**Trade-space Analysis Tool for Constellations (TAT-C)**

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### Definitions

A **Distributed Spacecraft Mission (DSM)** is a mission that involves multiple spacecraft to achieve one or more common goals.

A **Constellation** is a space mission that, beginning with its inception, is composed of two or more spacecraft that are placed into specific orbit(s) for the purpose of serving a common objective (e.g., Iridium).

### Objectives

- Provide a framework to perform pre-Phase A mission analysis of Distributed Spacecraft Missions (DSM)
- Handle multiple spacecraft sharing mission objectives
- Include sets of smallsats up through flagships
- Explore trade-space of variables for pre-defined science, cost and risk goals, and metrics
- Optimize cost and performance across multiple instruments and platforms vs. one at a time
- Create an open access toolset which handles specific science objectives and architectures
- Increase the variability of orbit characteristics, constellation configurations, and architecture types
- Remove STK licensing restrictions

### Science Requirements - Inputs

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Components</td>
<td>Includes mission components, including recurring, non-recurring, spacecraft bus, and payload</td>
</tr>
<tr>
<td>Instruments and Platforms</td>
<td>Includes instruments and platforms vs. one at a time</td>
</tr>
<tr>
<td>Science, Cost, and Risk Goals</td>
<td>Includes science, cost, and risk goals, and metrics</td>
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</tbody>
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### Science Requirements - Outputs

<table>
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<th>Output</th>
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<tr>
<td>DSM Architectures</td>
<td>Generates DSM architectures for a mission</td>
</tr>
<tr>
<td>Coverage Metrics</td>
<td>Computes coverage metrics for instruments and platforms</td>
</tr>
</tbody>
</table>

### Graphical User Interface (GUI)

- **Graphical User Interface**
  - TAT-C Mission Analysis
  - Proposed "TROPICS" Mission Analysis

### Trade-space Search Iterator (TSI)

- TSI reads user inputs given to the GUI to create iterator inputs (JSON files).
- Uses default values from Landsat 8 (w/ ETM+ payload) if no inputs.
- Generates DSM architectures for a combination of variable values that satisfy iterator inputs.
- DSM architecture is a unique combination of variable values (altitude, inclination, FOV, number of satellites, etc.).
- For each arch, TSI creates files and sends commands to module ‘Reduction & Metrics’ to compute architecture performance and to module ‘Cost and Risk’ to compute architecture cost.

### Orbit & Coverage Module

- **Purpose of Module**
  - Model orbits balancing accuracy and performance
  - Compute coverage metrics for constellation/sensor set
  - Compute ancillary orbit data for performance, cost, and risk
  - Development Approach

### Reduction & Metrics Module

- Reduction & Metrics is responsible for calling module ‘Orbits & Coverage’ to propagate the orbit of every sat and compute coverage given payload specs.
- Reduction & Metrics integrates coverage and computes all performance metrics.

### Cost & Risk Module

- **Motivation**
  - Constellations require that traditional cost estimating assumptions be challenged
  - Previous work highlighted limitations of existing models w/r to constellations
  - No comprehensive cost model for constellations has been developed
  - Implementation
    - Aggregate model consisting of Cost Estimating Relationships (CERs) from widely accepted, publically available models
    - Output: Proba density function showing most likely cost for mission lifecycle + selected mission components, including recurring, nonrecurring, spacecraft bus, and payload

### Knowledge Base

- Centralized store of structured data readable by humans and machines
- Support TAT-C tasks:
  - Analysis: compose new mission concepts from existing model inputs
  - Exploration: discover new mission concepts by querying previous results
  - Layered client-server architecture over HTTP

### Future Directions

- Various constellations
- Launch vehicle and manifest framework
- Various sensor models
- Add on/off maintenance abilities
- Comparative risk model
- Knowledge Base development
- Complete GUI/Visualization development