

Integrating Mission Analysis with SysMLv2 and Requirements Assessment

Cameron Krivitsky Peter Douglas

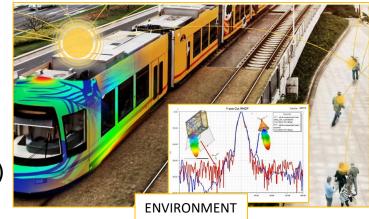


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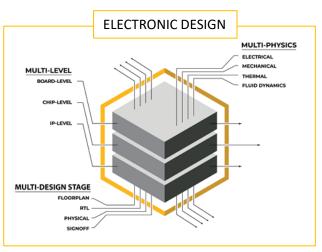
DIGITAL MISSION ENGINEERING AND SYSTEMS V DIAGRAM

Framing of the problem...





DIGITAL ENGINEERING



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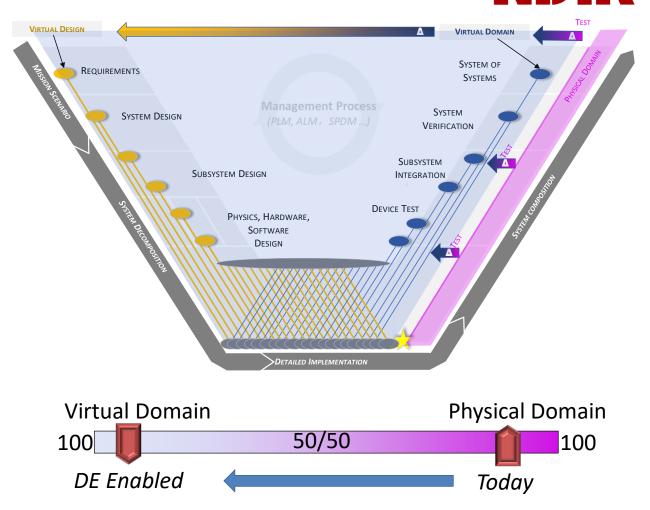
• How do I...

- Use my requirements to drive the system development
- Produce high quality digital engineering products (frameworks, models, etc.)
- Integrate multiple tools across the MBSE, MBE, and MS&A stack
- What if...
 - We use a different algorithm, architecture, component, or antenna
 - We place the hardware in a different location, or change the configuration
 - The operational environment changes... ambient temperature, landscape, etc.

Using a digital engineering framework results in system knowledge capture, insight in system interoperability, system ability to meet mission objectives – ultimately leading to a better engineered solution throughout the lifecycle.

Digital Engineering enabled System-V Diagram

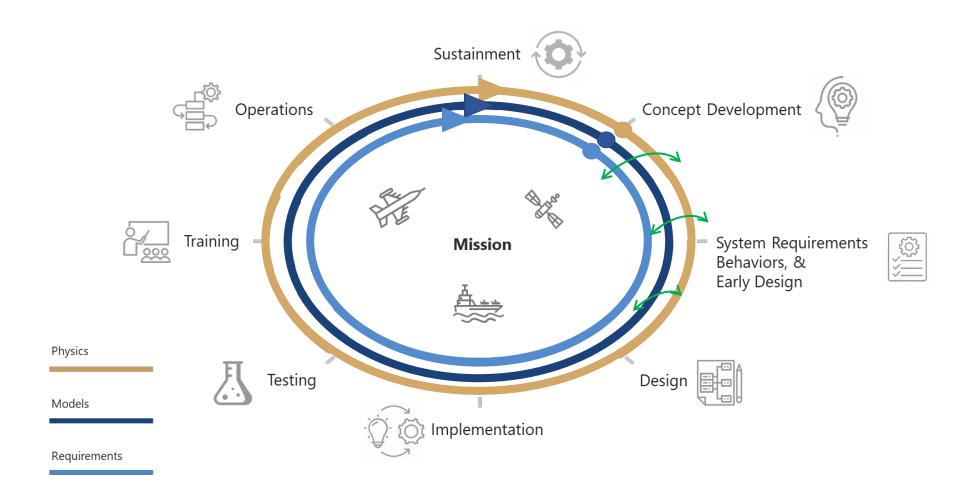
- A connected and collaborative Model Based Systems Engineering and Modeling, Simulation and Analysis ecosystem
- 2-Domain System-V Diagram
 - Virtual Design and Integration
 - Physical Domain and Test
- Value occurs through the combined use of the Virtual and Physical domain to solve complex engineering challenges



Result: Increased use of modeling and simulation accelerates integration, deployment, and sustainment.

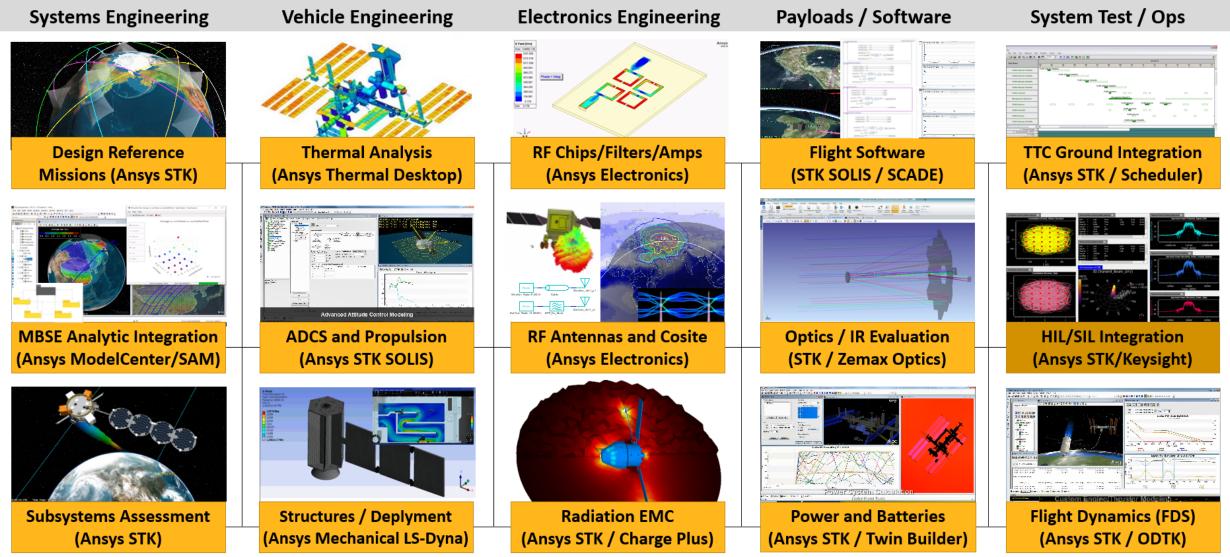
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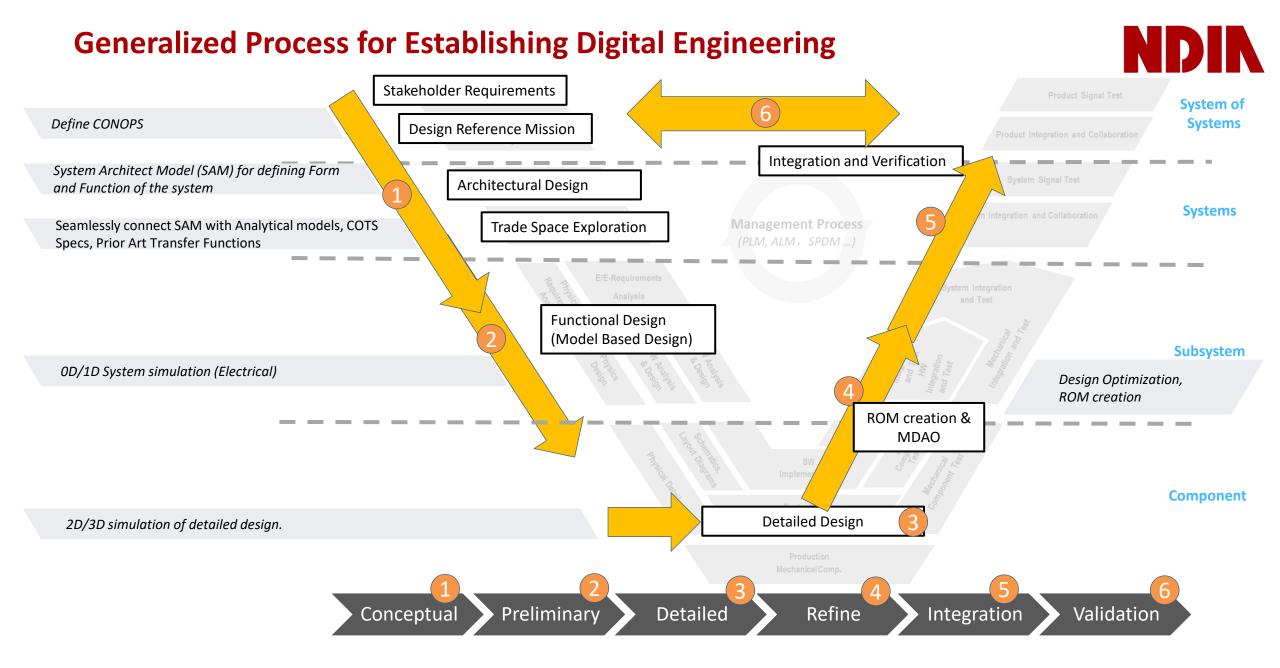




DME Accelerates Space Systems Design and Verification







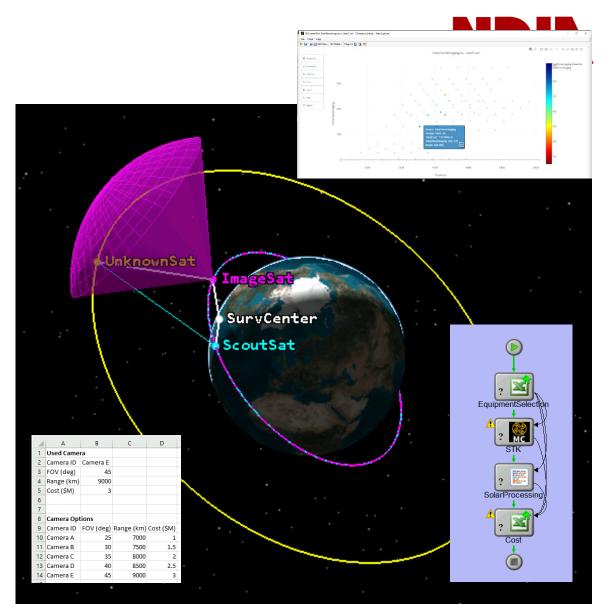


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NOTIONAL USE CASE

Example Demo – Notional RFP

- **RFP Overview:**
 - Design two satellites in LEO that image unknown satellites
 - ScoutSat must first identify an unknown satellite before notifying ImageSat via ground relay to begin taking images
- **RFP Requirements:**
 - 1. Total cost of mission shall be less than **\$150M**
 - 2. Total imaging time of the unknown satellite shall be above **5 minutes**
 - The ImageSat's solar panels shall generate an average of 300 W of power
 - 4. The ImageSat's sensor shall have a mean SNR greater than 200
- Design Variables:
 - ScoutSat & ImageSat's Semimajor Axis, Inclination, and Spacing (True Anomaly)
 - ImageSat's Camera Selection
 - ImageSat's Solar Panel Selection



Design Reference Mission (DRM)

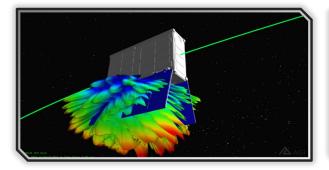
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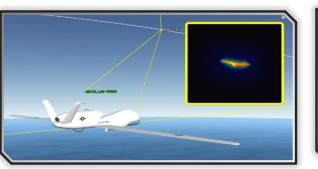
A series of **representative mission profiles** that **sufficiently describe the intended system use** across its nominal and most stressful operating conditions.

The DRM is used to **evaluate system performance** and **guide development efforts**.

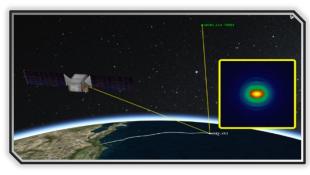






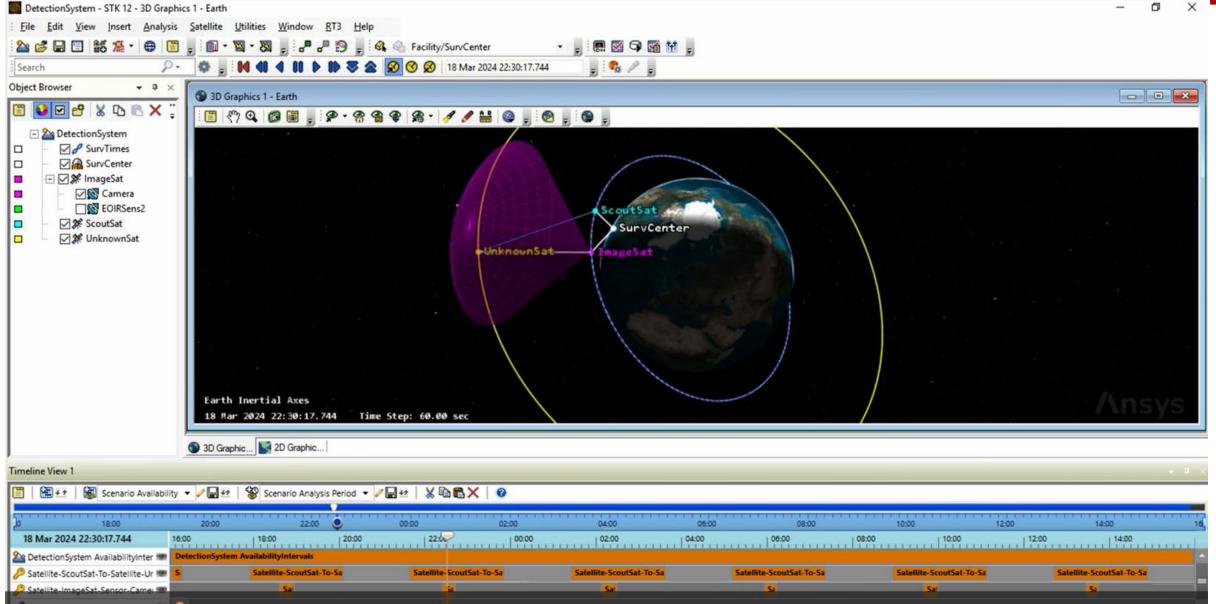






Mission Scenario





Ansys DELAB

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 Logging into the Ansys Digital Engineering Lab Machines which are VMs hosted using AWS or Azure resources.

• The files needed for my workflow are shown below.



Automated Toolchain for DME

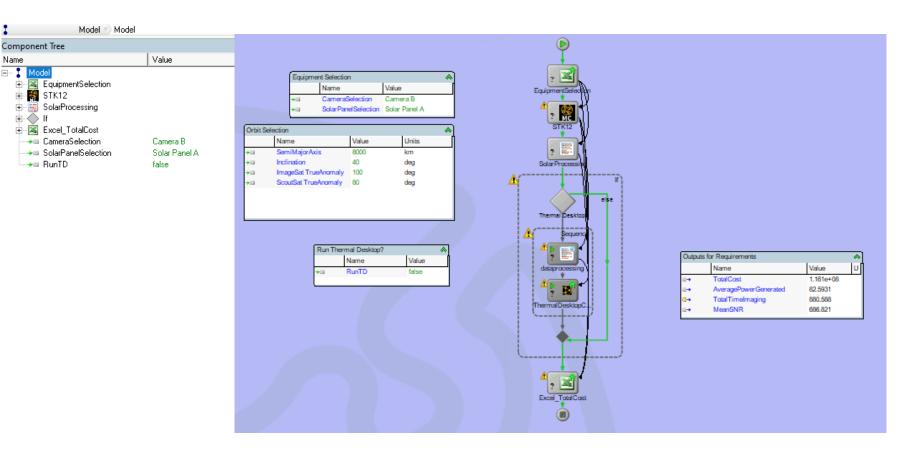
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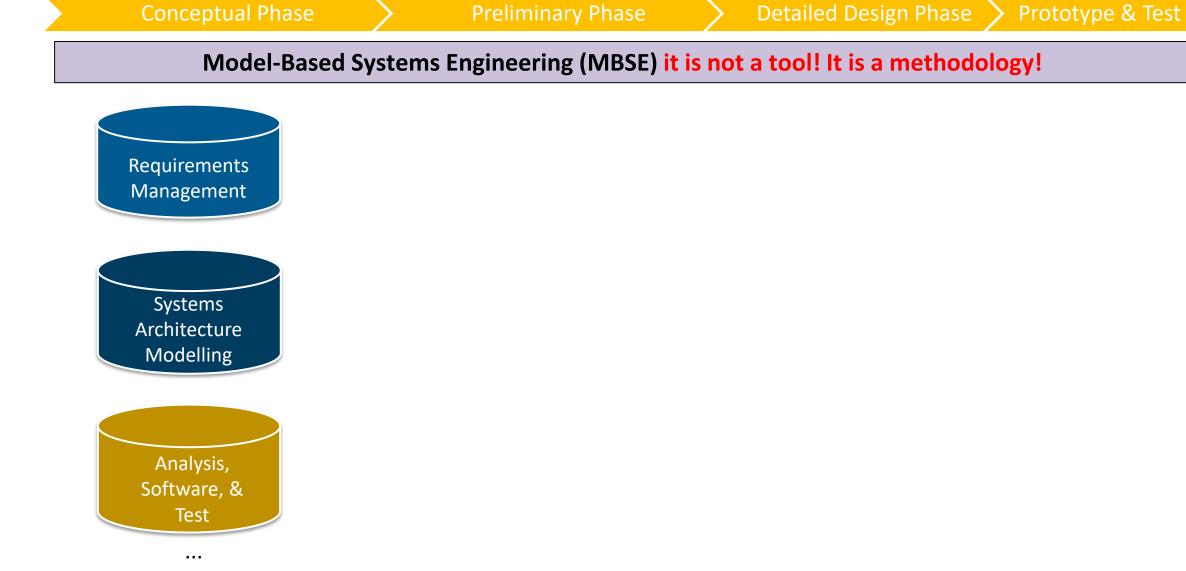
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- This is my automated workflow showing various tools.
- Once tools are chained, can be used to execute and run design of experiments.
- This is what I will use to tie to the systems model.



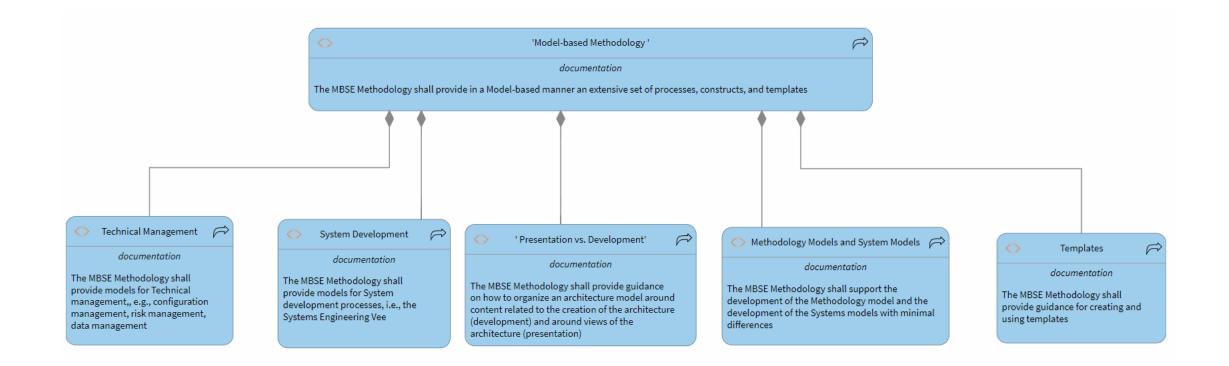
Model-Based Systems Engineering Approach



Ansys System Architecture Modeler (SAM)



 The Ansys SAM is a general-purpose system architecture modeling tool based on SysML v2



Why SysML v2?



- We chose SysML v2 for our modeler because we believe that it will be significantly easier to learn, easier to use, and more powerful that SysML v1.
- Compared to SysML v1, SysML v2 was designed to be:
 - More Precise
 - More Expressive
 - More intuitive and Regular
 - More Consistent
 - Have better Interoperability with other engineering models and tools
- SysML v2 is grounded in formal semantics and includes a very powerful API.
- Expect v2 to be the new industry standard

Key Characteristics of the Ansys SAM



- Cloud Native. The Ansys SAM can be installed on a public cloud (*e.g.* AWS, Azure, etc.) or installed on an on-premise server. It will be accessible to any user from a standard web browser. This means that our modeler is scalable to large numbers of users.
- Real-time Collaboration. A key feature of the Ansys SAM is real-time collaboration. Multiple users will be able to work on model development at the same time, and each user can see in real-time what other users are doing.
- Open Infrastructure. The SAM is built using an open infrastructure philosophy – open in terms of data, models, and APIs so that it fits into our customer's MBSE ecosystem. Close integrations with Ansys tools (*e.g.* ModelCenter, Medini, Scade, solvers) and third-party tools (*e.g.* PLM, external simulations, etc.)

Ansys System Architecture Modeler



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Ansys SAM Dashboard



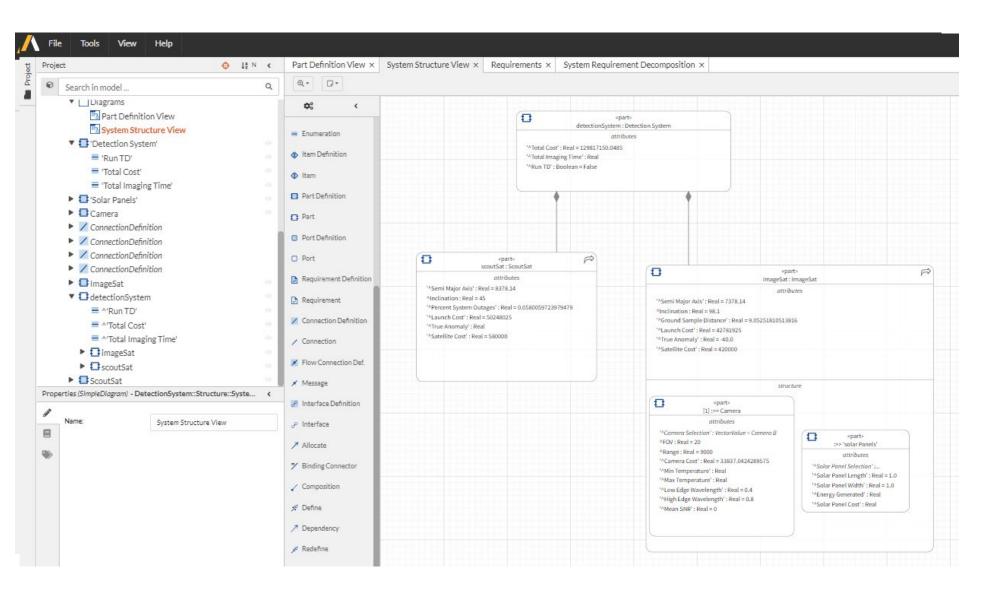
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System Requirement Decomposition



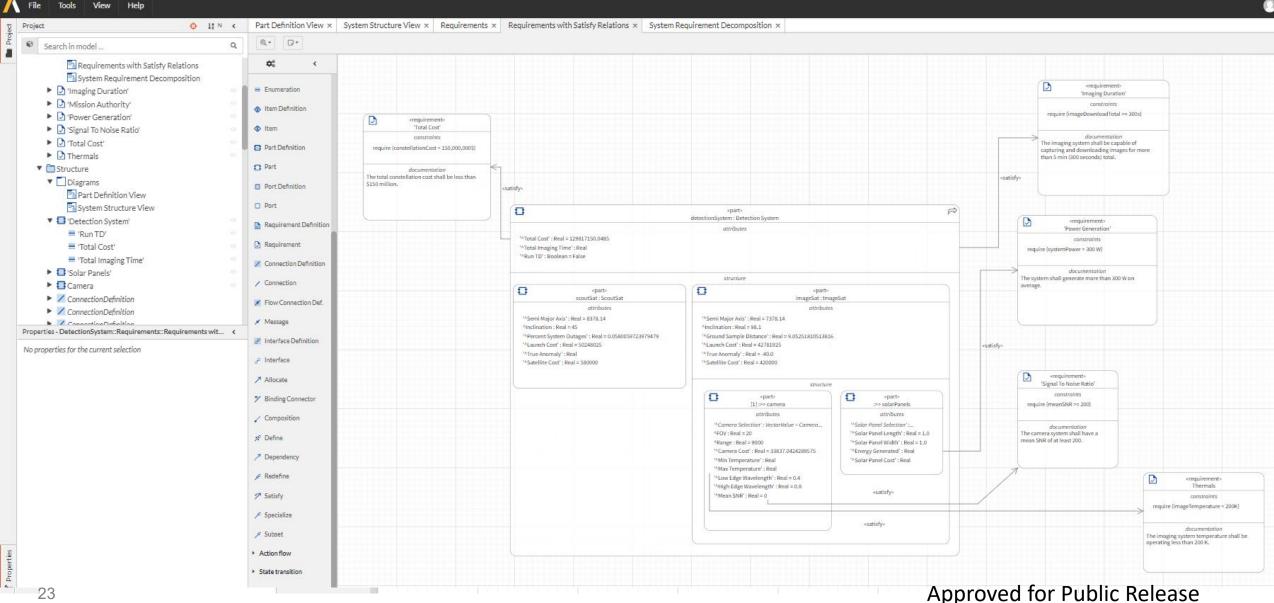
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System Structure with Definition and Usages





Requirements Depicted and Structure Allocated



MBSE within the Ansys SAM



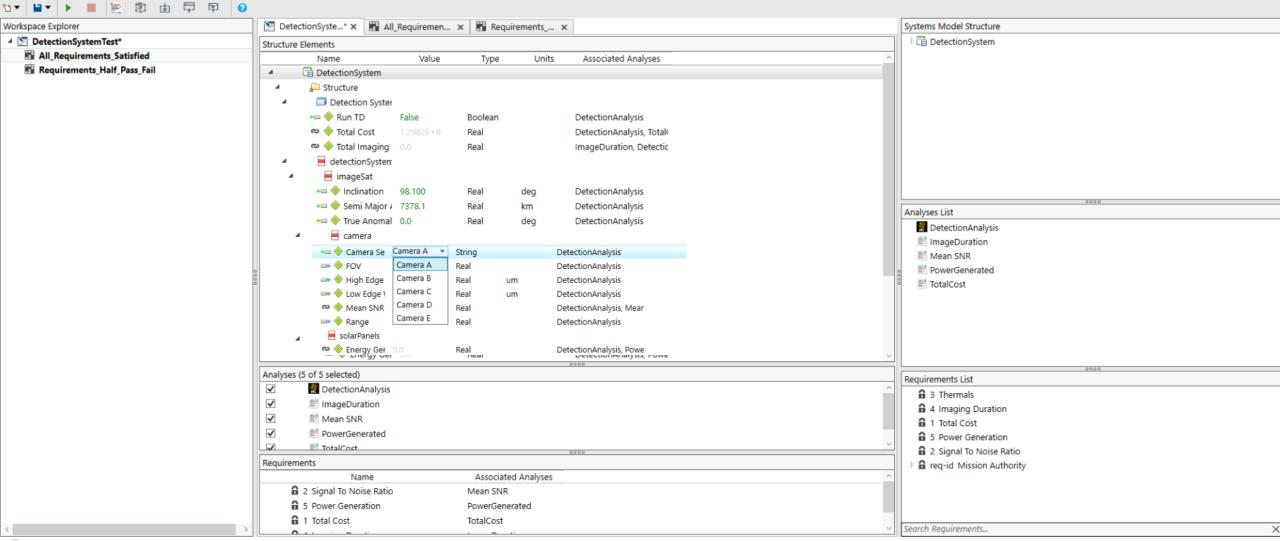
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MBSE Execution Plan

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Execution Plan with Design of Experiments

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Data Explorer and 2D Scatter Plot



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MBSE Results with Two Failed Requirements

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MBSE Results with All Requirements Satisfied

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Thank You!