices
- Antenna Type?
- Antenna Location?
- Antenna Data Sheets
- General Assumptions
- Enhanced Scripting
- Etc.
AGI Software – Test & Evaluation Timeline

Mojave Flight Test Demonstration
Test Planning - Adding Scheduling & Coordination
Detailed Test Event Planning

Test Plans

Test-point details

- Requirements
- Objectives
- Resources
- Evaluation Criteria
- MOPS

Test Cards

Data Links

Radar

EW

EO/IR

Mission Deck Test Cards

Flight Routes
**Predictive Computation**

- Determine Values Which Meet Mission Objectives
  - Geometric
  - Proximity
  - Pointing
  - Lighting
  - Line-of-sight / atmospheric conditions
  - Inter-object geometry
  - Comm link quality, Jamming values
  - Radar performance measures
  - Terrain vertical profile
  - GPS DOP and Nav accuracy prediction
  - Etc!
Test Event Route Assessment

- Interactive Route Design
  - Fuel Remaining
  - Aspect Angle
  - Comm Performance
  - Telemetry Assurance
  - Dynamic Geometry
  - Lighting Directionality
  - RF Directionality
  - Safety of flight
  - Multi-Ship Choreographing
  - Number of Test-Points
Multi-Constraint Prediction

Timeline

Constraint 1

Constraint 2

Constraint 3

C1+C2+C3

- Determination of “Multi-Constraint” Satisfaction Times
Increasing Test-point Density per Flight

Designed test-point routes

Coordination holds & refuel waits

En route & return

“white-space”

“green-space”

“white-space”
System Modeling Tools to Evaluate Plans

Aircraft Performance Modeling
Route Modeling
Comm Link Modeling
Radar Modeling
Route Parametrics
Sensor Modeling
Terrain Effects
Test & Evaluation Demonstration

Advanced Test Execution and Timing Plans
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
## STK Benefit Potential in T&E Process

<table>
<thead>
<tr>
<th>Develop Test Plan</th>
<th>Test-Event Design</th>
<th>Event Rehearsal</th>
<th>Pre-Test Re-Plan</th>
<th>Test Execution</th>
<th>Post-Test Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Test scenario development</td>
<td>- Selection of test points for specific objectives</td>
<td>- Use of pre-flight briefing materials</td>
<td>- Pre-test adaption to last minutes changes</td>
<td>- Test event situational awareness tools</td>
<td>- Rapid production of “quick-look”</td>
</tr>
<tr>
<td>- Timing of test events</td>
<td>- Flight plan design to match test point goals</td>
<td>- Nominal test scenario run through</td>
<td>- Flexibility to bring up nominal test plan in M&amp;S environment and quickly make changes</td>
<td>- Real-time visualization of test event</td>
<td>- Actual flight path –vs– nominal</td>
</tr>
<tr>
<td>- Gross system trades</td>
<td>- Coordination of test resources</td>
<td>- Scheduling check</td>
<td>- Airspace changes impact assessment &amp; adaption</td>
<td>- Actual test points achieved comparison to plan</td>
<td>- Actual test points achieved comparison to plan</td>
</tr>
<tr>
<td>- Detailed system trades</td>
<td>- Multiple aircraft</td>
<td>- Coordination of test resources</td>
<td>- Wind direction impact assessment &amp; adaption</td>
<td>- Visualization of test geometry history correlated with collected test data</td>
<td>- Visualized &amp; identification of variables for control and measurement</td>
</tr>
<tr>
<td>- Determine objectives – given &amp; derived</td>
<td>- Multiple sensors</td>
<td>- Quick reaction test plan modifications</td>
<td>- Weather conditions changes impact assessment &amp; adaption</td>
<td>- M&amp;S supplement to actual test results</td>
<td>- M&amp;S supplement to actual test results</td>
</tr>
<tr>
<td>- Determine essential elements of analysis and MOEs</td>
<td>- Air &amp; ground</td>
<td></td>
<td>- Provides a means to allow for changes with low impact to test objectives achievement</td>
<td>- Use of STEP process approach to validate M&amp;S models as part of the feedback loop within the test series</td>
<td>- Use of STEP process approach to validate M&amp;S models as part of the feedback loop within the test series</td>
</tr>
<tr>
<td>- Identification of variables for control and measurement</td>
<td>- Design &amp; planning of specific test</td>
<td>- Pre-flight briefing material production – animations, snap shots, event schedules</td>
<td>- Real-time re-planning to adapt to changes and to execute secondary objectives and test points</td>
<td>- Test point trade space extrapolation</td>
<td>- Test point trade space extrapolation</td>
</tr>
<tr>
<td>- Gross trades of schedule of objectives</td>
<td>- Scheduling</td>
<td></td>
<td>- Remote real-time SA of test events and participation in real-time re-plans</td>
<td>- Variations of parameters to aid in the design of next test event</td>
<td>- Variations of parameters to aid in the design of next test event</td>
</tr>
<tr>
<td>- Design of Experiments</td>
<td>- Planning &amp; analysis of infrastructural items</td>
<td></td>
<td>- Post test briefing material production</td>
<td>- Animation of entire test event</td>
<td>- Animation of entire test event</td>
</tr>
<tr>
<td></td>
<td>- Telemetry systems</td>
<td></td>
<td></td>
<td>- Specific test point geometry depictions and animations</td>
<td>- Specific test point geometry depictions and animations</td>
</tr>
</tbody>
</table>
Break

Please Return in 15 Minutes......
Test Execution
Test Execution

- **Enhanced Situational Awareness**
  - Monitor Events in Real-Time
  - Visualize Systems/Platforms
    - Position & Attitude
    - Sensor Behavior
  - Geometric Relationships
    - Proximity to Other Assets
    - Stand-off Distances
    - No-Fly Zones/Air Corridors

- **Planned vs. Achieved**
  - Actual Flight Path Measured Against Planned Route

- **Rapid Re-Planning**
  - Identify Needs To Alter Flight Plan
  - Re-plan Quickly and Analyze Mission Impacts
Data Streaming Example (Realtime)

- **STK Realtime Mode**
  - Attached sensor payload projection
  - Communication link between aircraft and ground facility

- **Simulated Flight Data**
  - UDP Broadcast
  - Streaming position/attitude data
Post Flight Analysis
Post Flight Analysis

- **Ingest Recorded Flight Data**
  - Ingest formatted data
  - Any time-correlated data of interest
    - Position/Orientation
    - Control Surface States
    - Instrumentation Readings / Yoke States
    - Engine Data
    - Onboard Instrumentation Data
    - Data Recorders
    - Range Instrument Data
    - Etc.

- **Dynamically Color & Stack Routes**
  - Color route lines based on any flight data parameter or test result
  - Stack lines for easy visual comparison

- **Video Overlay (Picture In Picture)**
  - Overlay in 3D Window
  - Time-synced video overlays (cockpit video, range cameras, etc.)
Post Flight Analysis

- **Vector Creation**
  - Create vectors/angles of interest from flight data

- **Visualize Test Point (Start/Stop)**
  - Overlay icons/markers representing test intervals along vehicle route
  - Visualize correlated test intervals in STK’s Timeline View Window

- **Manage Terrain, Imagery, Maps, GIS**
  - Easily manage data sets for visualization and analysis

- **Custom Scripting Window**
  - Utilize scripting languages (MATLAB, VBSCRIPT, etc.) natively within the toolkit for custom manipulation of ingested data
Post Flight Demonstration

- **Paya Lebar – Singapore Test Flight**
  - Test Flight from Paya Lebar airfield in Singapore
  - Specific zones for the following tests
    - GCS Communications System Test
    - Air-to-Air Radar System
    - Air-to-Ground Radar (Ship Detection)
    - Flight Dynamics Test
  - External flight data import via Test and Evaluation Tool Kit
    - Test data explored and analyzed via streamlined tools and utilities within the tool kit workflow
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
Exploiting the Data

- Begin with traditional imagery request techniques
- Incorporate models to infer information about the imagery
- More accurate images returned based on request
- Faster image retrieval
Discoverable Full Motion Video Application

**STK Objects**

- Aircraft Route
- Attitude
- Sensor FOV
- Sensor Pointing
- Terrain Data
- Imagery
- GIS Information
- Etc.

**Mission Data**

**Sensor Model**

**Environment Model**

**Video Archive**
Video Exploitation / Demo

- **Data Fusion**
  - Quick Search for Desired Video
  - Custom Interface
  - Easy to Use!!

- **Interoperable**
  - Imagery Data
  - Video Data
  - GIS Information
Summary of Proven Potential

- **Efficiency of Test Force Operations**
  - Reduced time for test-force process elements
    - Test-plan process, test-card development process, post-test process
  - Shortened and more effective meetings, pre-flight reviews, etc.

- **Effectiveness and efficiency of test flights**
  - Improved robustness of test-card designs – validation against test plan objectives
  - Increased number of test-points per flight
  - Improved scheduling of refuel operations
  - Positive overall test-force flight schedule impact
  - Enabling the complicated choreographing of multi-ship flights

- **Communications within the program and with customer**
  - Illustration of complex concepts and issues at all stages of the execution T&E lifecycle
  - Enable greater collaboration
  - Shortened and more effective meetings, pre-flight reviews, etc.
  - Positive impact to test-point sign-off activities

- **Flight safety**
  - Rich material enabling added insight to pre-flight briefings
  - Robust treatment of multi-ship flight choreographing and event scheduling
F-35 Flight Testing - Case Study

**Problem:** Flight test planning is largely manual, relying on talent and intuition of experienced engineers.

**Solution:** Use STK MS&A Environment to improve flight test efficiency, effectiveness and repeatability.

**Outcome:** Proof-of-Concept demonstrated improved flight test plans, designs and analysis for mission systems testing.

Accelerated & optimized test planning, Increased flexibility in test event execution and Faster post-test analysis.
Problem: Hundreds of personnel operate in dangerous area with different data feeds and tracking systems.

Solution: STK Engine was integrated to create a real-time common operating picture (COP).

Outcome: C4VAS fuses multiple data feeds to help commanders keep units safe.

AGI software supports daily operations over large areas of the southwest US.
**Problem:** Wyle performs test and evaluation of new airborne networks and ground systems for USAF ESC/XR and the DoD.

**Solution:** STK selected STK as a conceptual planning tool for ESC and DoD test events and analysis.

**Outcome:** STK is used during the planning phase of nearly every test event to predict link margin and antennae gain, optimize performance and enhance technical decision-making.

*STK’s modeling and simulation helped reduce the test cycle, saving Wyle and its customers’ time, money and effort.*
**Problem:** Build A Realistic Model Of an Airborne Network Through Simulation to Predict Network Performance Over the Flight Regime. Validate AN Models Through Live Fly Results

**Solution:** Use STK, OPNET and Custom Integration Tools to Build a Robust Network Simulation. Compare Initial Model Results with Model Outputs Driven by Real Flight Data

**Outcome:** Allowed “Pre-flight” of the Network to Highlight Potential Issues and Supported “Post-flight” Link Performance Analysis After Live Exercise

---

**Risk Reduction Through Physics-based Modeling of the Airborne Network**

*This invention was made in the performance of a Cooperative Research and Development Agreement with the Department of the Air Force.*
**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 of high value aircraft and reduced schedule risk

“Valid flight testing at your desk”

— Bruce MacDougall, NGC
**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.
Virtual Flight Testing of Radar System Performance Using SystemVue and STK

- Integrated SystemVue (communications physical layer design) and STK (3D kinetic scenario modeling) for RF-accurate signals and results, with terrain-accurate Doppler and fading.

- Provide a “system-level” approach to traditional design and test to
  - Evaluate new jamming techniques or threats
  - Inject multiple dynamic emitters and targets
  - Allow various types of jamming based on a defined set of criteria for dynamic operation
  - Model and evaluate cross-domain effects, such as automatic gain control
  - Include unintended interference from commercial wireless networks, etc.

Virtual flight testing allows measurement-hardened algorithms to be deployed quickly, and a minimum of true operational testing to be done with greater confidence, to save costs. By closing the loop between lab-based virtual testing (simulation and test equipment) and operational testing, virtual testing can be made even more effective.
<table>
<thead>
<tr>
<th>STK Benefit Potential in T&amp;E Process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Develop Test Plan</strong></td>
</tr>
<tr>
<td>- Test scenario development</td>
</tr>
<tr>
<td>- Timing of test events</td>
</tr>
<tr>
<td>- Gross system trades</td>
</tr>
<tr>
<td>- Detailed system trades</td>
</tr>
<tr>
<td>- Determine objectives – given &amp; derived</td>
</tr>
<tr>
<td>- Determine essential elements of analysis and MOEs</td>
</tr>
<tr>
<td>- Identification of variables for control and measurement</td>
</tr>
<tr>
<td>- Gross trades of schedule of objectives</td>
</tr>
<tr>
<td>- Design of Experiments</td>
</tr>
</tbody>
</table>

| **Test-Event Design**                |
| - Selection of test points for specific objectives |
| - Flight plan design to match test point goals |
| - Coordination of test resources       |
| - Multiple aircraft                   |
| - Multiple sensors                    |
| - Air & ground                        |
| - Design & planning of specific test  |
| - Scheduling                          |
| - Planning & analysis of infrastructural items |
| - Telemetry systems                   |
| - Test range radars                   |
| - Comm systems                        |
| - Pre-flight briefing material production – animations, snap shots, event schedules |

| **Event Rehearsal**                  |
| - Use of pre-flight briefing materials |
| - Nominal test scenario run through  |
| - Scheduling check                   |
| - Coordination of test resources     |
| - Quick reaction test plan modifications |

| **Pre-Test Re-Plan**                 |
| - Pre-test adaption to last minutes changes |
| - Flexibility to bring up nominal test plan in M&S environment and quickly make changes |
| - Airspace changes impact assessment & adaption |
| - Wind direction impact assessment & adaption |
| - Weather conditions changes impact assessment & adaption |
| - Provides a means to allow for changes with low impact to test objectives achievement |

| **Test Execution**                   |
| - Test event situational awareness tools |
| - Real-time visualization of test event |
| - On-board aircraft                   |
| - Local to test range                 |
| - Remote to contractor facility or customer facility |
| - Monitoring of test points achievement versus nominal plan |
| - Quick reaction to real-time changes in actual flight paths versus planned nominal and impact on test points and objectives |
| - Real-time re-planning to adapt to changes and to execute secondary objectives and test points |
| - Remote real-time SA of test events and participation in real-time re-plans |

| **Post-Test Analysis**               |
| - Rapid production of “quick-look”   |
| - Actual flight path –vs– nominal    |
| - Actual test points achieved comparison to plan |
| - Visualization of test geometry history correlated with collected test data |
| - M&S supplement to actual test results |
| - Use of STEP process approach to validate M&S models as part of the feedback loop within the test series |
| - Test point trade space extrapolation |
| - Variations of parameters to aid in the design of next test event |
| - Post test briefing material production |
| - Animation of entire test event      |
| - Specific test point geometry depictions and animations |
Wrap-Up

System Modeling

Mission Planning

Flight Test Mission Design Tools

Custom Applications

Interoperability
Resources

AGI Website

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

www.agi.com

Contact Us

- support@agi.com
- asiasupport@agi.com
- +1 800 924 7244
Questions?

Thank You