AGI Software for Space Mission Design, Analysis and Engineering
Content

- Concurrent Space Mission design process
- Lessons learned
- STK for SMAD
- Practical example
- Results
- Summary
Space Mission Design Process

- Collaborative, iterative and spiral development methodology to consistently craft space missions concepts and alternatives that satisfy objectives within mission constraints
- In use by leading space agencies
- Involves:
  - Parallel processes (joint and offline)
    - Versioning, sharing, interactive discussions and decision-making
  - Qualified staff
    - Systems engineers, subsystems engineers, managers
  - Tools
    - Excel, STK, Matlab, CAD, specialized, subsystems, smart boards, social media, versioning
Conceptualization and engineering

C3 Architecture

Mission Concept

Mission Operations

COMMS

Launcher

Payload and Bus

Orbits

Subject
Why is it important?
Space mission lifecycle

Studies & Analysis
Preliminary Design
Trade-offs Alternatives
Concept Dev.
System Design & Dev.
Training/Planning
AIT
Launch
EOPS
Operations & Data Analysis
Space mission design process

1. Define Objectives
   - Quantitative needs and requirements

2. Characterize the mission
   - Analysis of alternatives and system drivers for each

3. Evaluate the mission
   - Critical requirements and usefulness
   - Baseline mission concept

4. Define requirements
   - Allocate requirements to system elements
Roles and expertise

- **Client**
- **Project Manager**
- **Systems engineer**
- **Space Segment**
  - Payload
  - AOCS – Attitude and Orbit Control System
  - CDH – Command and Data Handling
  - TT&C and Comms
  - Power
  - Thermal
  - Structures and mechanisms
  - GNC – Guidance Navigation and Control
- **Ground Segment**
  - Operations
  - Data processing
- **Launchers**
Interconnected spread sheets
Rapid CAD and simulation tools
Rapid prototyping tools for subsystem and system level analysis
Cost, Risk and Schedule
Versioning tools (Key system drivers)
Lessons learned

- Space is a collaborative and iterative effort
- Assumptions need to be clearly stated and questioned
- A bad design will be difficult to operate
- Each culture has their own set of challenges
- Simulation allow you to fail and learn while doing it
- Build and measure interactive models as you go - MBSE
- Investigate full solution space not just one solution
- Constraint are important!
STK as concurrent engineering tool for space missions
Satellite Architecture CONOPS

Features & Capabilities

- Architecture Simulation
- Analysis Of Alternatives
- Model Optimization
- Architecture Resiliency

- Comms and data
- AOCS and structure
- Power and Payload
- Cost Analysis

Integration Examples
Objective: Design and optimize earth-observation system to collect data on the world’s oceans

Design Drivers: cost, temporal coverage performance

Constraints:
- Ocean coverage
- 1 Satellite
- Payload: FOV and pointing
- Orbit: Altitude and Inclination

AGI software used to design/engineer:
- Payload
- Orbit
- AOCS
- COMMS
- Ground
- Power
- Thermal

Temporal coverage performance:
- % of total, Avg # intervisibilities/day, avg revisit time, avg cum coverage time
Results – Avg Revisit Time sensitivity

Coverage persistency is mostly influenced by orbit alone
Results – Avg # intervisibilities per day

Avg # of viewing opportunities is more important than inclination
Single domain Results

- **Avg. Cumulated Coverage Time**

  If near sunsync then 7000km is better – If equatorial then 7200km
Cross Domain Results

- % of total coverage

Coverage persistency is mostly influenced by orbit alone.
Summary

- Proven COTS software available \textit{today}
- Reduce cost, risk and time
- Unique capabilities
  - Comprehensive mission analysis, design, engineering and training – one technology
  - Collaborative and multidisciplinary rapid prototyping
  - Off the shelf Interoperability with in house tools and industry standards
  - Rapid integration with legacy systems
- Supports full system lifecycle from concept to deployment
- Interoperable with leading Space organizations
Thanks!