PHOENIX INTEGRATION

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Distributed Model Based Systems Engineering

Tim Gaydos, PhD

Parsons

Agenda

- Purpose
- Distributed Engineering
- Model Based Systems Engineering Approach
- Demonstration Overview
- Demonstration Video
- Requirements Verification
- Summary

Purpose

- Provide a Demonstration of the Capabilities to Support an Integrated Approach to Satellite Design
- Demonstrate the Value of Model Based Systems Engineering, Distributed Engineering, and Model Based Engineering
- Highlight the Ability to Collaborate using a set of Common Environments to enable rapid responses to changing requirements

MBSE/MBE/DE Enable the Development, Management, and Evaluation of Complex Systems of Systems

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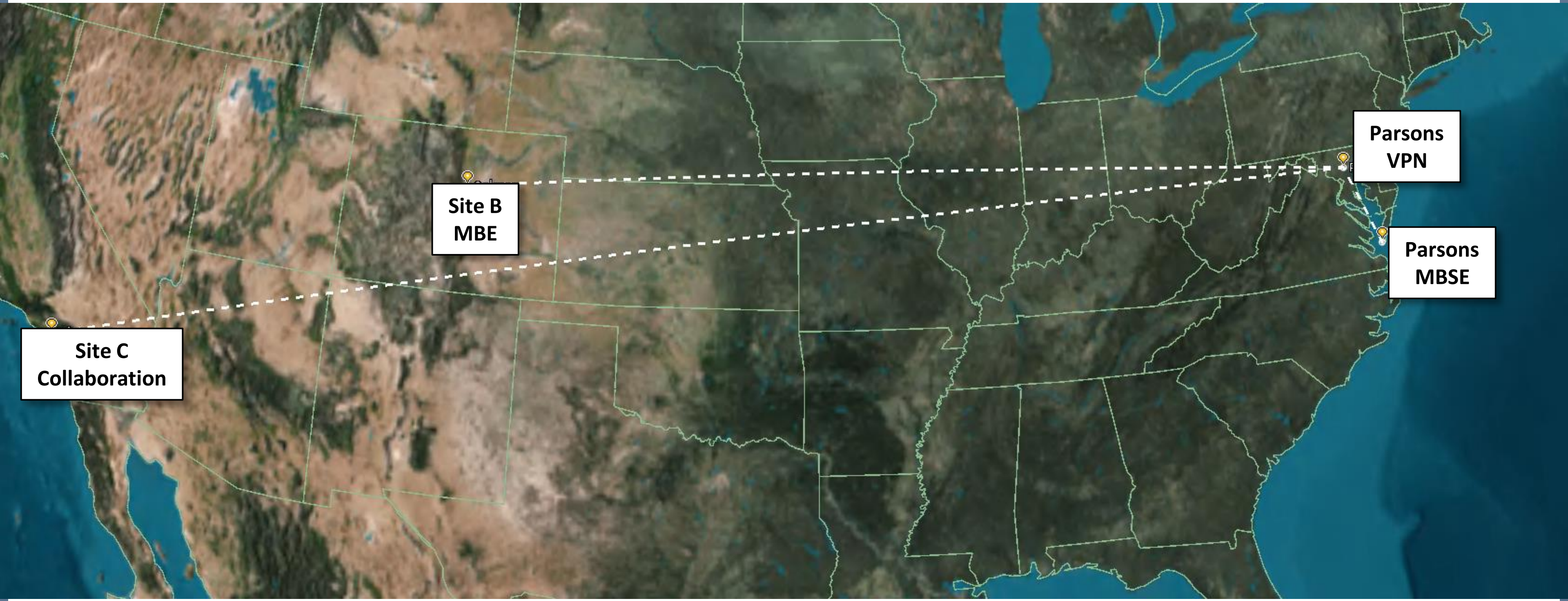
Distributed Engineering

- Asynchronous Automated Performance Evaluation and Trade Study Capability from Any Place in the USA as Long as There is Internet Connectivity
- Data Protected via a Cloud Based Virtual Private Network (VPN)

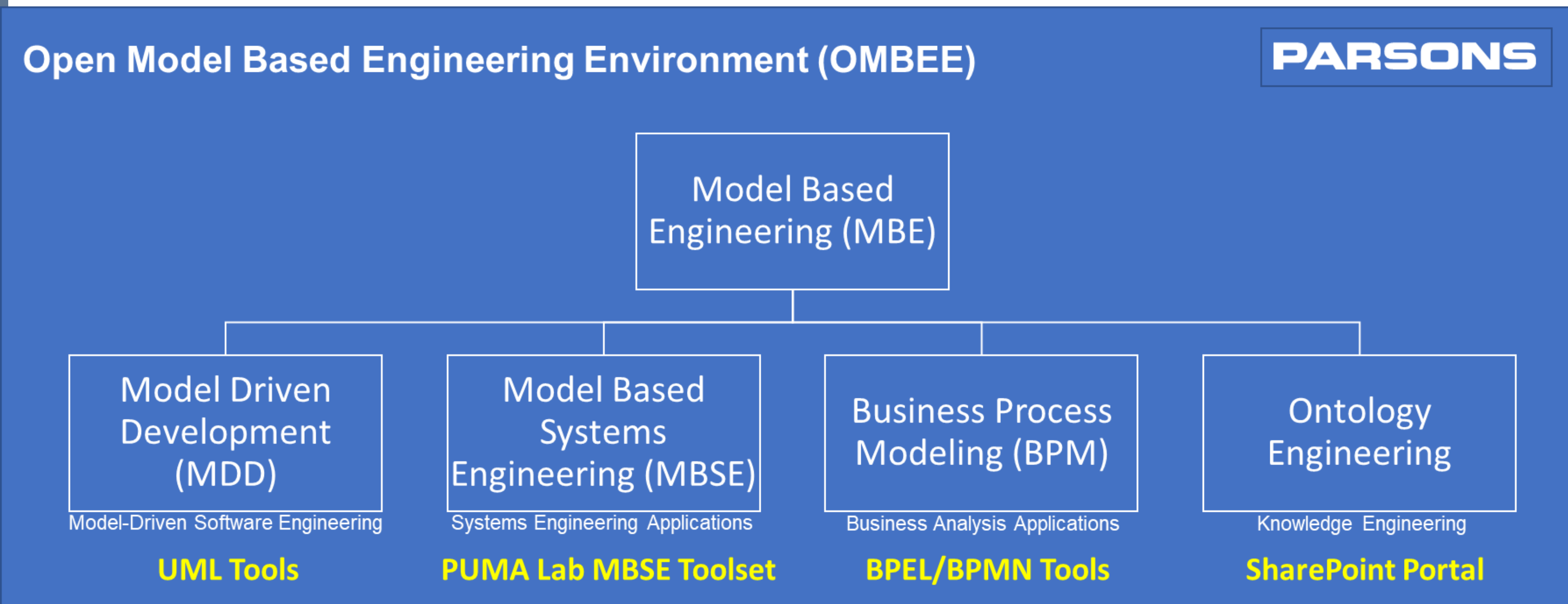


Distributed Engineering – Effective Use of Simulations and Subject Matter Experts on a Protected Network

Model Based Engineering Approach

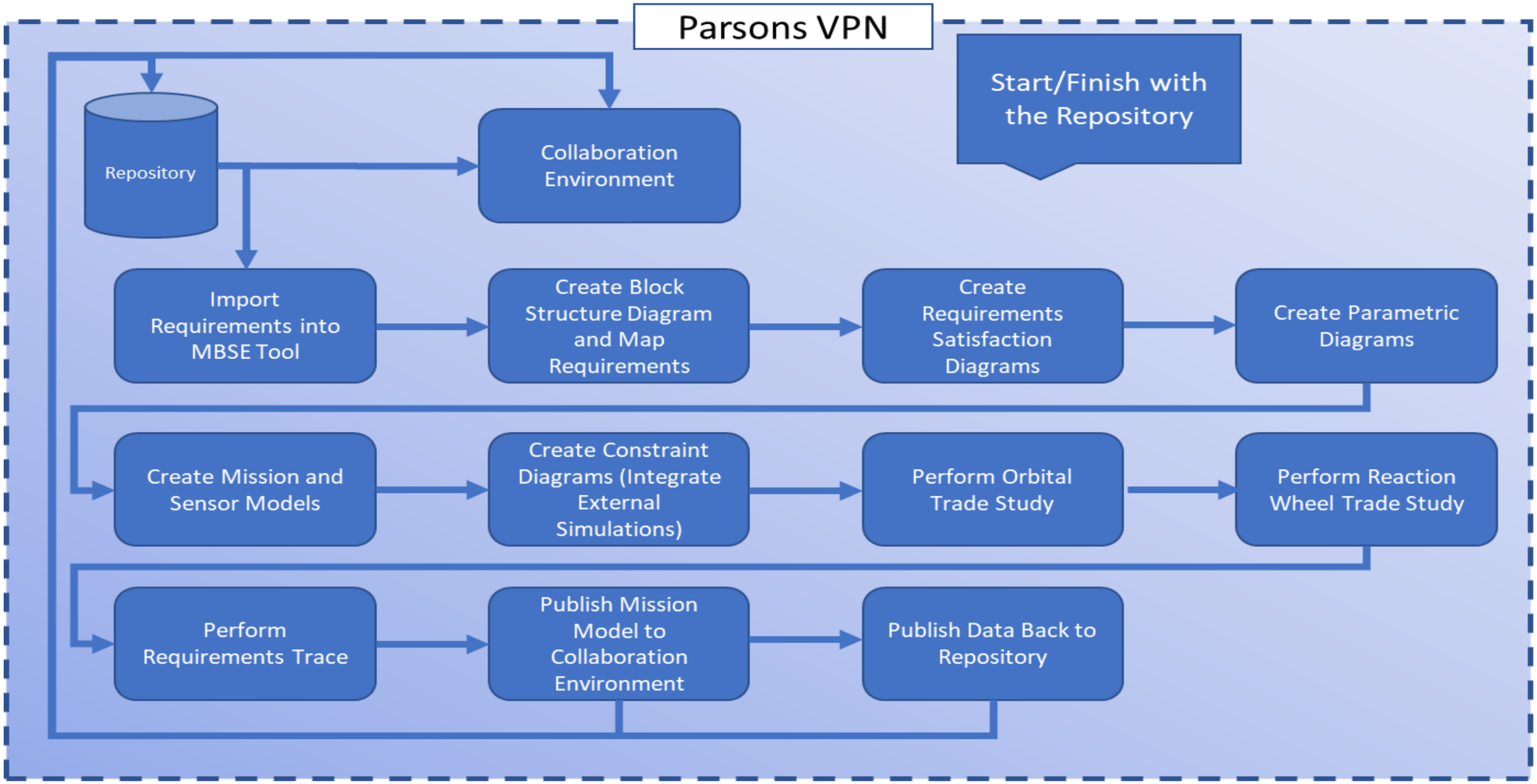
- Model Based Approach
- Wide Range of Applications
- Supports and Enables Modernization

PUMA Lab Model Based Engineering Architecture



Demonstration Overview

- Model Based systems Engineering (MBSE) Approach
- Based on Low Earth Orbit Weather Satellite
- Requirements Derived from the Technical Requirements Document



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Trade Study Overview

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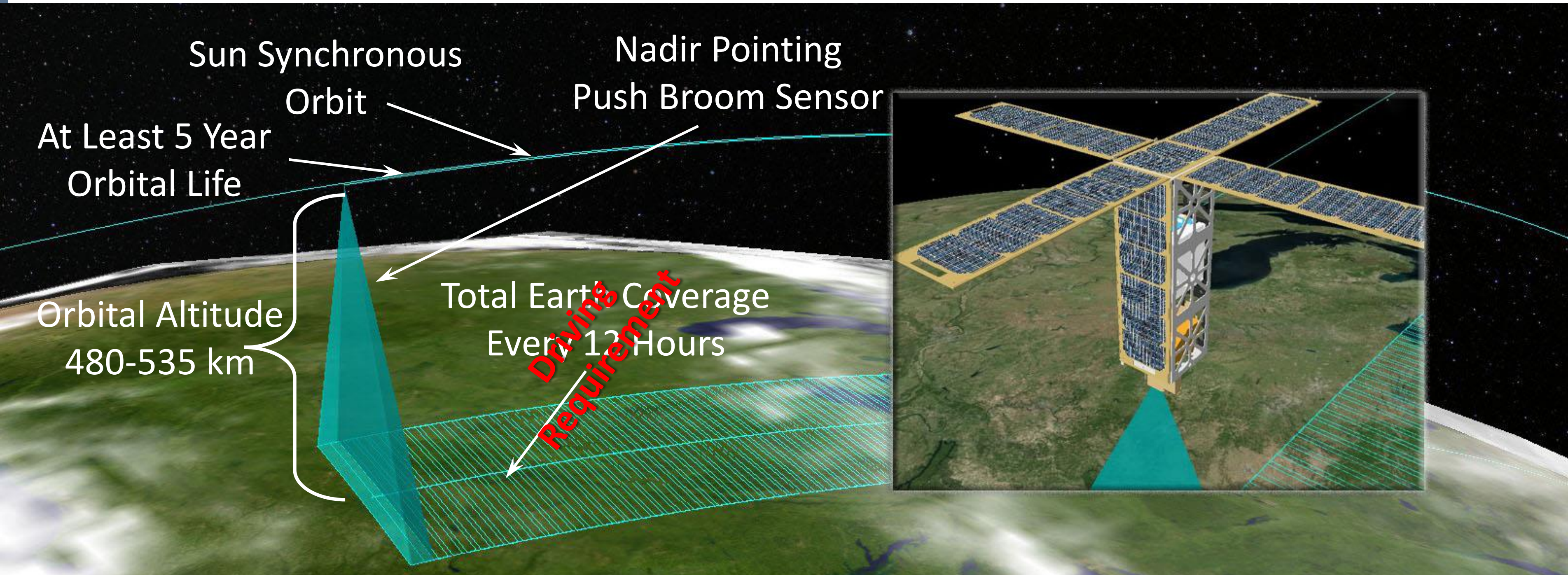
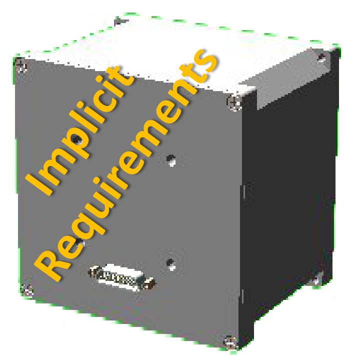


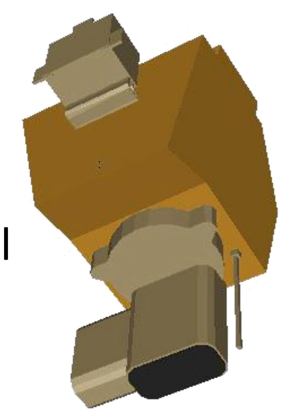
- 88 Requirements Derived From the Technical Requirements Document
- Orbital Trade Study Focuses on Five Requirements that are all Related

Reaction Wheel:
1) Nadir Pointing within 0.25°
2) Wheel Saturation less than 90%



Push Broom Sensor Horizontal Cell Resolution of < 2 km

Driving Requirement



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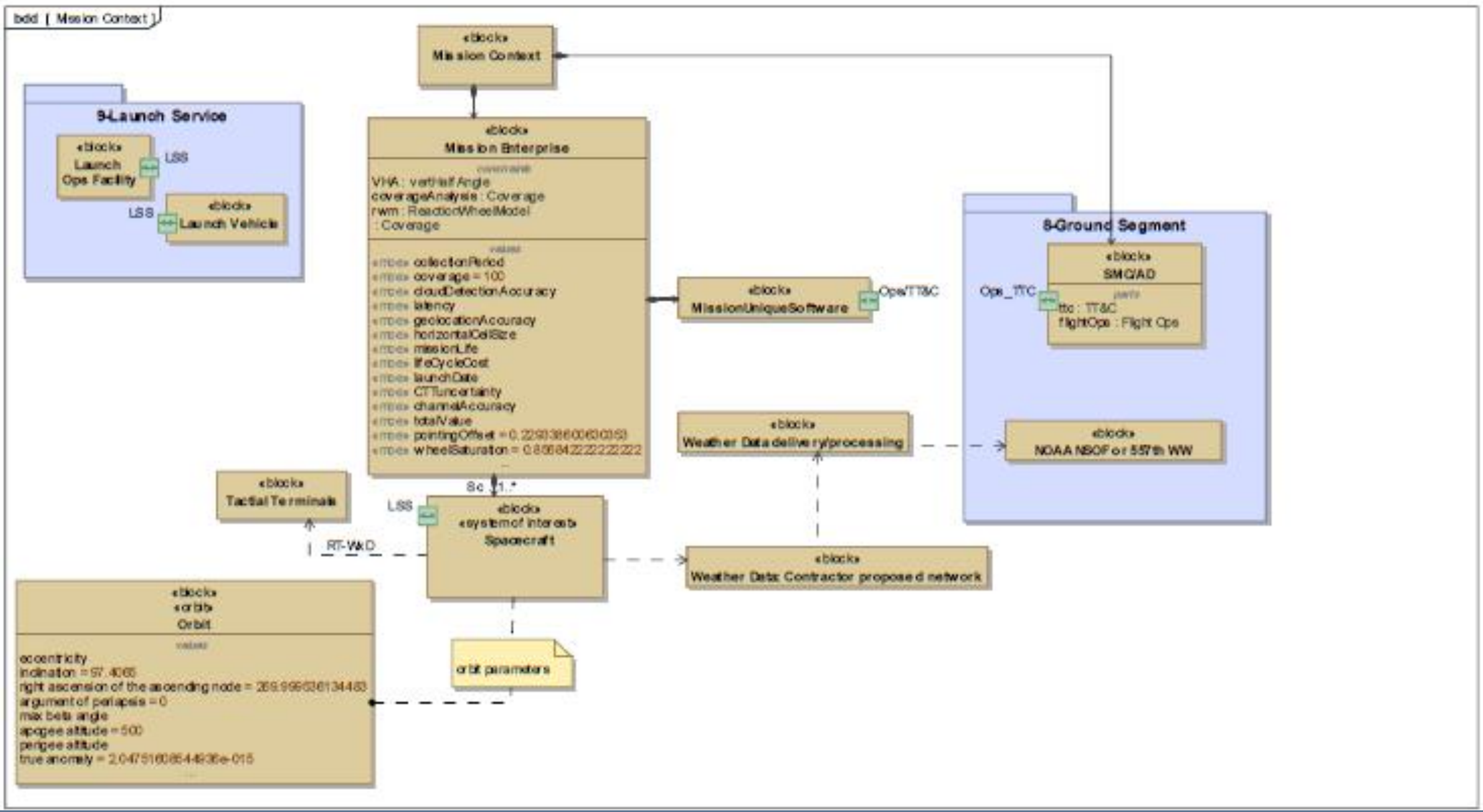
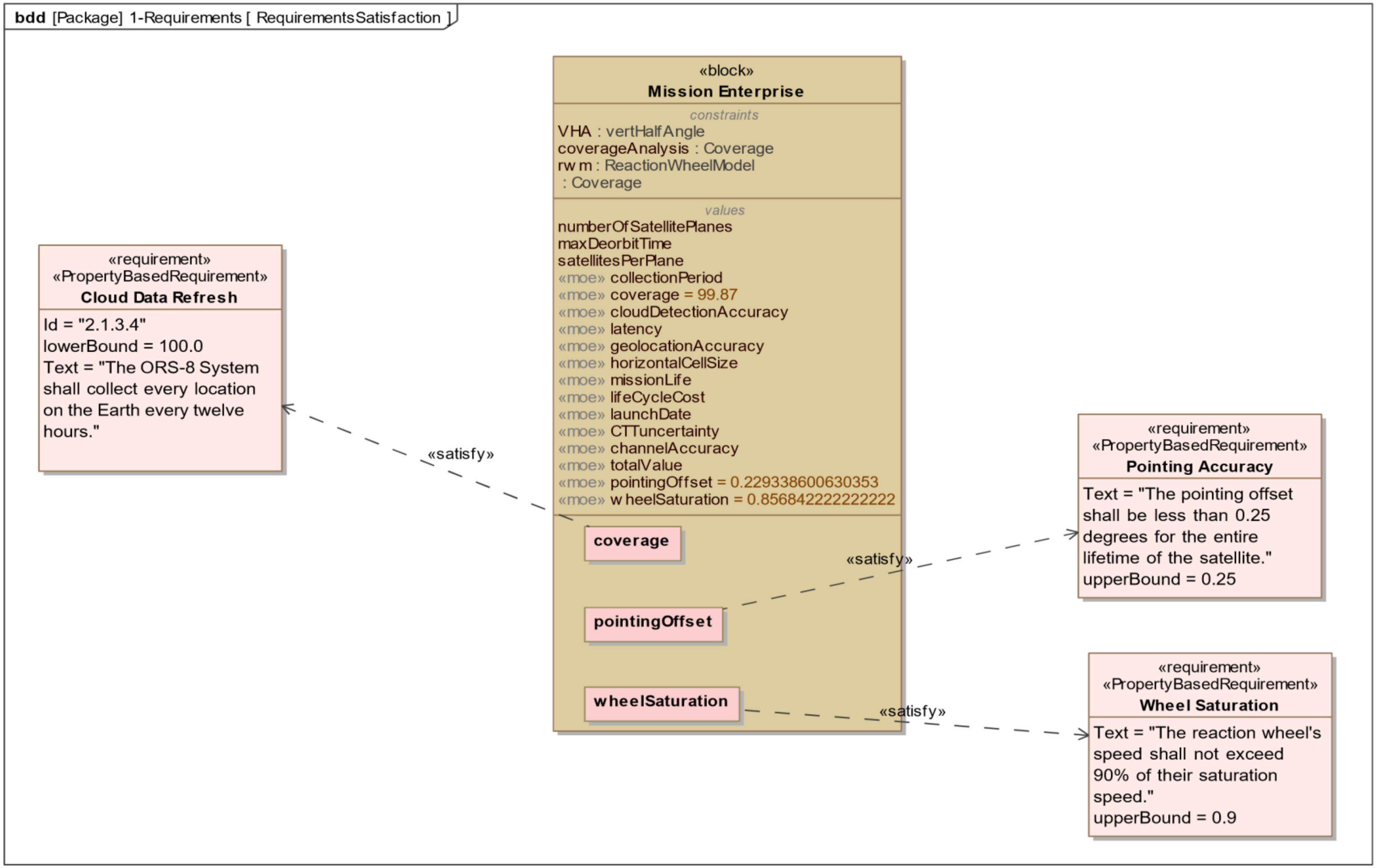
Block Definition Diagram

- Decomposition of the System into its mission areas and mapping data requirements



Requirements Satisfaction

- Defining the Performance Parameters that Satisfy the Requirements



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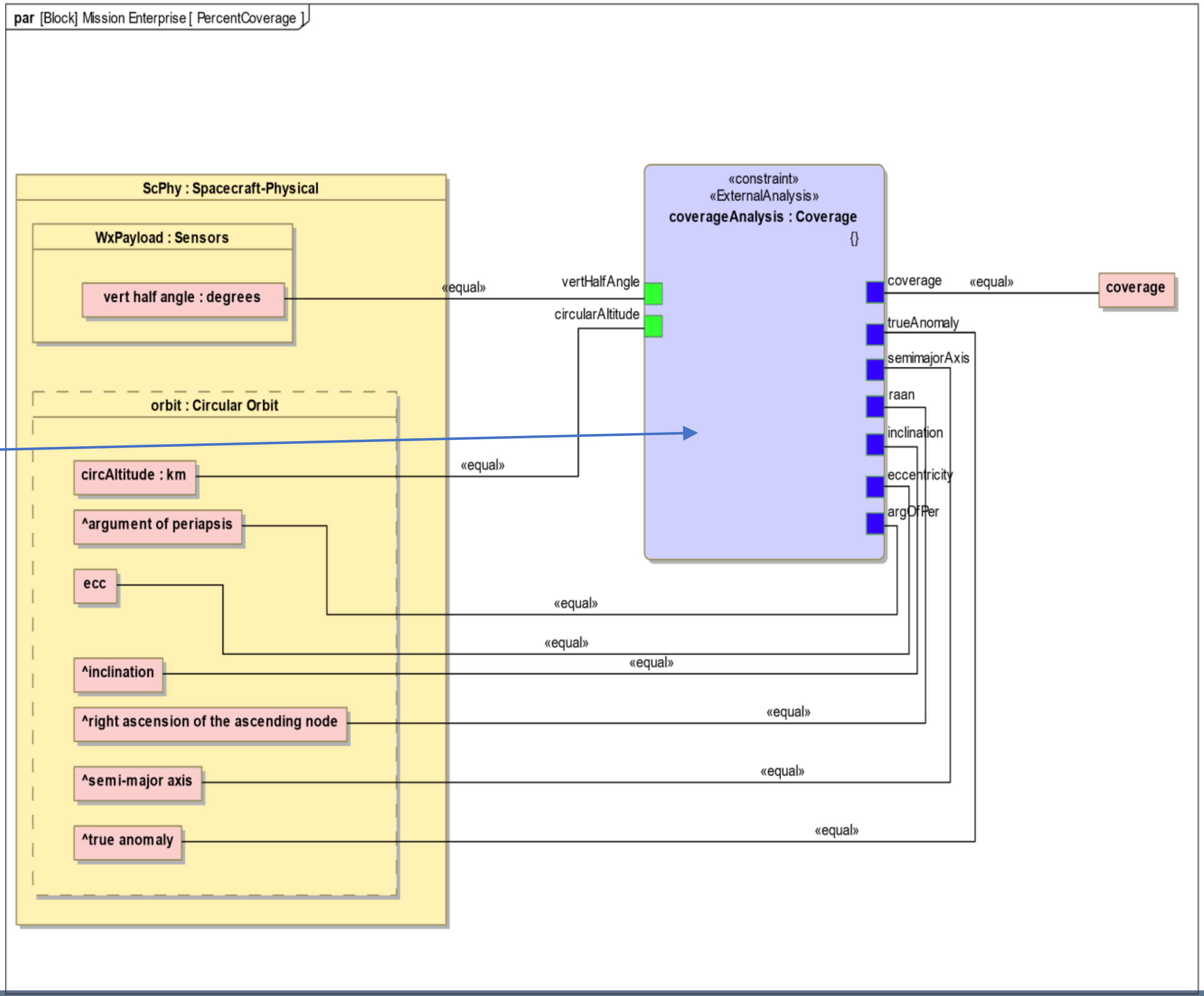
MBSE Parametric Diagrams

- Connect the Requirements to a Mission Context Performance Model

Parametric Diagram Mapping Requirements base Performance Data to Orbital Mechanics Simulation



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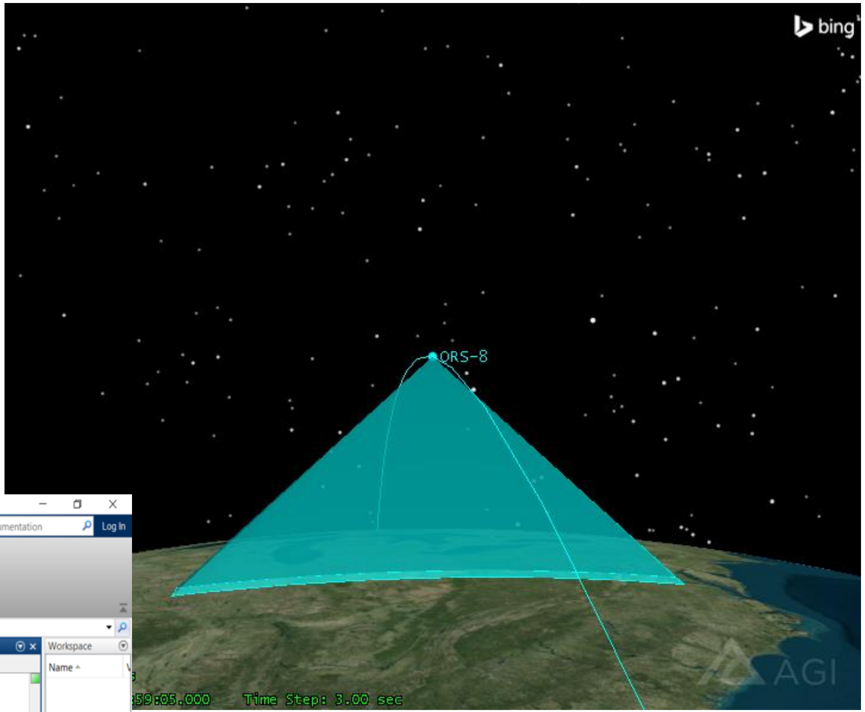
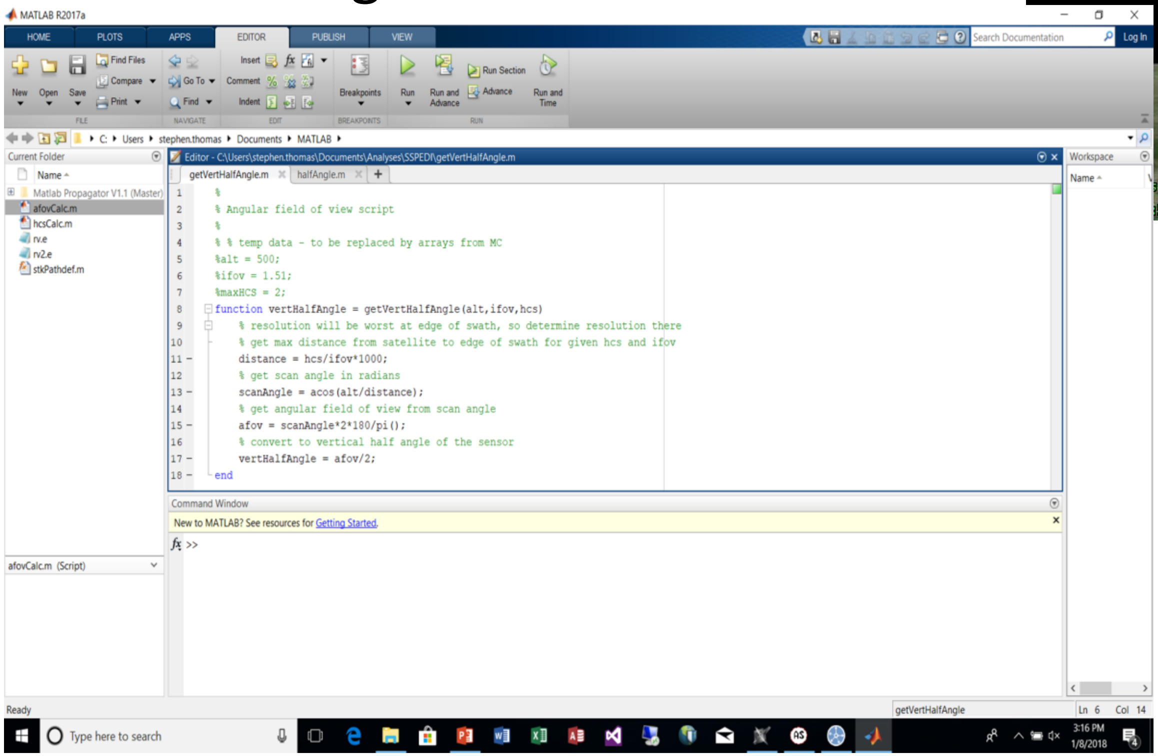
Sensor Model

- Custom Code in Matlab
  - Calculates Sensor Resolution based on Satellite Altitude
  - Used to Calculate Sensor Coverage





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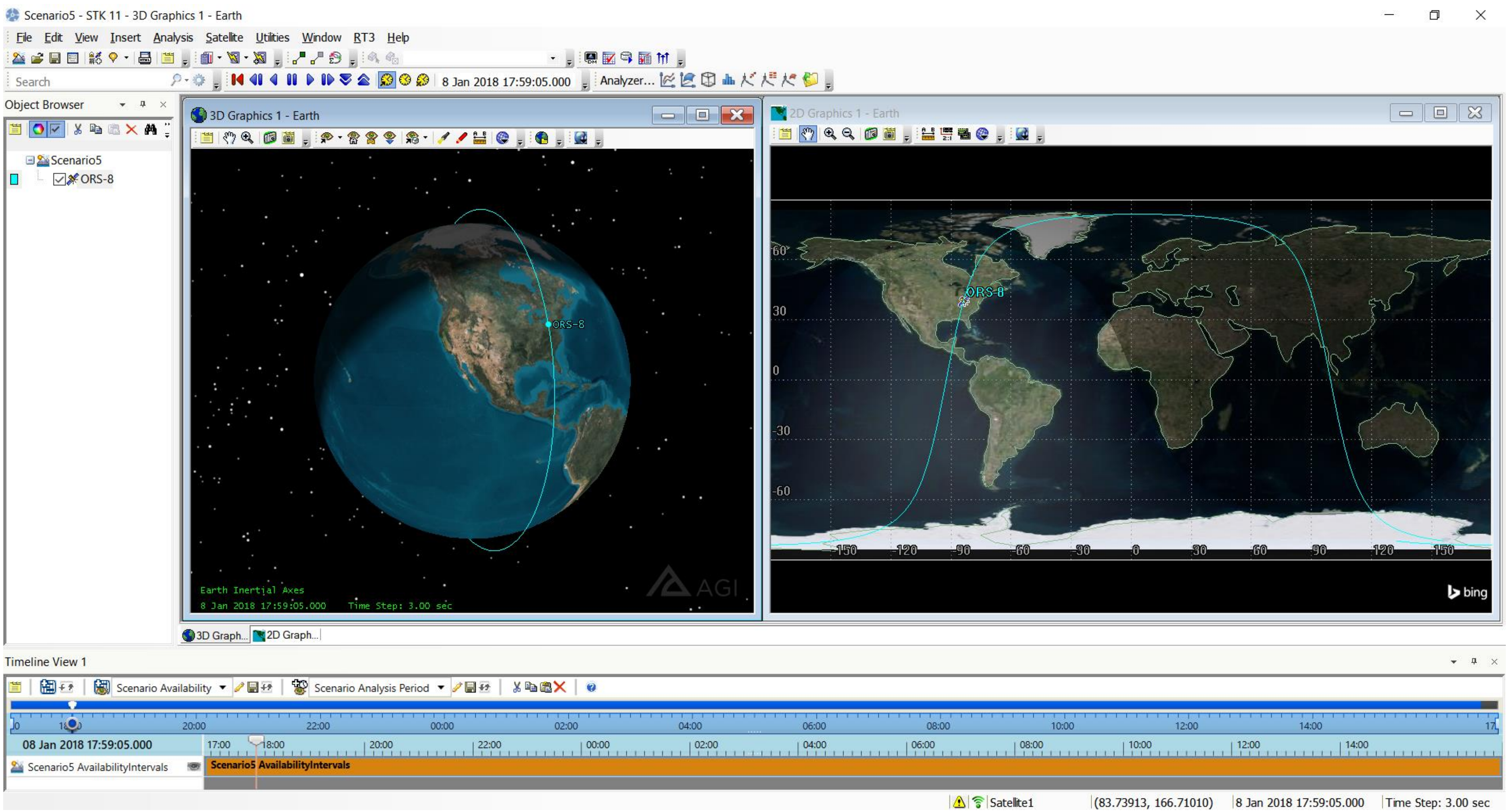
Mission Model

- Repeating Ground Track Sun Synchronous Orbit



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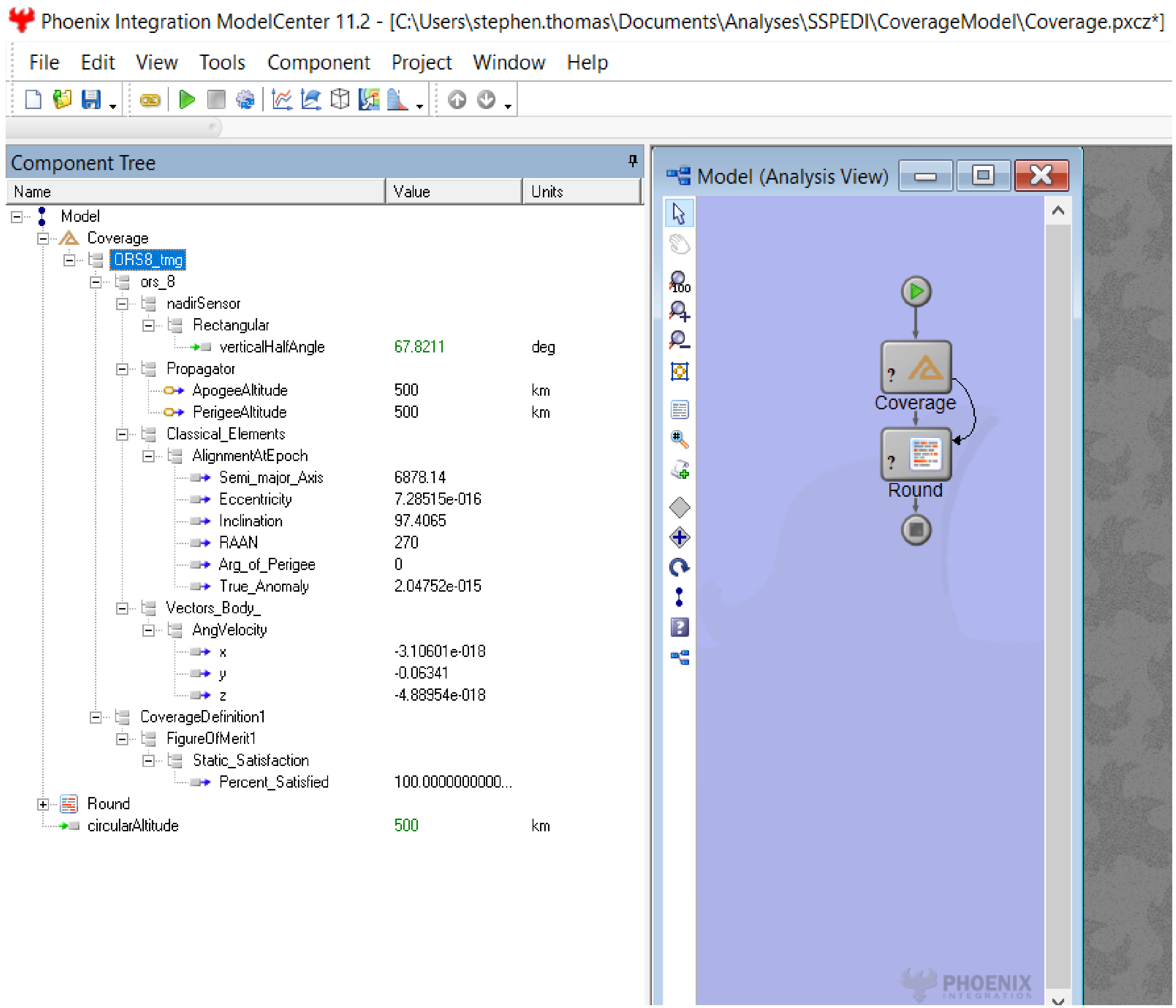
Integrate Mission Model

- Create wrapper for models and integrate into SysML model



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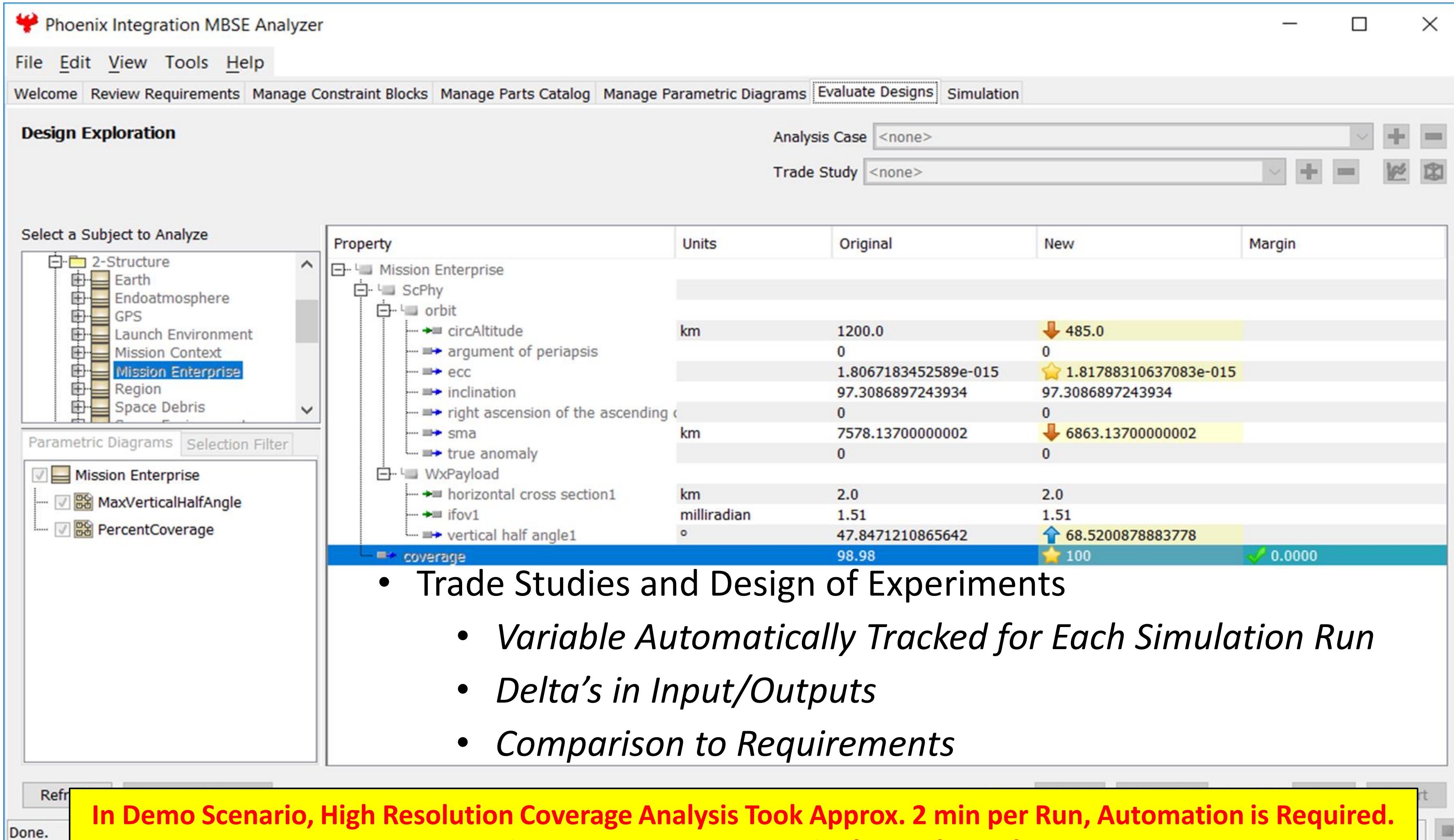
Trade Studies



- Trade Studies and Design of Experiments
  - *Variable Automatically Tracked for Each Simulation Run*
  - *Delta's in Input/Outputs*
  - *Comparison to Requirements*

In Demo Scenario, High Resolution Coverage Analysis Took Approx. 2 min per Run, Automation is Required.
30 Minutes to Sweep 15 Runs in the Trade Study.
However, it only takes 1 min to setup experiment, the rest is automatic…

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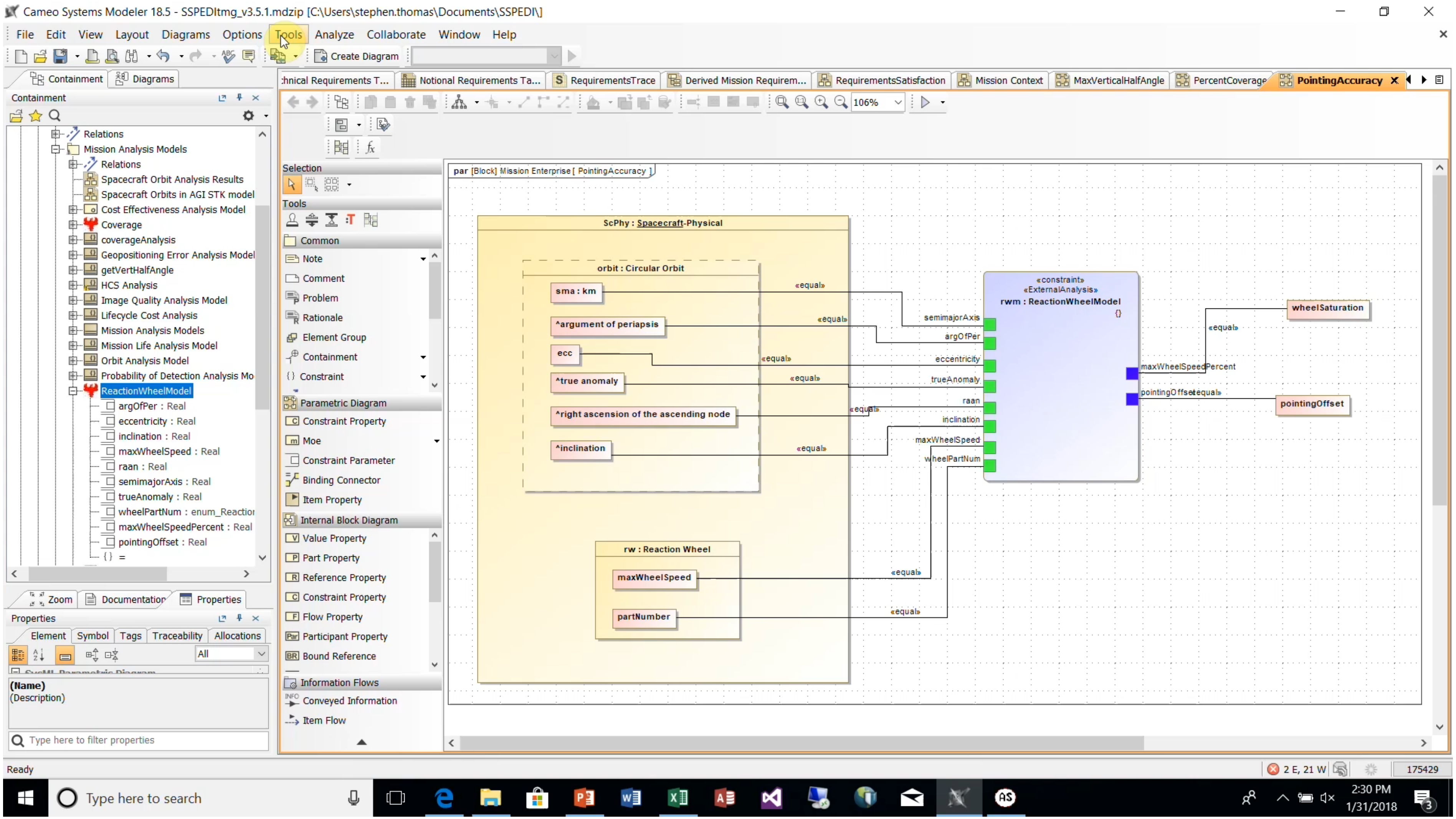
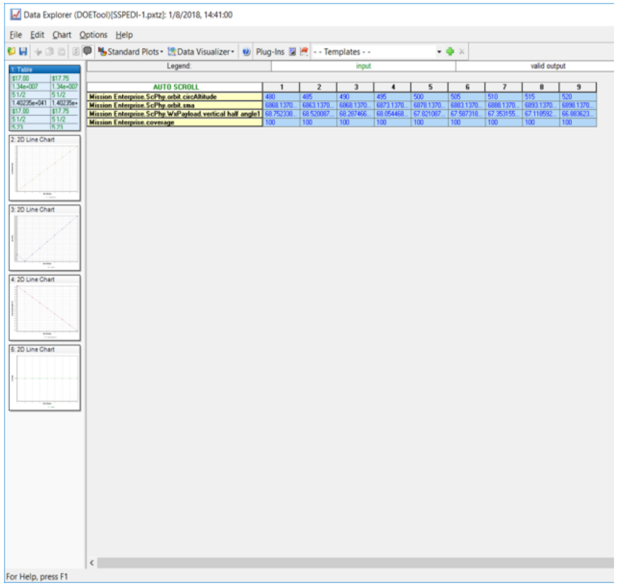
Demo – Orbital Trade Study Video

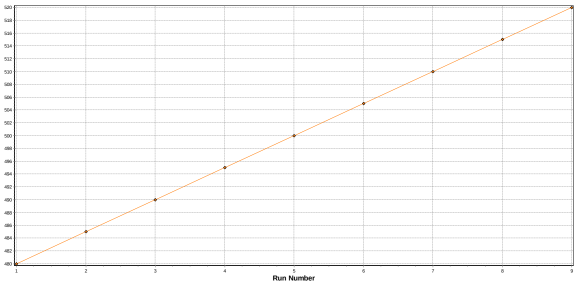


MBSE Analyzer - Results

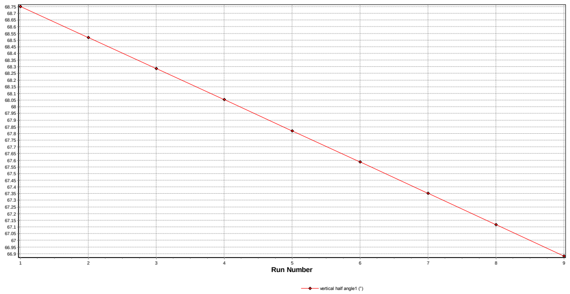
- To Maintain the Sensor Resolution and 100% Coverage Requirements
  - Single satellite Design
  - Decreasing Altitude Maintained Requirements
  - Corollate to Min Satellite Orbital Lifespan
  - Implicit Requirement is Reaction Wheel Performance Required to Maintain Bias to Keep Sensor Pointed to Nadir, which is a function of Satellite Altitude



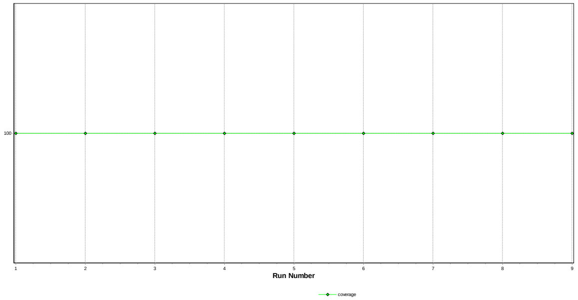
Circular Altitude



Sensor Angular FOV

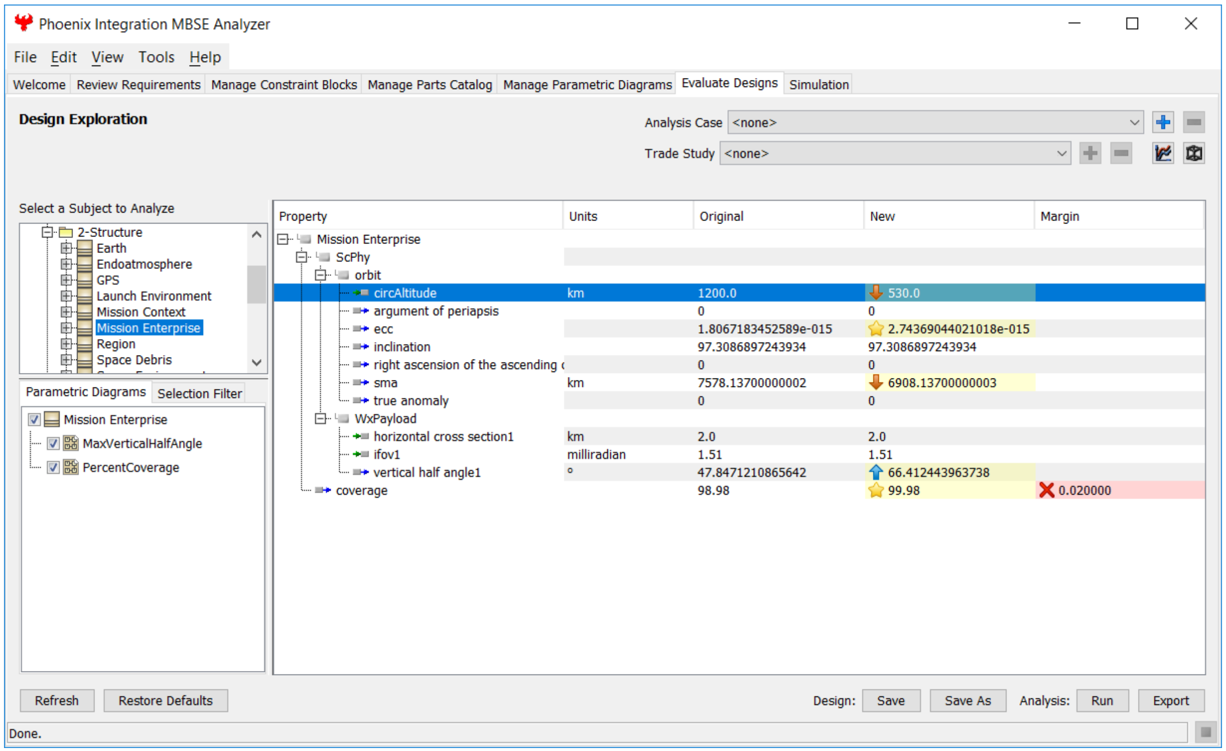


Percent Coverage



MBSE Analyzer - Results

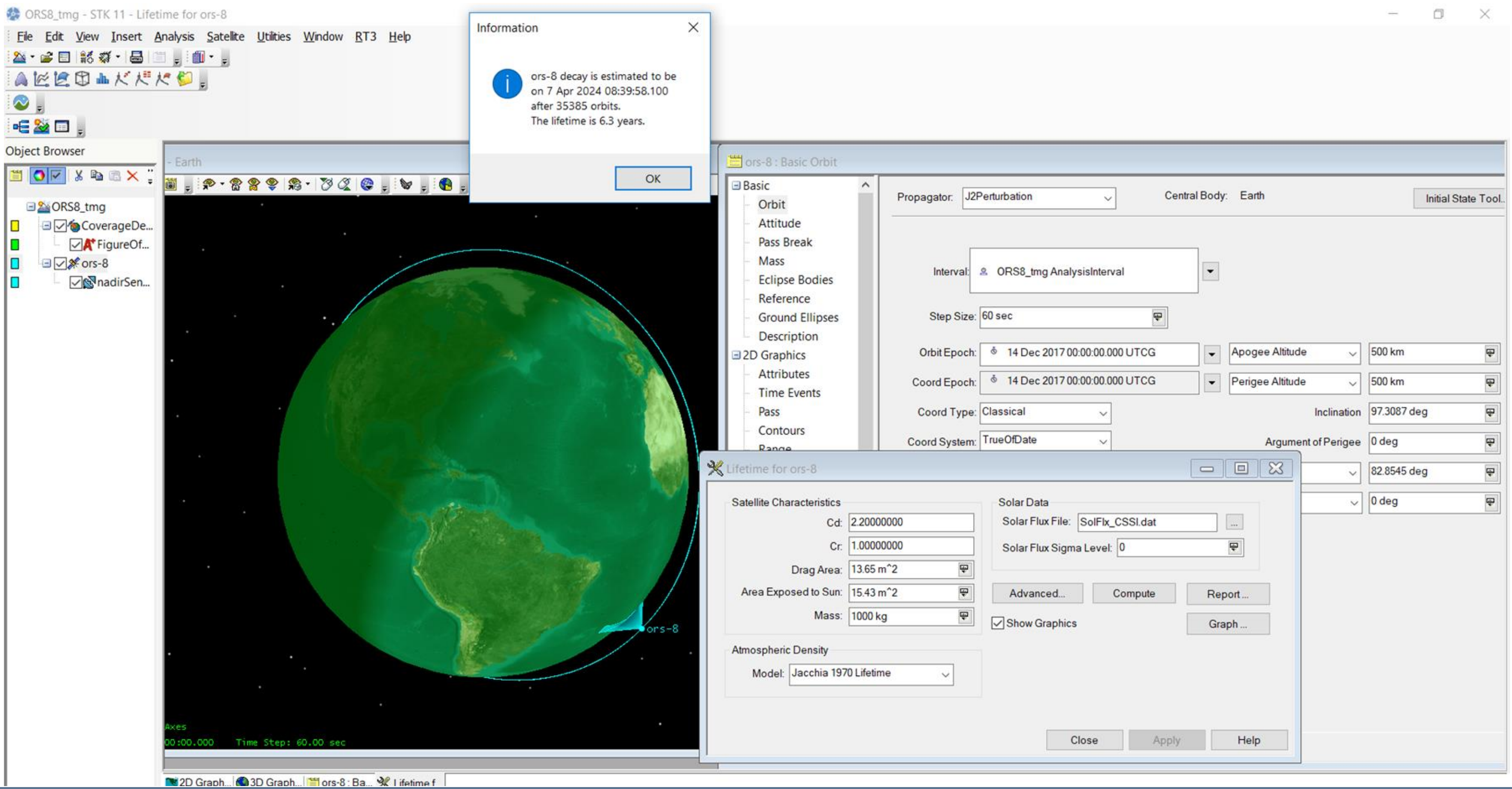
- To Maintain the Sensor Resolution and 100% Coverage Requirements
  - 530 km and Higher Orbits do not Satisfy the 100 % Coverage Constraint



An Orbital Altitude Range of 480 – 520 Km will Satisfy the Orbital Life, Coverage, and Resolution Requirements

MBSE Analyzer - Results

- To Maintain the Sensor Resolution and 100% Coverage Requirements
  - 500 Km Orbit Satisfies the 100 % Coverage Constraint
  - Orbital Life is satisfactory



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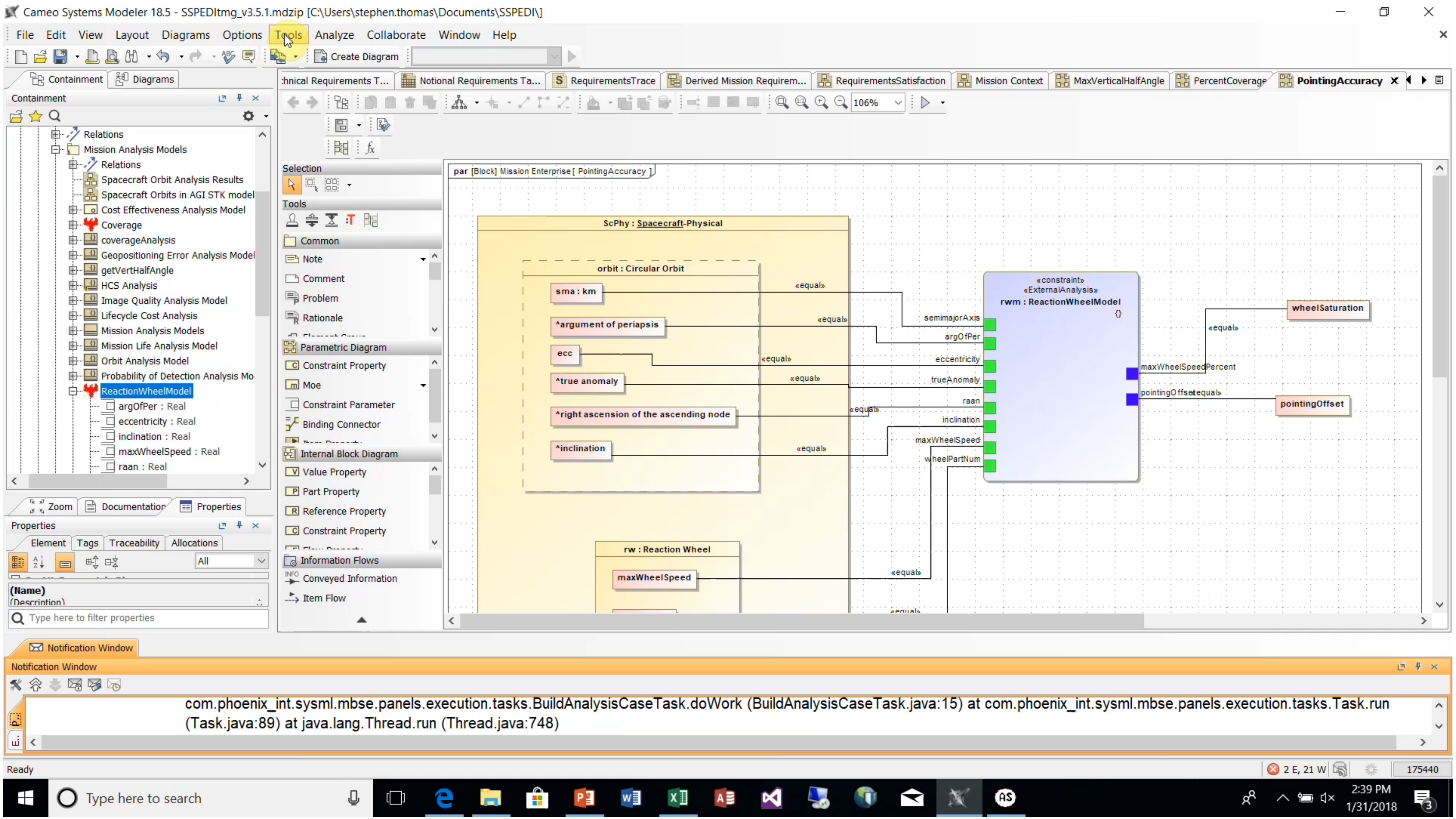
Demo – Reaction Wheel Trade Study Video



Requirements Verification

- 500 km Orbit
  - Meets 100% Coverage within a 12 hr. Period
  - Meets Sensor Resolution Requirements of 2 km
  - Orbital Life Estimate is Greater than 6 Years
- Reaction Wheel Design #1
  - Meets Wheel Saturation Percent Requirement <90%
  - Meets Nadir Pointing Accuracy Requirement 0.25 deg

Summary

DEMONSTRATED

- Collaboration Between the Team to Provide a Rapid Capability to:
  - Manage Complexity of Design of Satellites Through MBSE
  - Perform quick turn Trade Studies to Optimize Performance, Cost, Risk, or Schedule
  - Early Identification of Disconnects Between the Architecture and Requirements
  - Automated Distributed Engineering Analysis
  - Model Based Engineering

BACKUP