



AGI USER EXCHANGE

WASHINGTON, D.C. 2007

Detect, Sense, and Avoid Analysis for Unmanned Aircraft Systems (UAS)

Dennis M. Coulter

Modern Technology Solutions, Inc.

dennis.coulter@mtsi-va.com

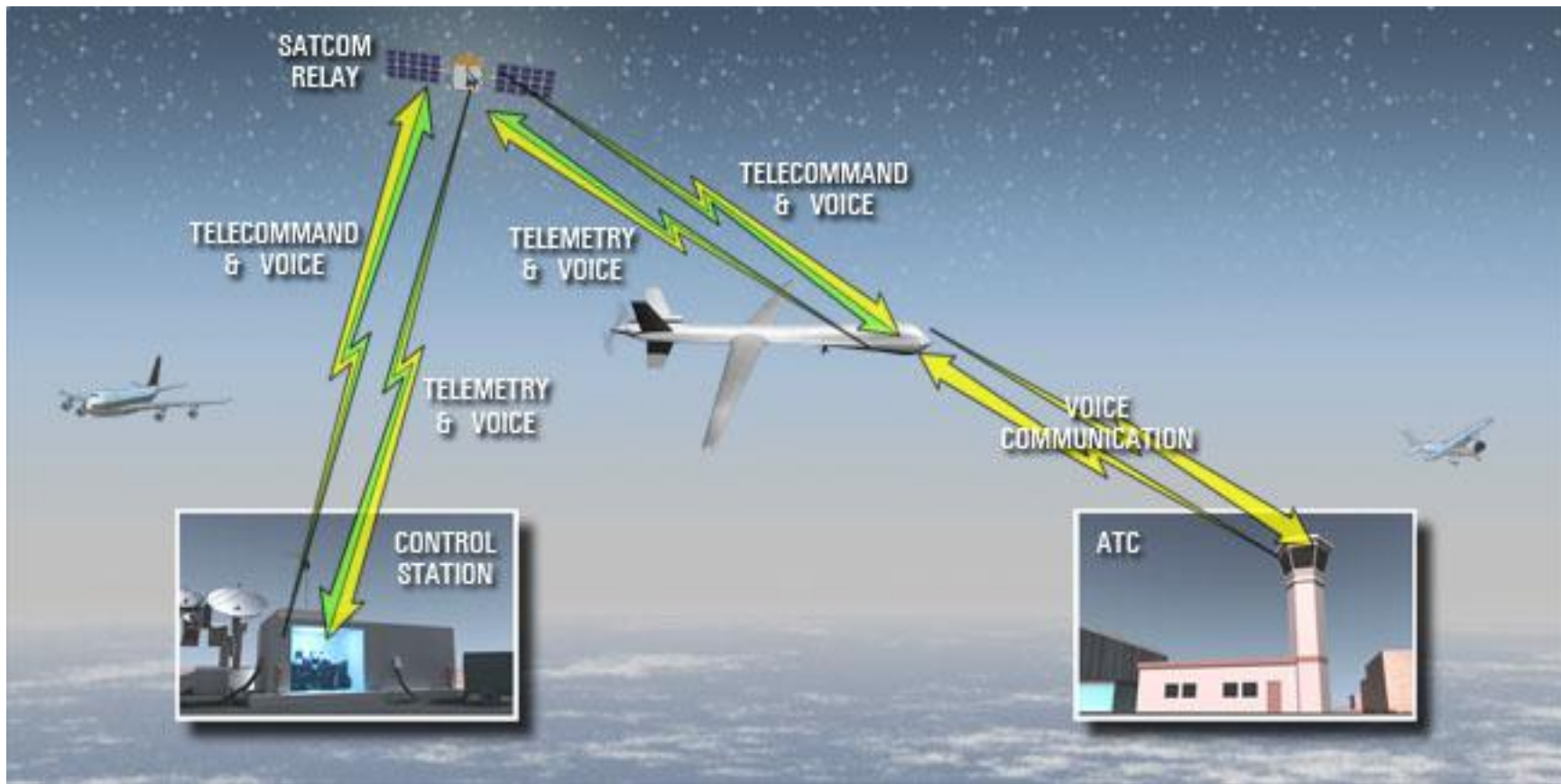
Introduction

- An Unmanned Aircraft System (UAS) Detect, Sense and Avoid (DSA) system capability is key to National Airspace System (NAS) access
 - *FAA “see-and-avoid” requirement*
- RTCA Special Committee - 203
 - *Federal Advisory Committee chartered to develop UAS Sense and Avoid Minimum Aviation System Performance Standards (MASPS)*
 - *Recommendations provided to FAA*
 - *Analytically derived values for sense and avoid system performance parameters*
 - Limited real-world experience

14CFR91.113 (b) General: ..., vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft.

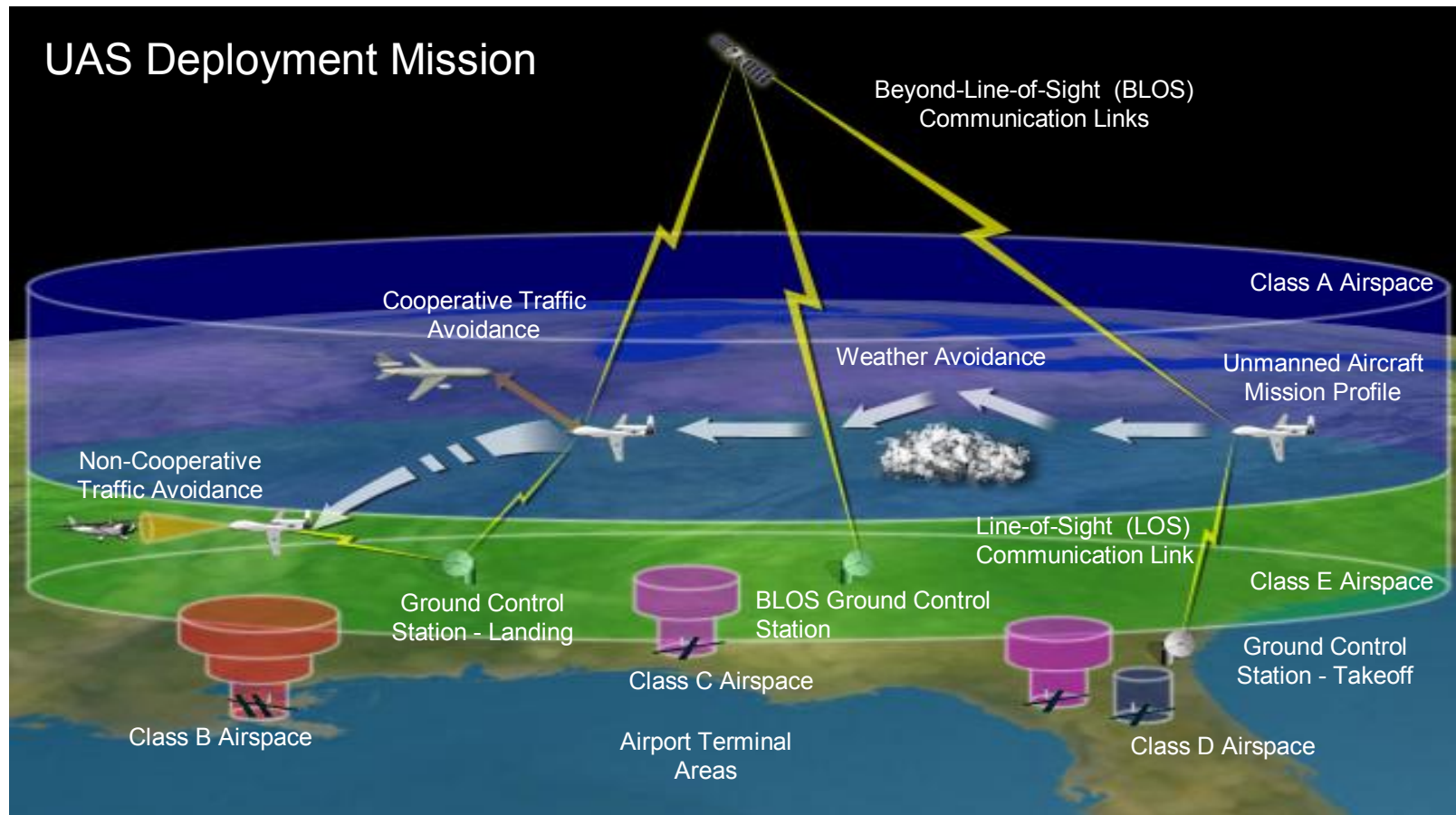
Background

Unmanned Aircraft System



Background

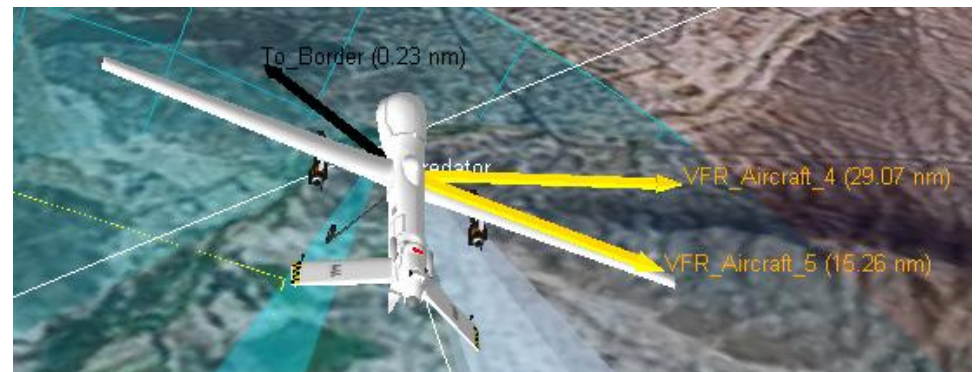
UAS Operations in the NAS



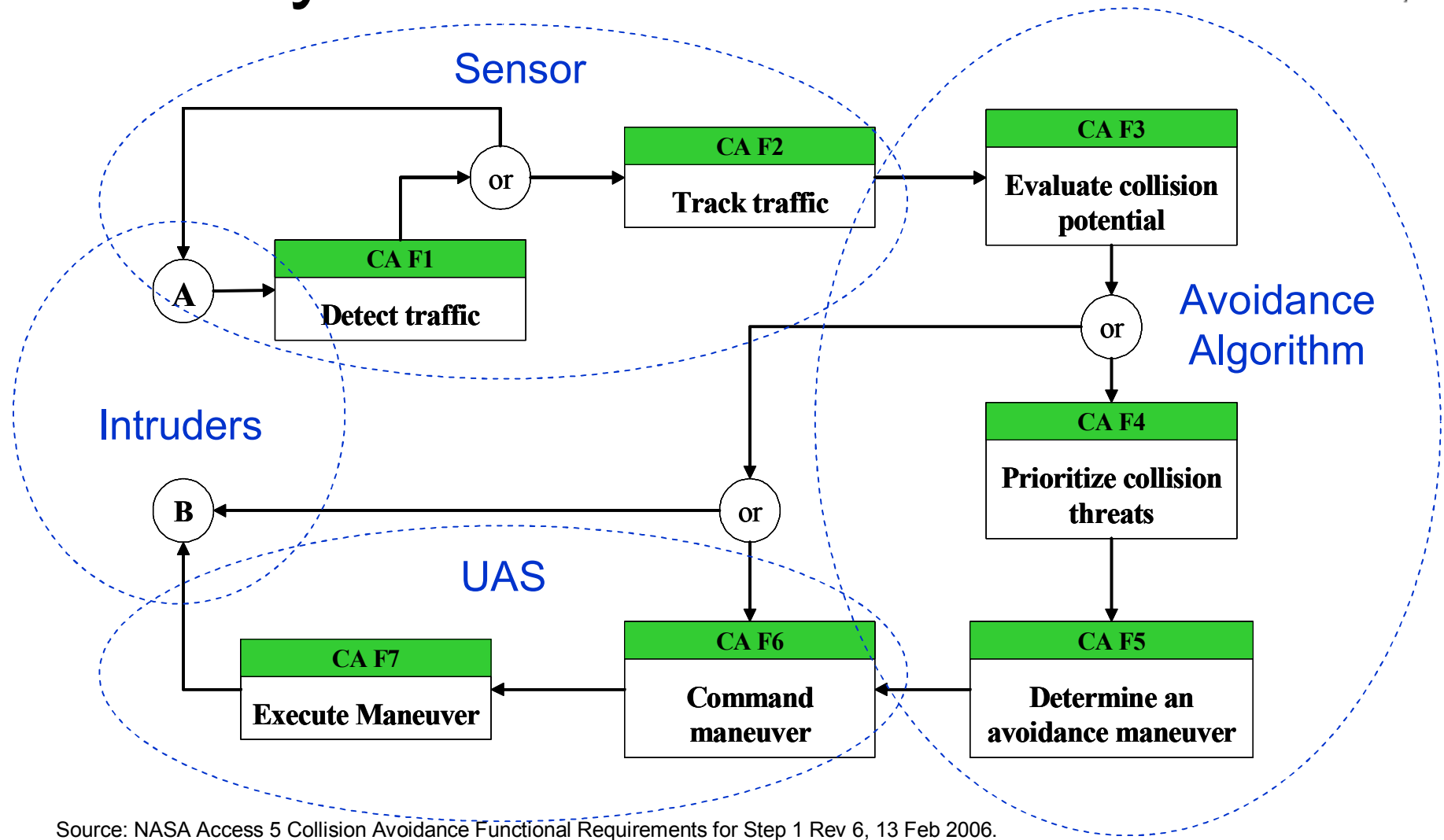
Purpose

- Meet SC-203 needs for a UAS collision avoidance modeling capability
 - *Incorporate lessons learned from previous efforts*
 - *Utilize existing STK capabilities*
 - *Develop additional model components, as required*
 - *Goal – sense and avoid system performance recommendations*

- Key model elements
 - UAS
 - Other aircraft (Intruders)
 - UAS S&A system
 - Sensor
 - Avoidance algorithm



S&A System Functions

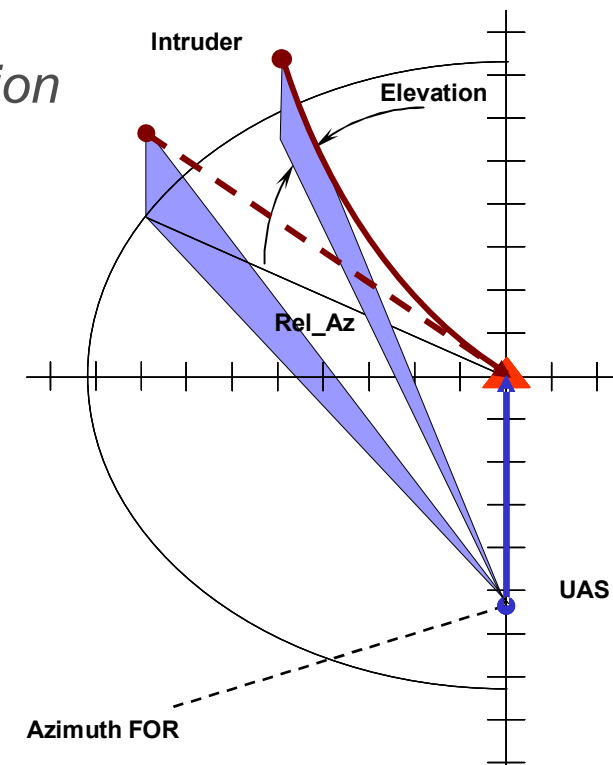


Previous Efforts

- Based on NASA Access 5 Functional Requirements
 - *Quantify performance requirements*
- Performance parameter independent analysis
 - *Isolate system functions*
 - *Develop better understanding of system elements*
- Visual Basic 6.0 applications
 - *Elevation Field-of-Regard Model*
 - Purpose - Determine the vertical scan limits necessary to detect other traffic
 - *Track Capability (TRACAP) Model*
 - Purpose – Determine the number of aircraft the DSA system must simultaneously track

Elevation FOR

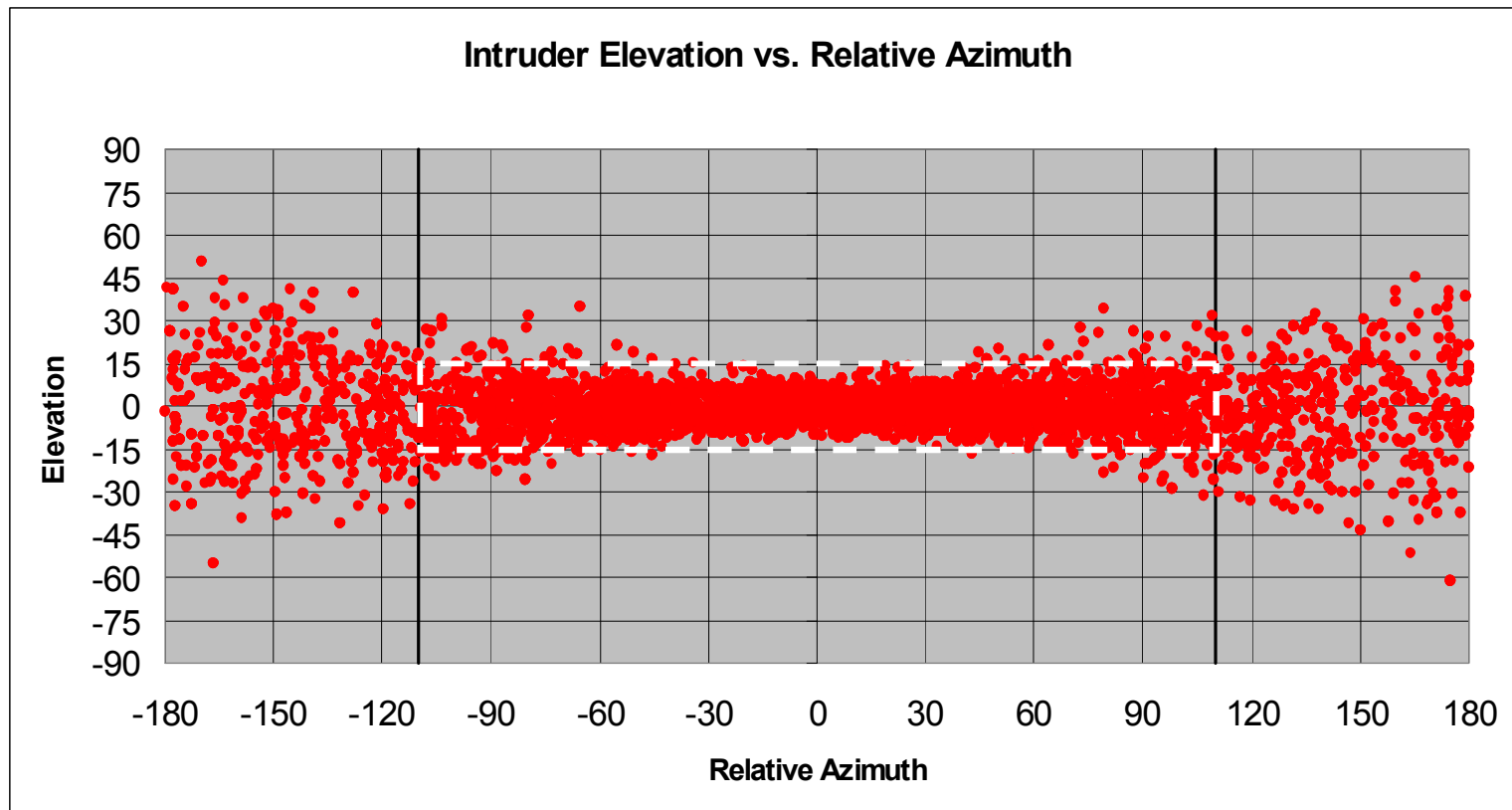
- Static Intruder detection analysis
 - *Determine intruder position at first detection*
 - Elevation
 - Azimuth
- Random parameters
 - *Bounded distributions*
 - Velocity (n)
 - Climb/Descend (n)
 - Bank angle (n)
 - Intruder relative heading (u)



n – Normal
u – Uniform

Elevation FOR Results

- Elevation FOR requirements vary with Intruder azimuth

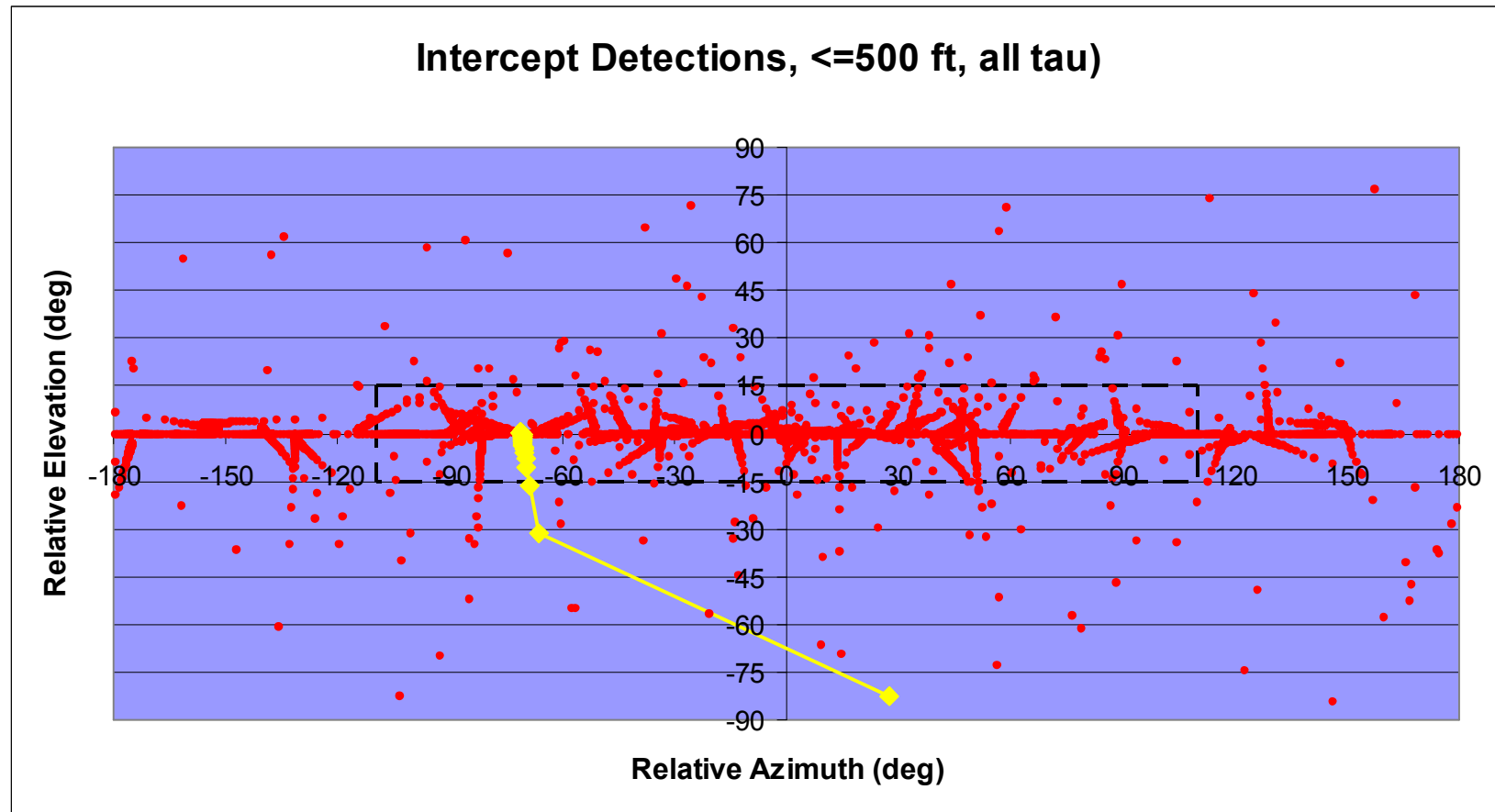


TRACAP

- Initially developed as a static laydown model
 - *Simultaneous Track Capability*
 - Number of Intruder aircraft simultaneously within the sensor volume
 - Range, azimuth, elevation
- Airspace traffic density model
 - *Key model component developed to represent other traffic*
 - *Provided basis for STK Random Track module*
- Evolved to include limited flight path modeling
 - *Analyze tracks vs. individual detections*

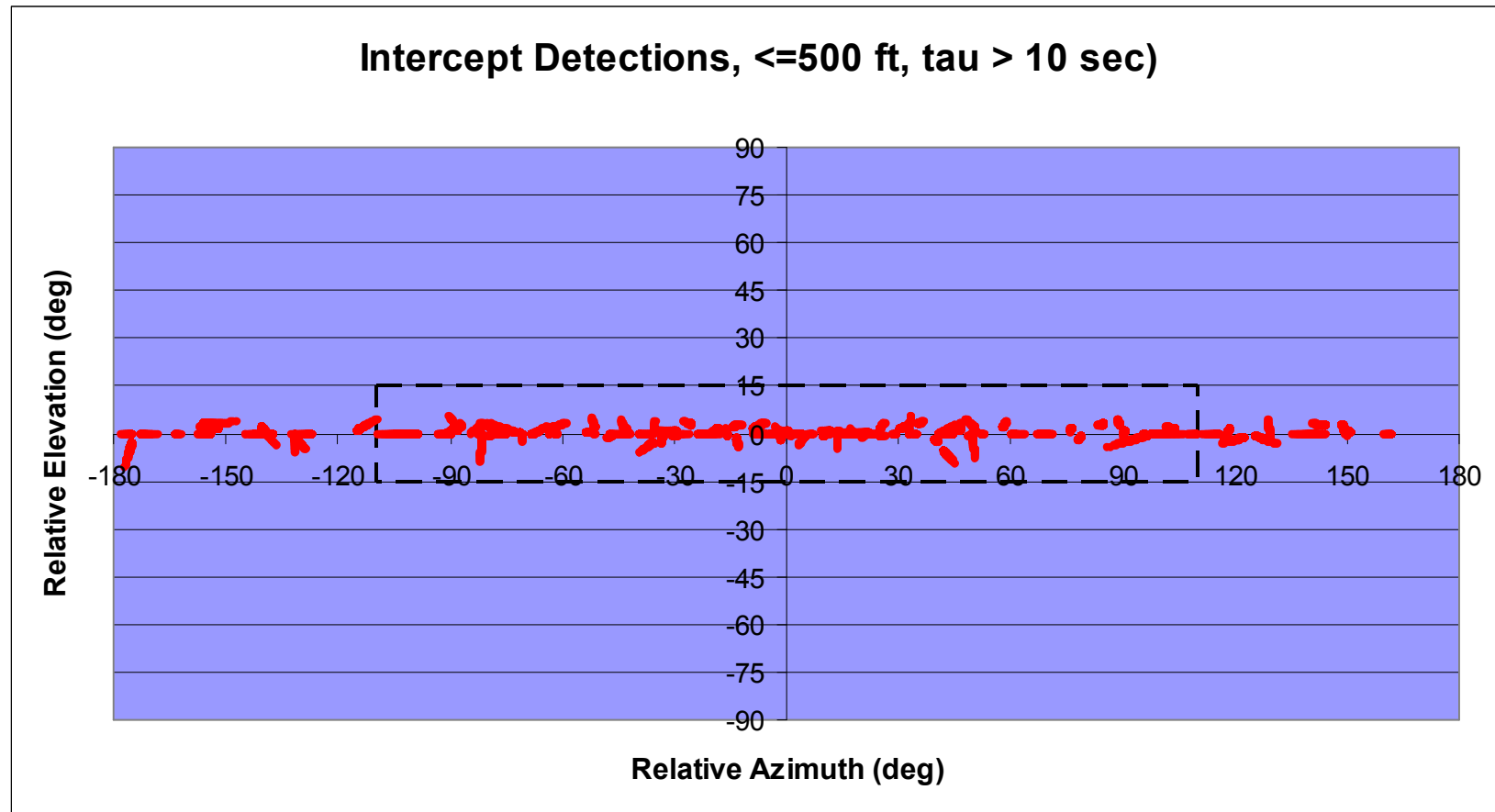
TRACAP Results

Intruder Track Analysis



TRACAP Results

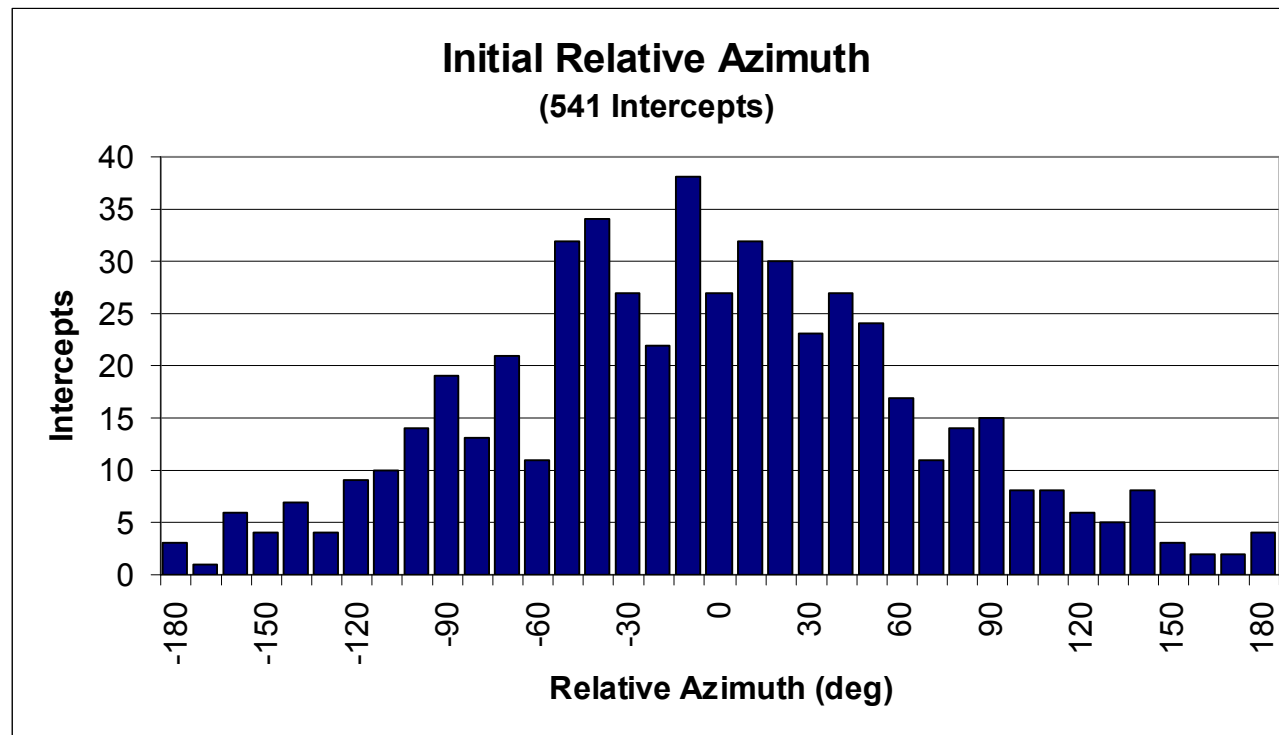
Intruder Track Analysis



TRACAP Results

Intruder Relative Azimuth

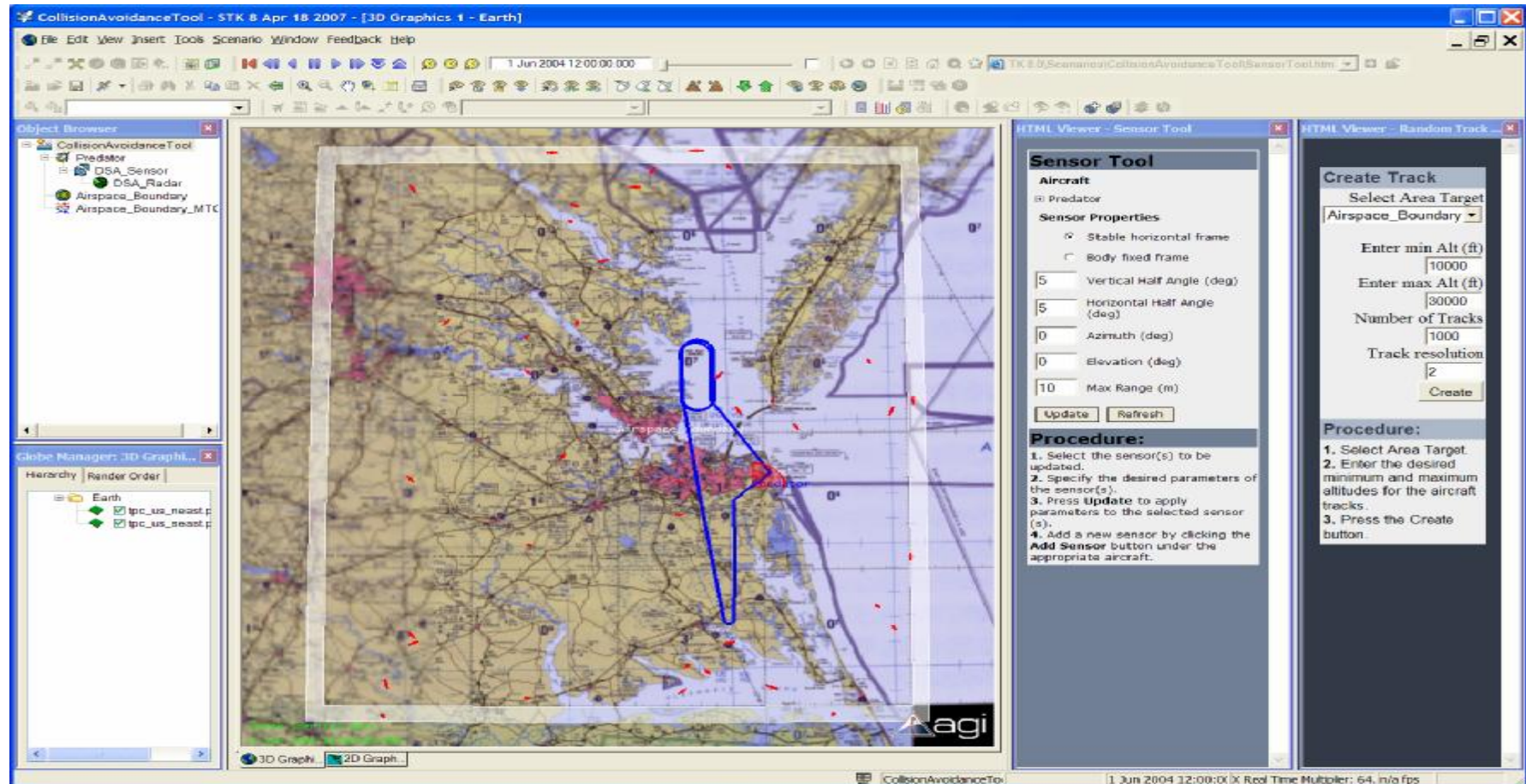
- Conflicting traffic azimuth distribution
 - *Normal, not uniform*



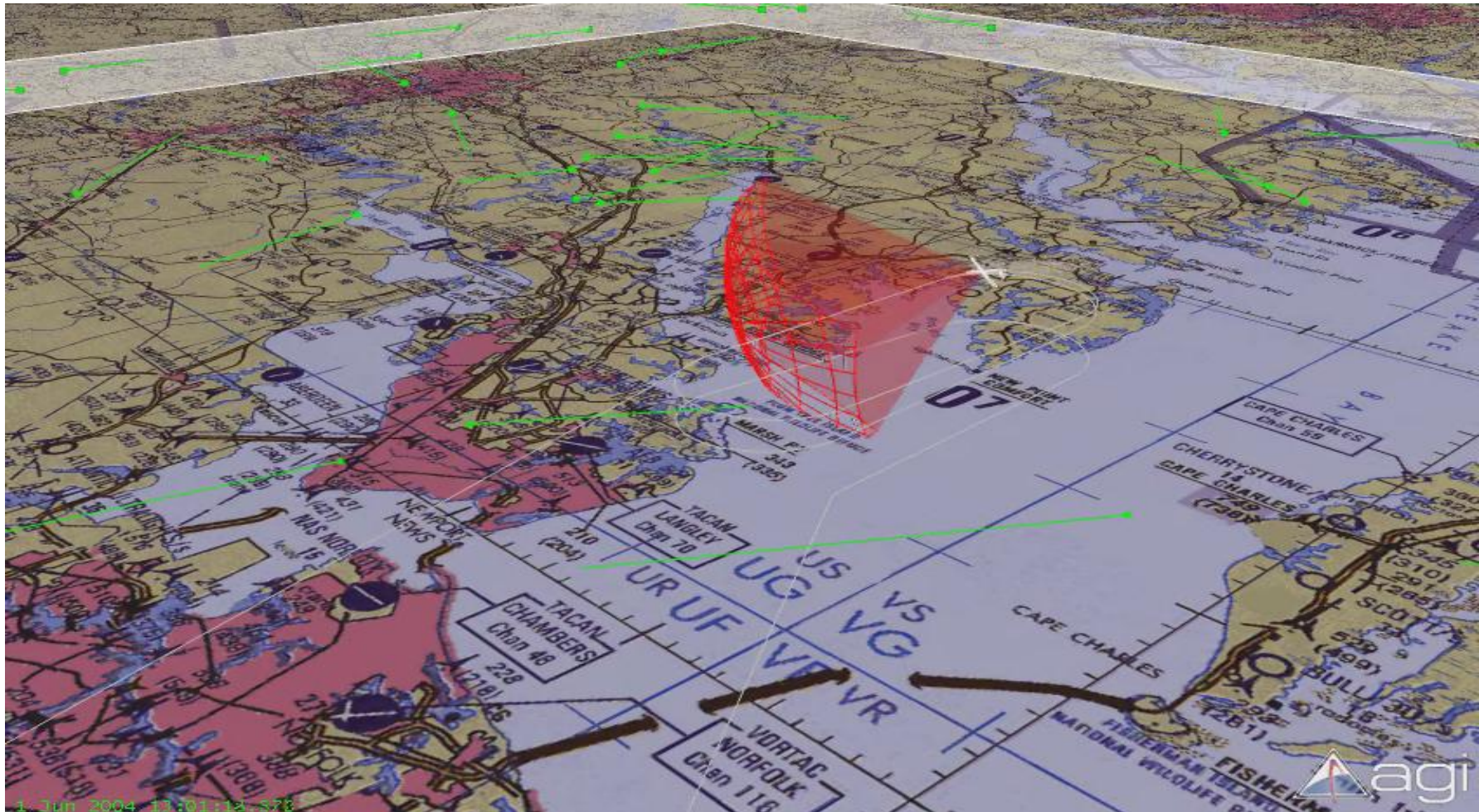
STK Model

- Overcome VB 6.0 model limitations
 - *Runtime*
 - *Data storage*
 - *Restricted flight path modeling*
 - *Parameter-specific analysis*
 - e.g. Sensor range vs. minimum detect time
- STK modifications
 - *Improve Multiple Target Object (MTO) intervisibility*
 - *Develop*
 - Random Traffic Tool
 - Sensor Tool
 - Flight path response

STK Collision Avoidance Tool



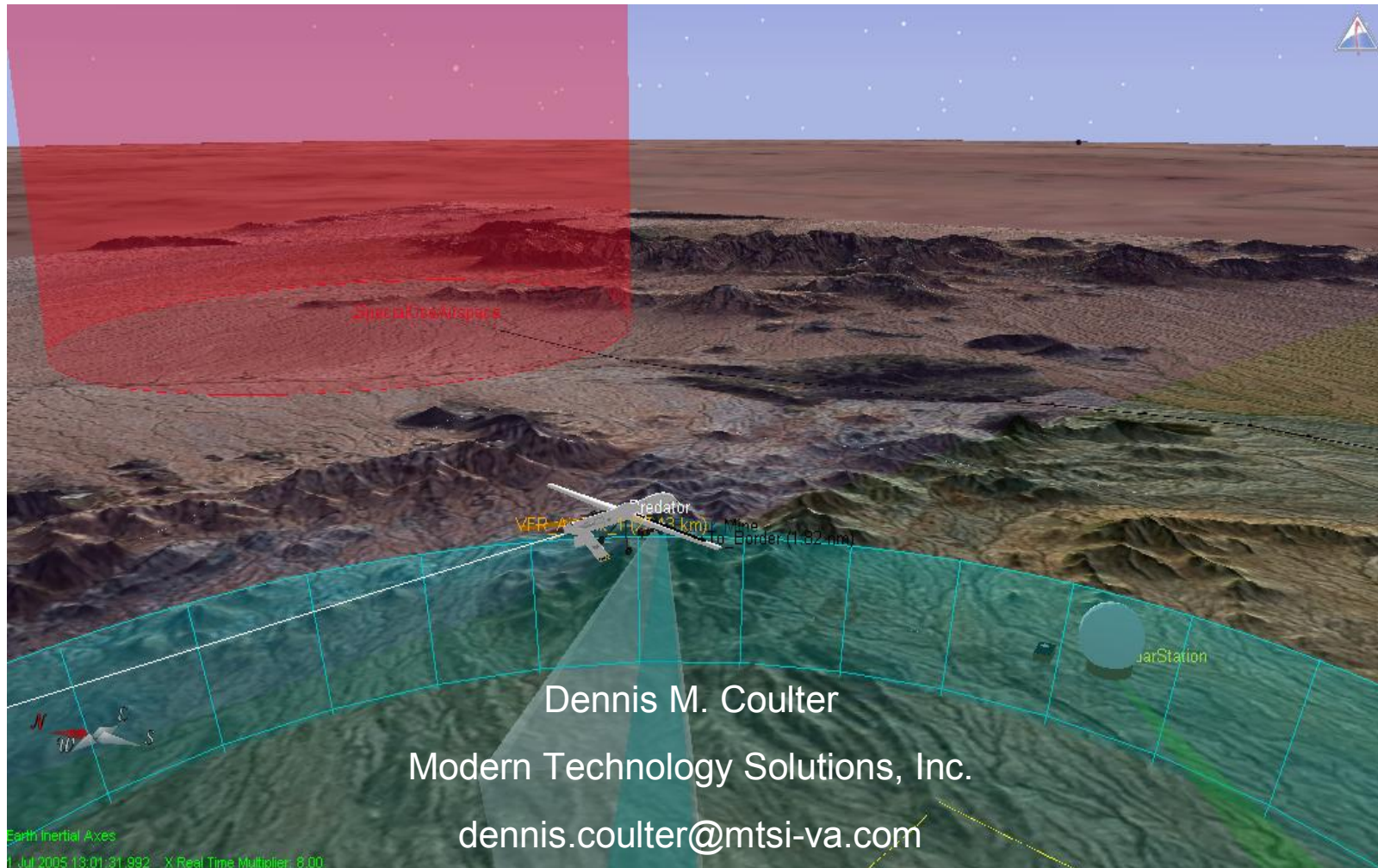
STK Sensor Modeling



Summary

- UAS collision avoidance modeling capability is evolving to meet the needs of UAS users and developers
 - *RTCA SC-203, civil aircraft*
 - *DoD UAS Airspace Integration Joint Integrated Product Team, public aircraft*
 - Department of Defense
 - Department of Homeland Security
- Provides a robust system analysis platform
 - *Readily available modeling option for examining system trade-offs*
 - *Analytical basis for S&A requirements*

Thank You



Dennis M. Coulter
Modern Technology Solutions, Inc.
dennis.coulter@mtsi-va.com