AGI INTERNATIONAL USERS CONFERENCE

AGI Software for Space Mission Design, Analysis and Engineering

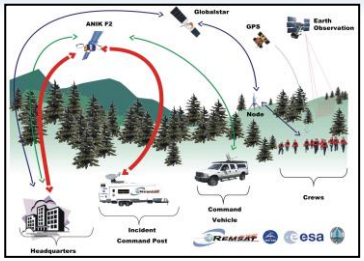
Content

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

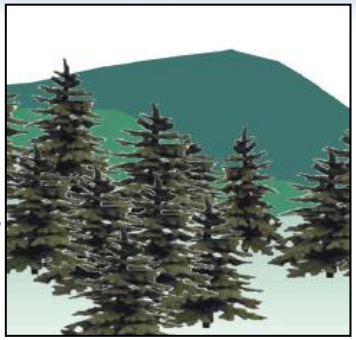
Space Mission Design Process

- **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



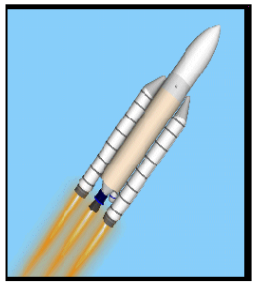
Subject

Mission Operations

Mission Concept

Orbits

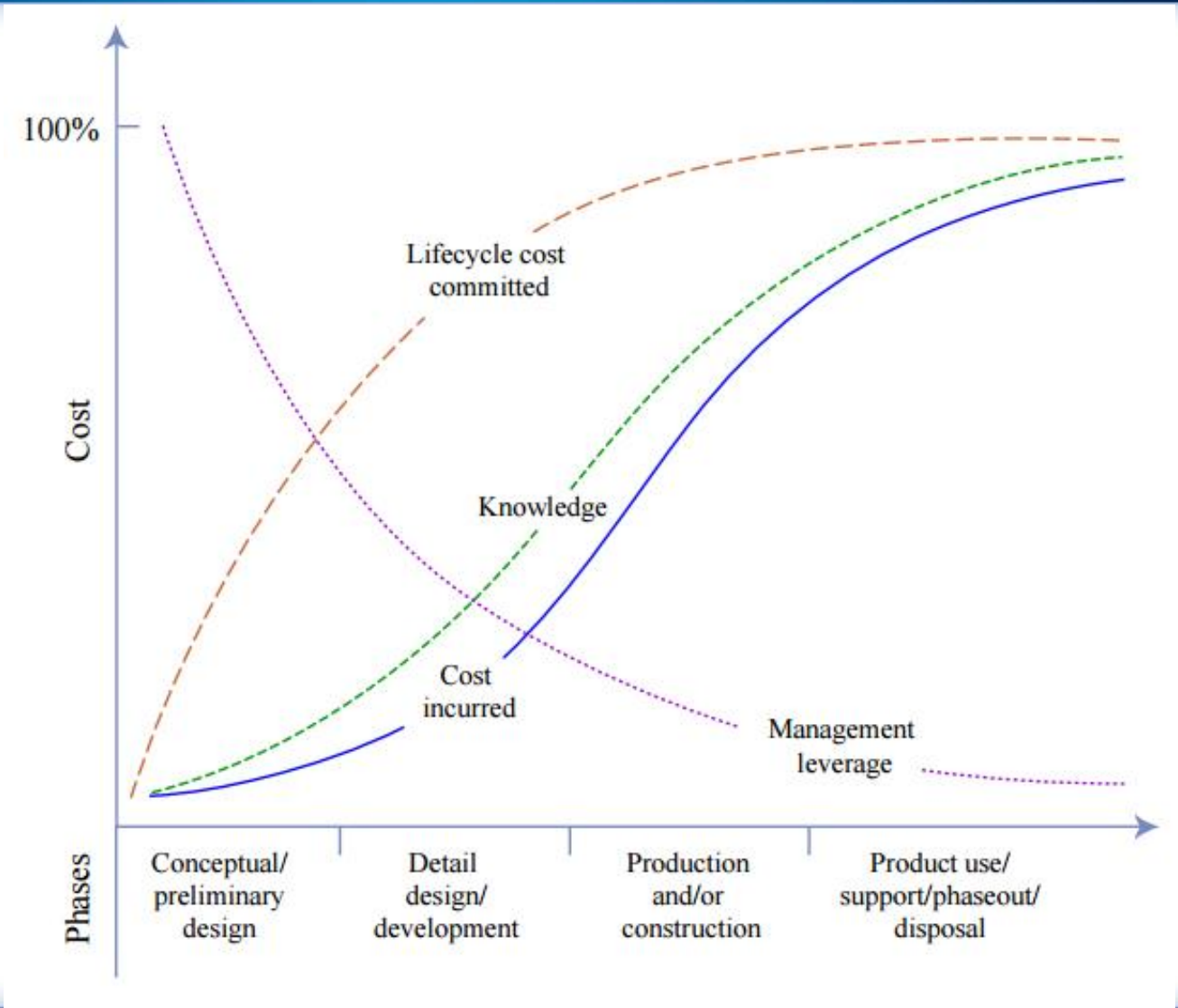
COMMS



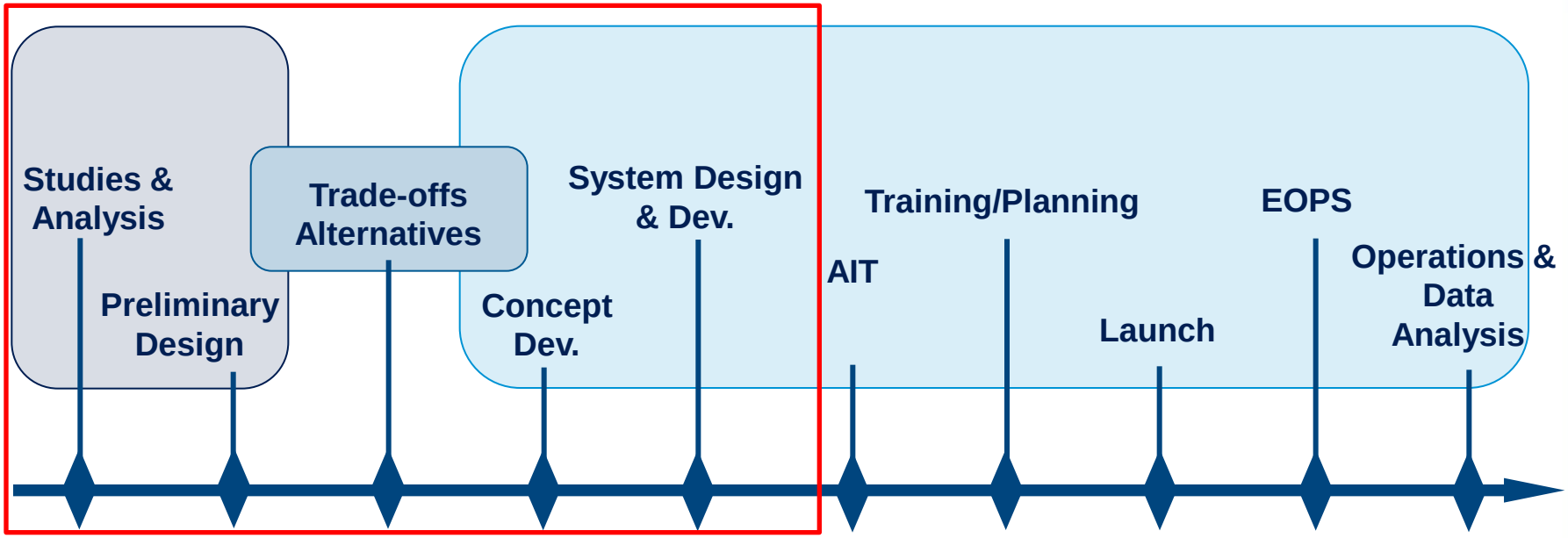
Launcher

Payload and Bus

Why is it important?



Space mission lifecycle



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**

Tools

- 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!

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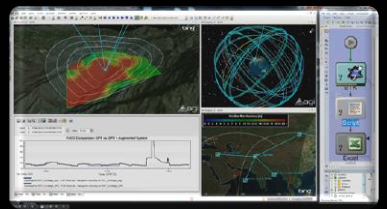
Analysis software for land, sea, air, & space

STK as concurrent engineering tool for space missions

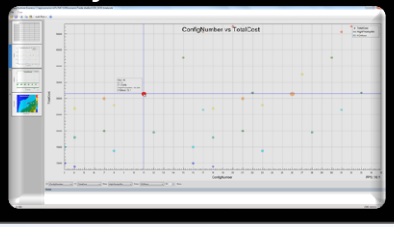
Satellite Architecture CONOPS

Features & Capabilities

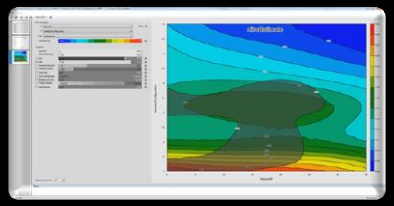
Architecture Simulation



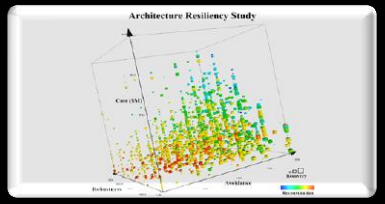
Analysis Of Alternatives



Model Optimization

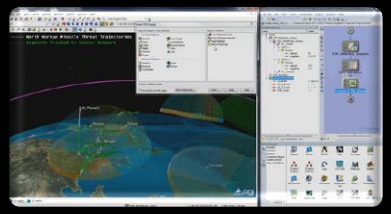


Architecture Resiliency

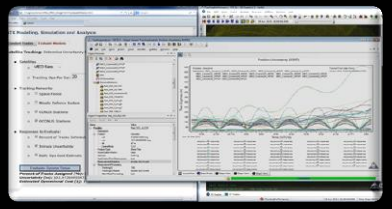


Comms and data

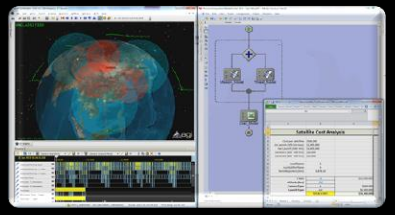
AOCS and structure



Power and Payload



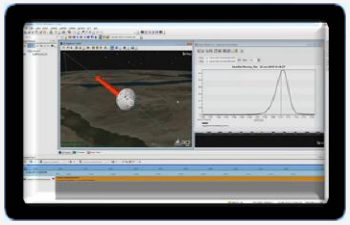
Cost Analysis

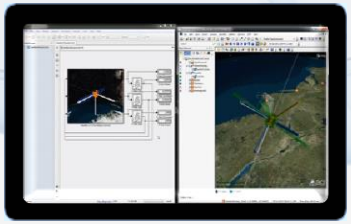


Integration Examples

Microsoft .NET

Java





Space mission design - study

- 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

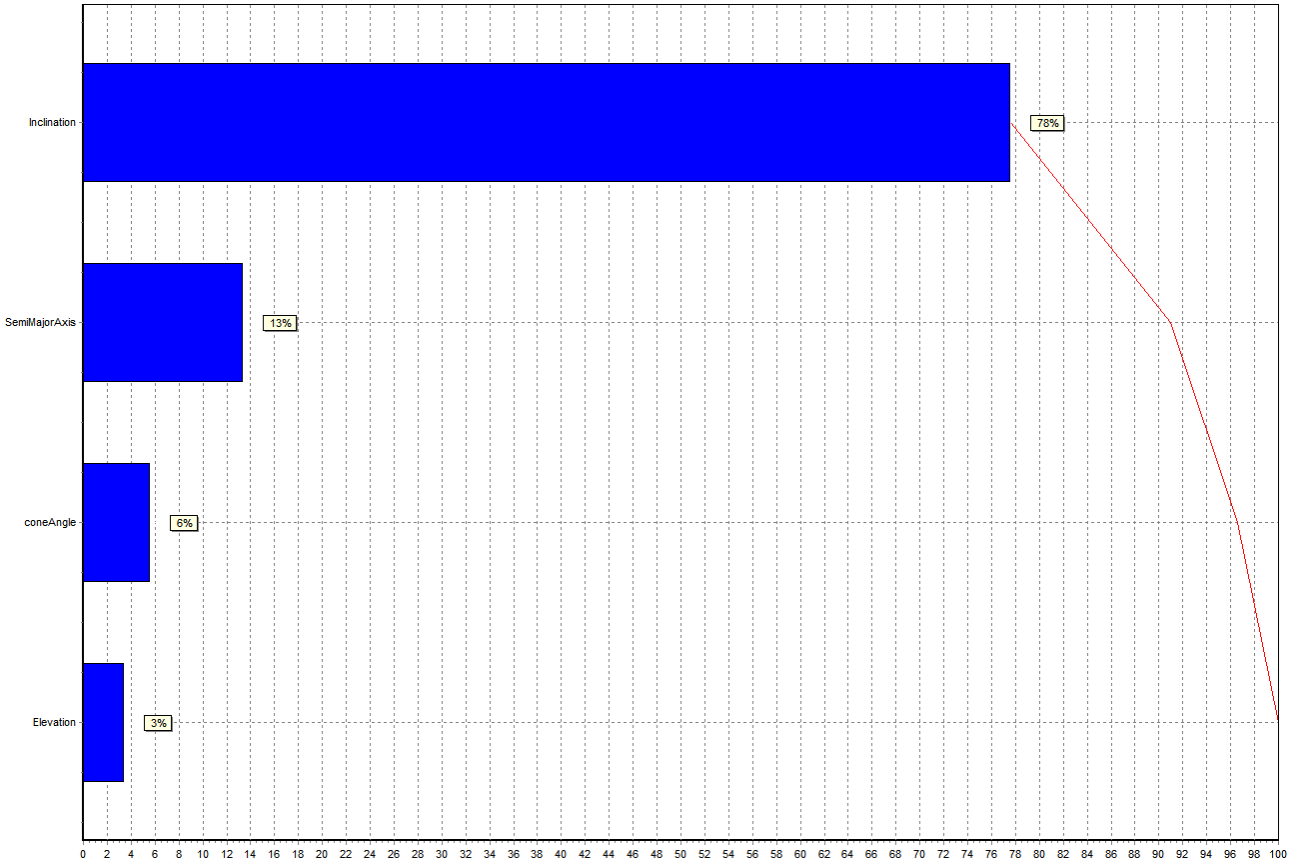
Results – Avg Revisit Time sensitivity

Orbit: inclination

Orbit: altitude

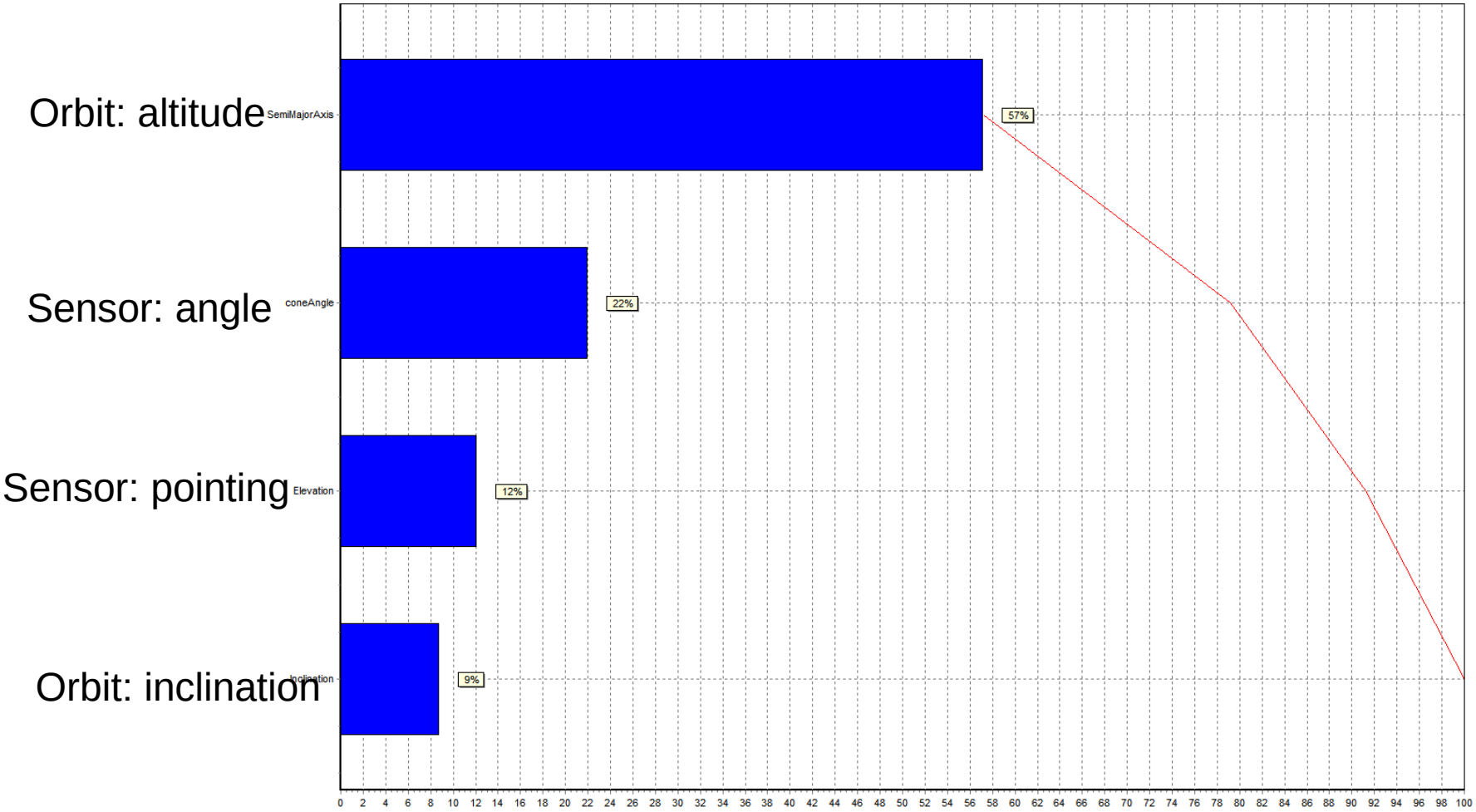
Sensor: angle

Sensor: pointing



Coverage persistency is mostly influenced by orbit alone

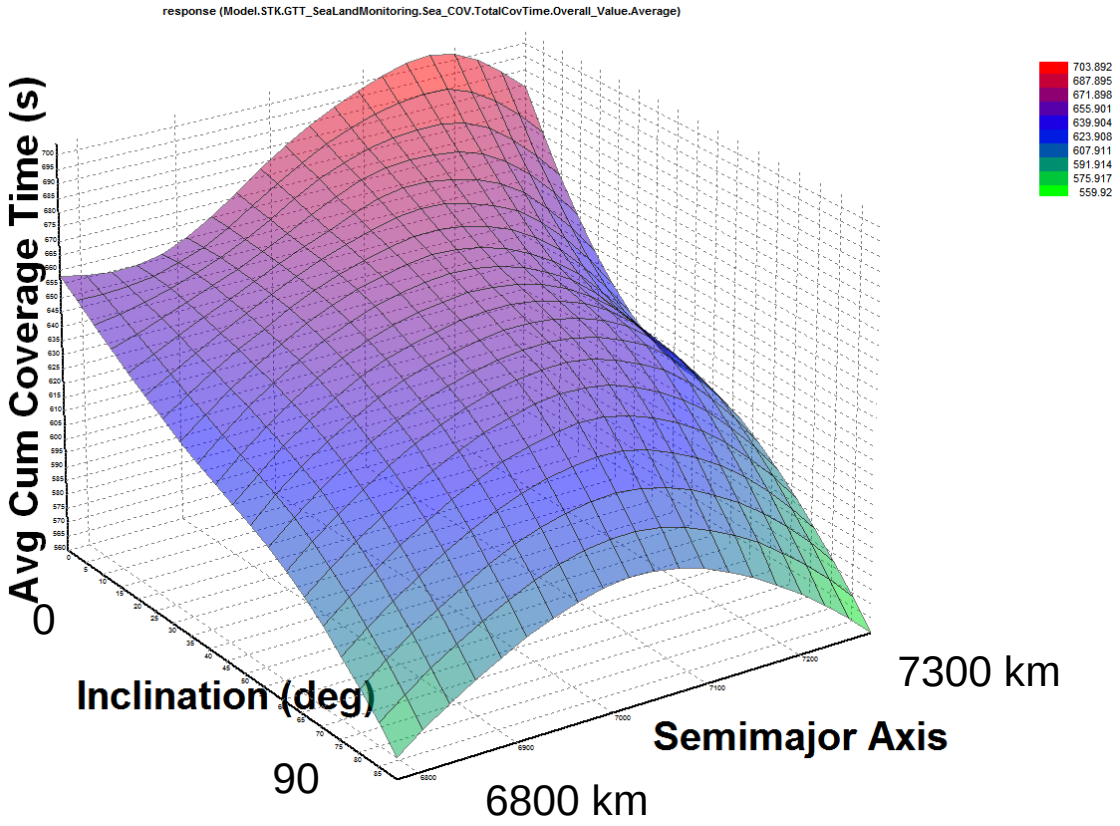
Results – Avg # intervisibilities per day



Avg # of viewing opportunities is more important than inclination

Single domain Results

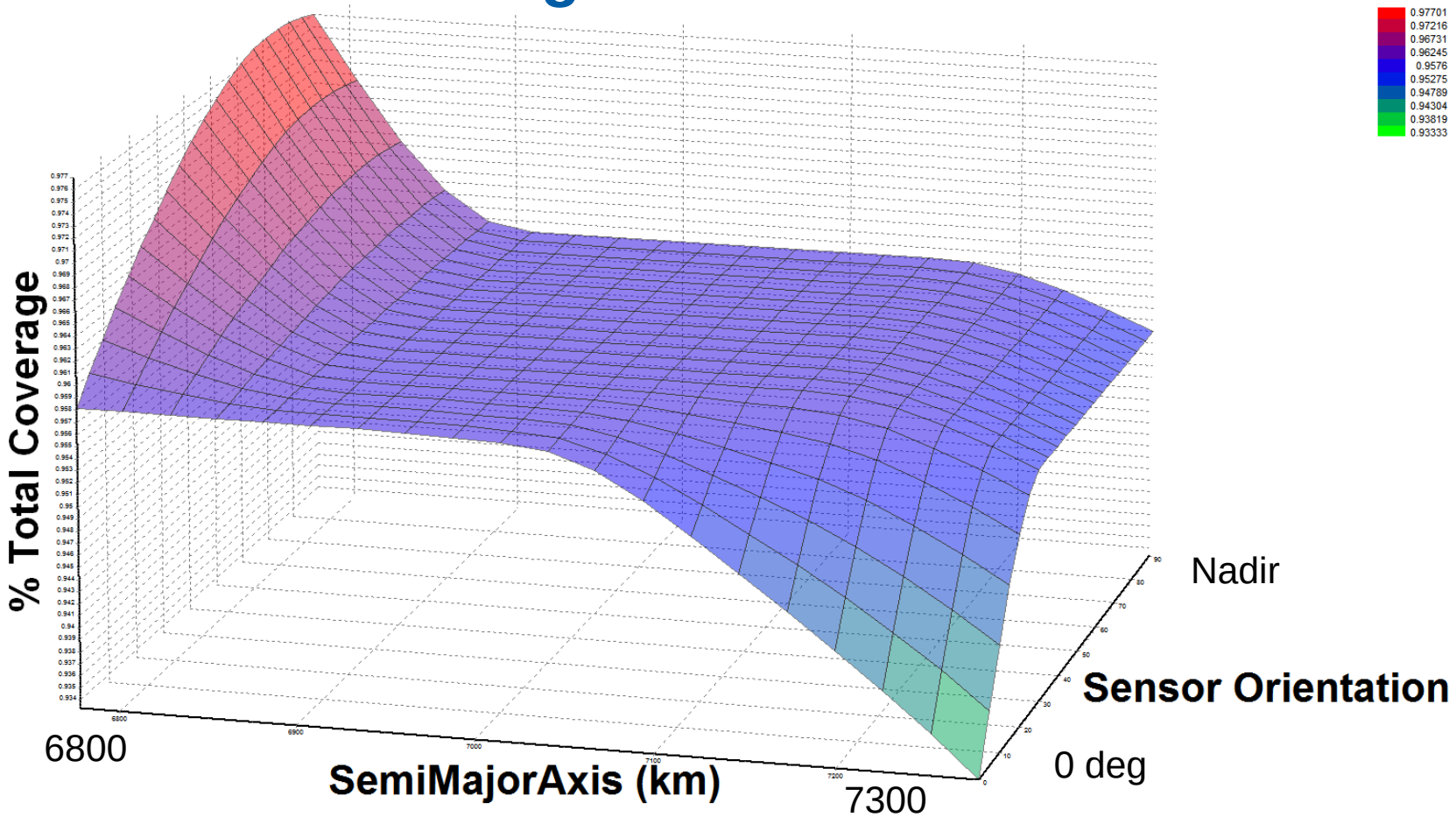
- **Avg. Cumulated Coverage Time**



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 *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**

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Thanks!