ASTOS 8.1

Mission Performance Analysis, System Concept Analysis and Other New Features

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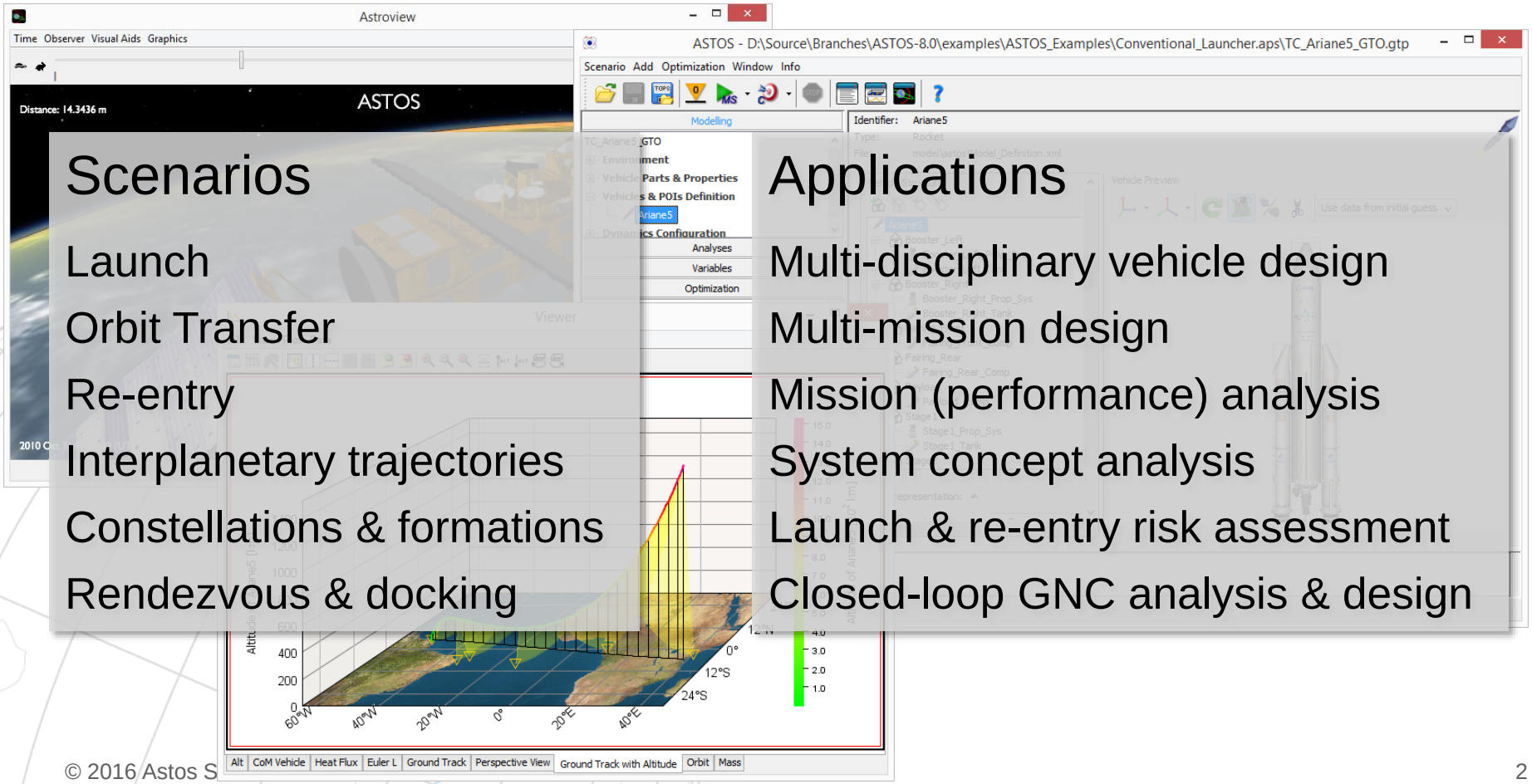
ASTOS – An Overview

ASTOS – **A**nalysis, **S**imulation and **T**rajectory **O**ptimization Software for **S**pace Applications



Scenarios

- Launch
- Orbit Transfer
- Re-entry
- Interplanetary trajectories
- Constellations & formations
- Rendezvous & docking

Applications

- Multi-disciplinary vehicle design
- Multi-mission design
- Mission (performance) analysis
- System concept analysis
- Launch & re-entry risk assessment
- Closed-loop GNC analysis & design

New Features of ASTOS 8.1

- System concept analysis for power, thermal control and data management aspects
- Completed mission analysis capabilities required for Earth observation missions
- Integrated CAD import & texturing tool
- Wizards to improve usability and to increase the user performance
- Further small extensions like
  - Initial state definition as Lissajous or HALO orbit
  - Propagation as circular restricted three-body problem
  - Consideration of relativistic effects and solar-radiation pressure
  - Injection and correction maneuvers for interplanetary trajectories
  - Pork-chop plots

Mission Performance Analysis

- Full mission analysis support according to ESA mission analysis guidelines for EO missions for all mission phases (launch, LEOP, operation, disposal), e.g.:
  - Operational Life-time prediction (fuel budget)*
  - Spacecraft illumination analysis
  - Link budget analysis
  - Ground station coverage analysis
  - Long-term propagation (orbit evolution)
- Automatic generation of a mission analysis report in Word or HTML format*
  - Contains all analysis results
  - Follows the structure defined in the annex of the ESA mission analysis guidelines for EO missions (DOPS-GS-RM-1002-OPS-OSA)
  - Customizable content and design

*) new in ASTOS 8.1

Operational Life-Time Prediction

- The operational lifetime is limited by the fuel budget.
- Fuel consumption is considered with respect to these aspects
  - Orbital correction maneuvers (e.g. decay and GEO station keeping)
  - Collision avoidance maneuvers (based on debris fluxes obtained e.g. by means of the ESA MASTER software)
  - End-of-life disposal (de-orbit or transfer into graveyard orbit)
  - Attitude control (desaturation of wheels)
  - Injection accuracy
- The operational lifetime prediction analysis provides
  - Operational lifetime
  - Total ΔV and fuel requirements for each type of manoeuvre
- No long-term closed-loop 6-dof propagation required
  - If requested this can be done with ASTOS and its Simulink interface

Automatic Mission Analysis Report

8. formation acquisition with Sentinel

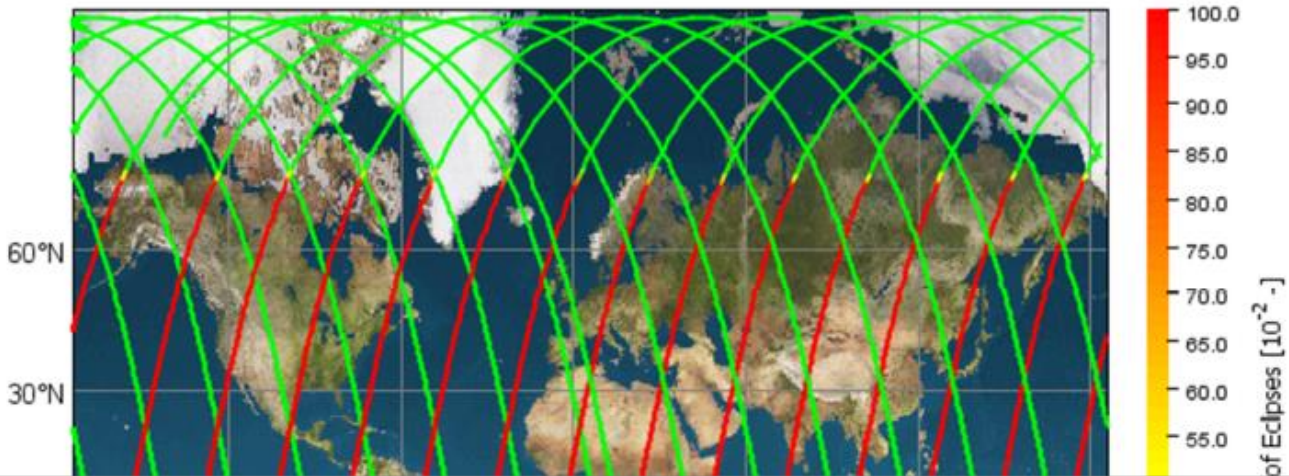
The first part of the LEOP sequence is carried out autonomously by the satellite, only requiring ground intervention if deployment fails.

3.5 Eclipse Analysis during LEOP

The following eclipse characteristics have been identified during the LEOP phase until the moeuvre into mission orbit is executed:

Property of Eclipse Analysis	Calculated Value
maximum duration of eclipse	34.848min
minimum duration in sun light	30.240min

The following map plot shows the eclipse pattern:



System Concept Analysis – Power

- The following dedicated power generation and management models have been added:
  - Battery
  - Solar Generator
  - Power Control and Distribution Unit (PCDU)
- Each actuator, vehicle component or sensor can be a consumer with specified electrical power (optional input)
- PCDUs specify multiple circuits, each with different voltage
- Solar panels consider angle towards the sun, eclipses and temperature to calculate generated electrical power
- Batteries are charged and discharged based on available/required electrical current within a PCDU

System Concept Analysis – Thermal

- Model provides temperature evolution of each thermal node
- The model considers:
  - Heat transfer between nodes
  - Irradiation and Emission for dedicated surface elements
- Surface elements are defined as planar and can comprise a user-defined number of thermal nodes
- Thermal nodes are available for every actuator, component or sensor (optional)
- User-defined connections between thermal nodes (defined by thermal resistance)
- Thermal nodes are defined by specific heat capacity, initial temperature and the mass of the corresponding equipment

System Concept Analysis – Data

- Modelling of radio-transmission, data generation and data storage
- Dedicated model: data buffer with user-defined capacity
- Each equipment block can be defined as data source (housekeeping and payload data)
- Data is transmitted to other vehicles and ground stations (user specifies communication partners for sensors)
- Several data busses can be realized (by means of user-defined connections between data sources, data storage and transmitters)

CAD Import and Texturing Tool

- CAD files typically do not contain appropriate surface materials and textures such that cannot be used directly for realistic visualizations. These are required for
  - Managerial presentations
  - Public relations
  - Camera simulations
- CAD format converter and 3D modelling software was required to create a model with textures and realistic surface characteristics
  - High effort
  - long learning curve
  - Available texture projections do not always satisfy the needs

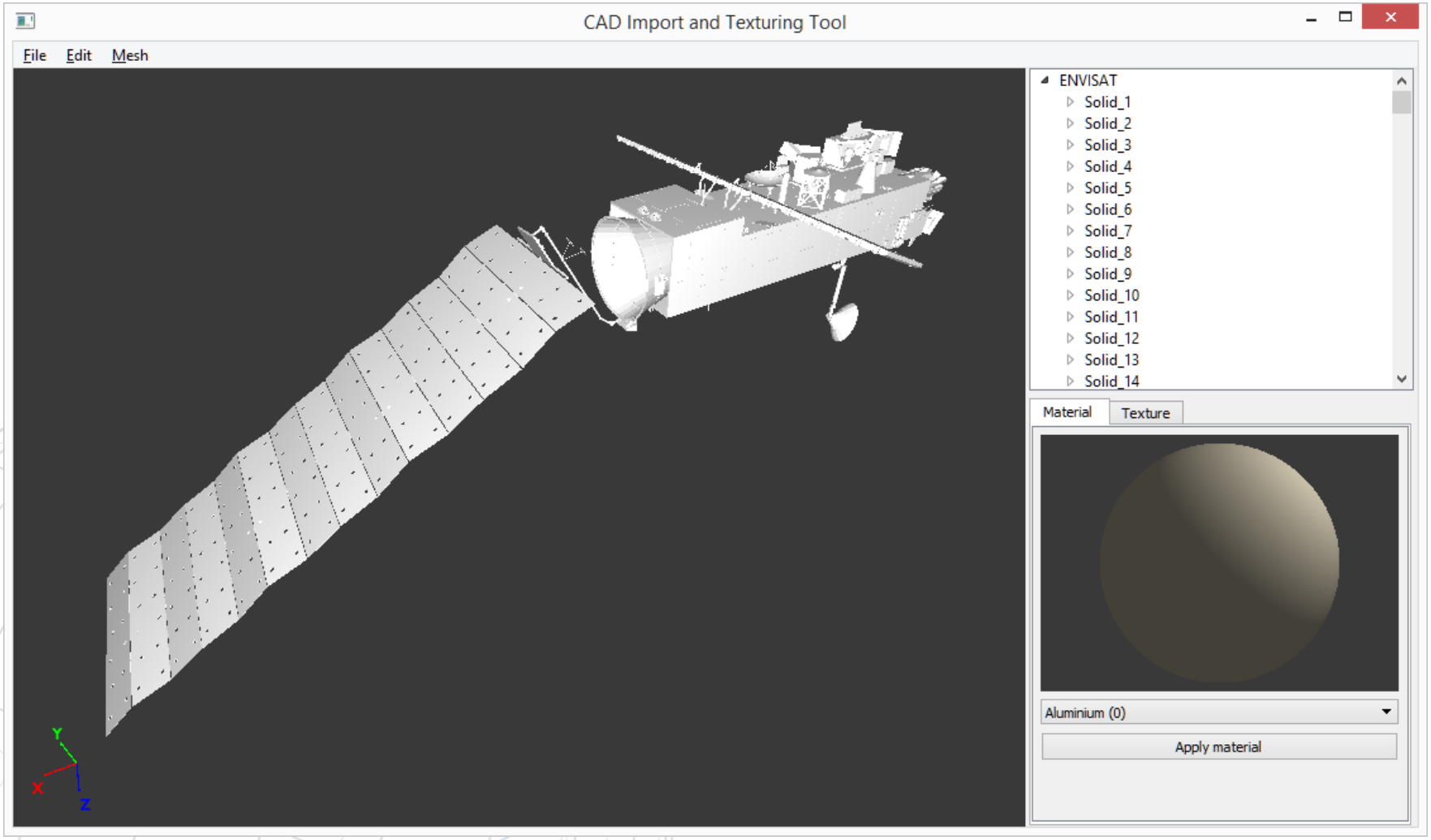
CAD Import and Texturing Tool (2)

ASTOS CAD Import and Texturing Tool:

- Import of Wavefront OBJ and STEP files (AP 203, 209, 214)
- Export of Wavefront OBJ files
- Automatic texture projection based on object extends and texture distortion reduction
- Manual planar, spherical and cylindrical projection
- Predefined materials consider physical extends
- Logos can be placed on top of material textures

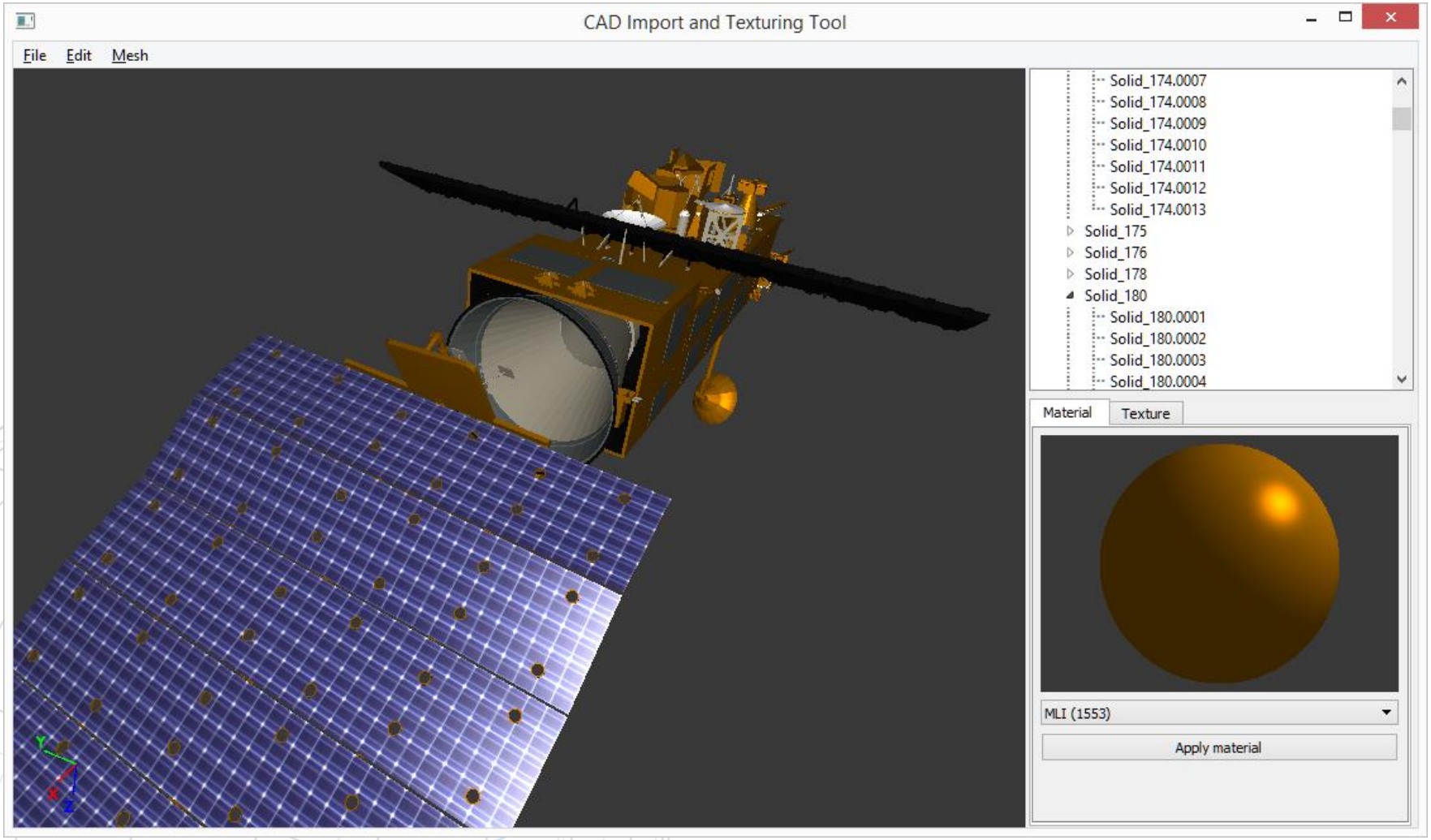
CAD Import and Texturing Tool (3)

Imported CAD model without material and textures:



CAD Import and Texturing Tool (4)

Model with appropriate material properties and textures:

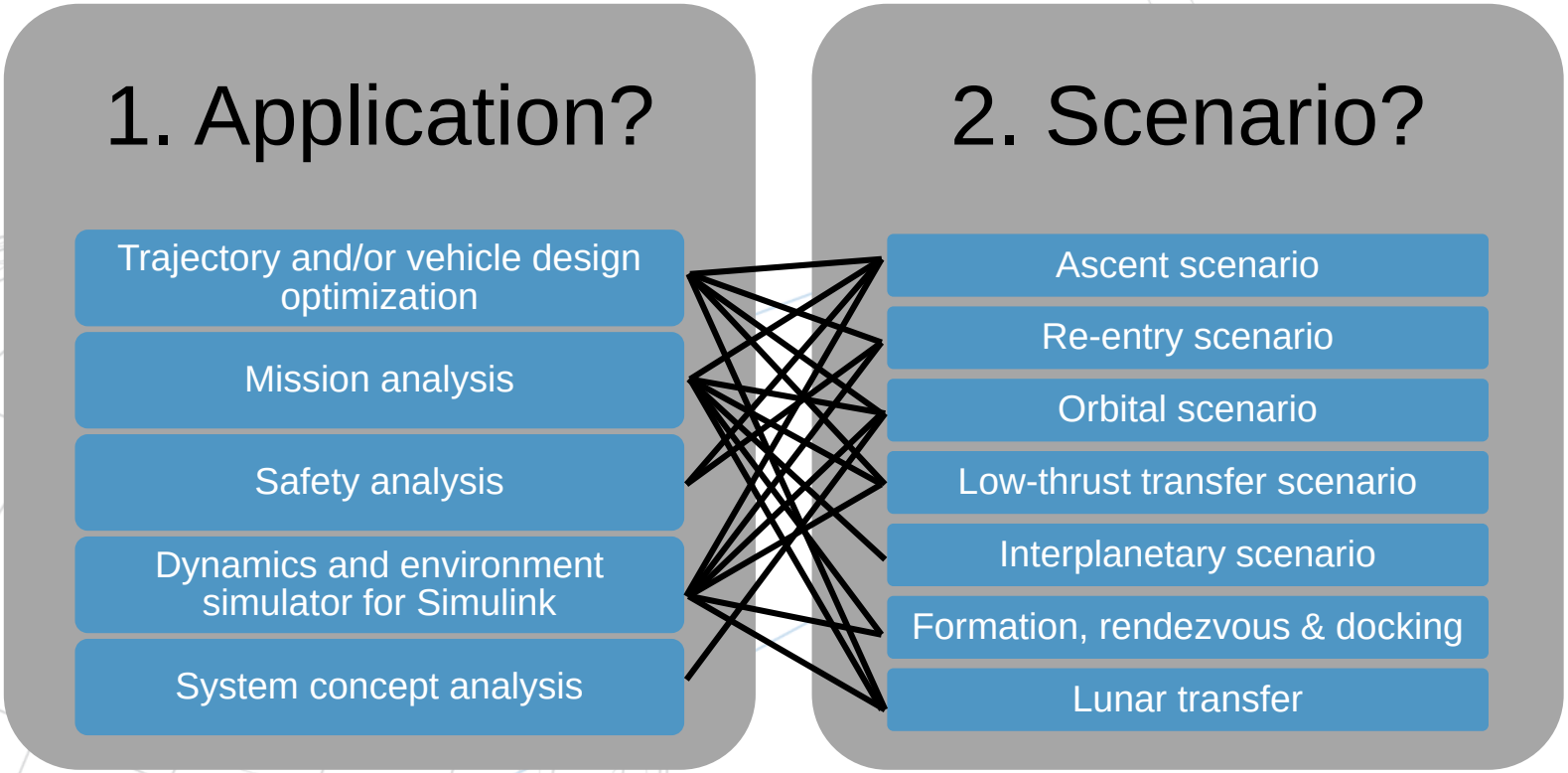


CAD Import and Texturing Tool (5)

Textured model as it looks like in the ASTOS animation window:

Wizard

- The wizard questions guide the user towards the definition of his/her application and scenario
- Modification of exisiting scenarios is supported as well



Availability

- ASTOS 8.1 is currently in the qualification process and will be available in approximately two months
- Time-limited trial licenses of ASTOS can be requested and are for free
- Free academic licenses for non-commercial applications
- ASTOS can be downloaded from www.astos.de