Model Based Systems Engineering for Space Based Applications

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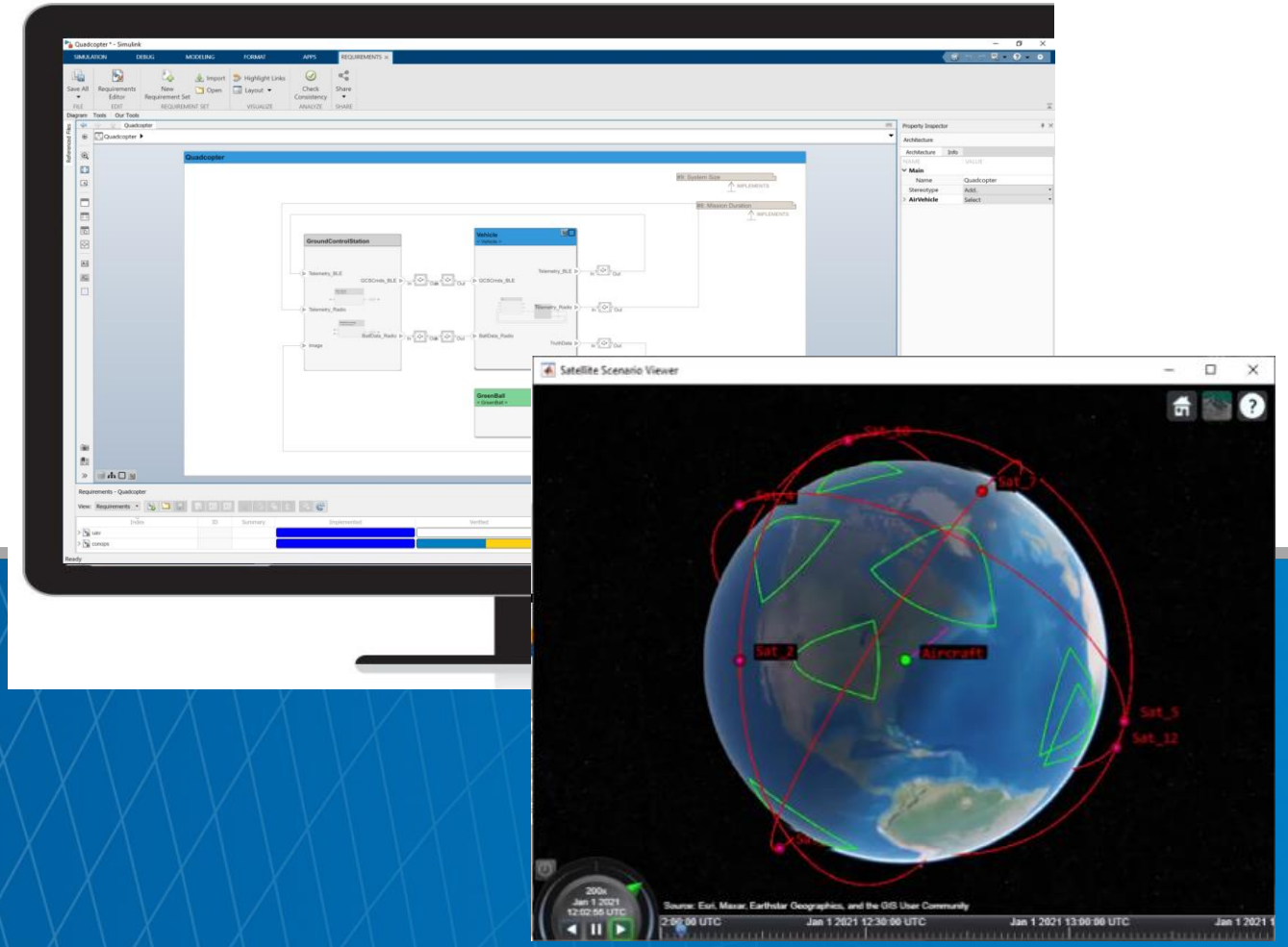


Key Takeaways

- MATLAB and Simulink products for Model Based System Engineering (MBSE)…
  - enable intuitive, scalable and adaptive modeling of architecture models
  - utilize the architectures to conduct analysis early in the design cycle
  - provide a digital thread from architecture to behavior models

MathWorks Digital Engineering Capabilities

System Requirements

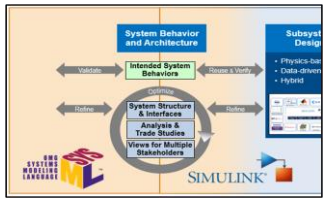
Use cases

Requirement docs and models

System Functionality and Architecture

Behavior models

Architecture models



Subsystem Design

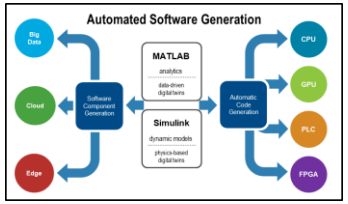
Physics-based

Data-driven

Subsystem Implementation

Automatic codegen
- C/C++
- VHDL/Verilog
- GPU code

Hand-code support

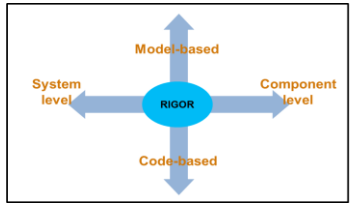


System Integration and Test

Model-based V&V

Code-based V&V

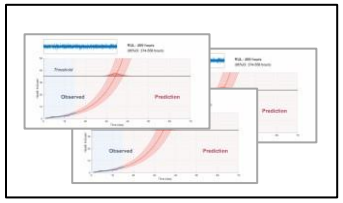
Certification workflows



Operations and Sustainment

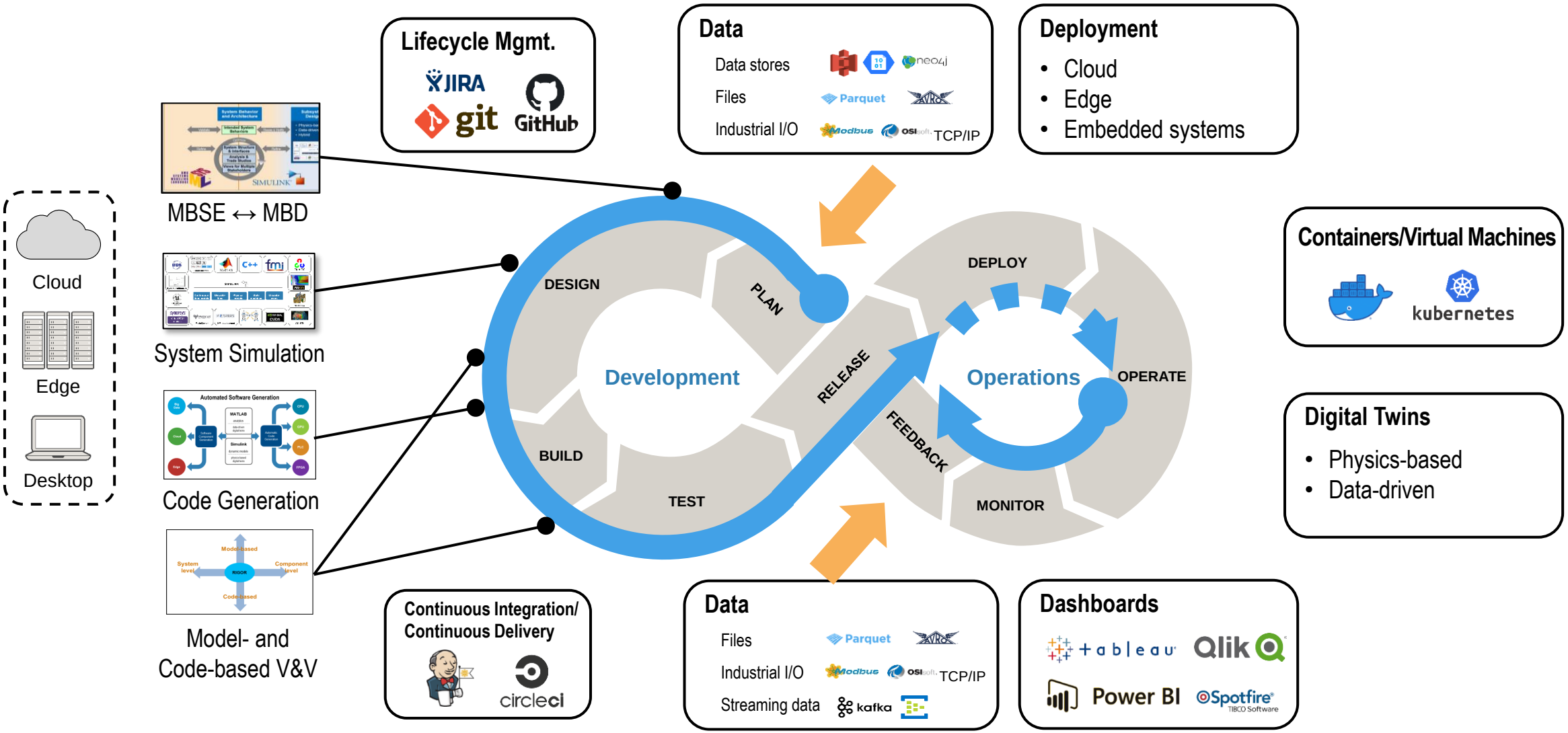
Predictive maintenance

Digital Twins



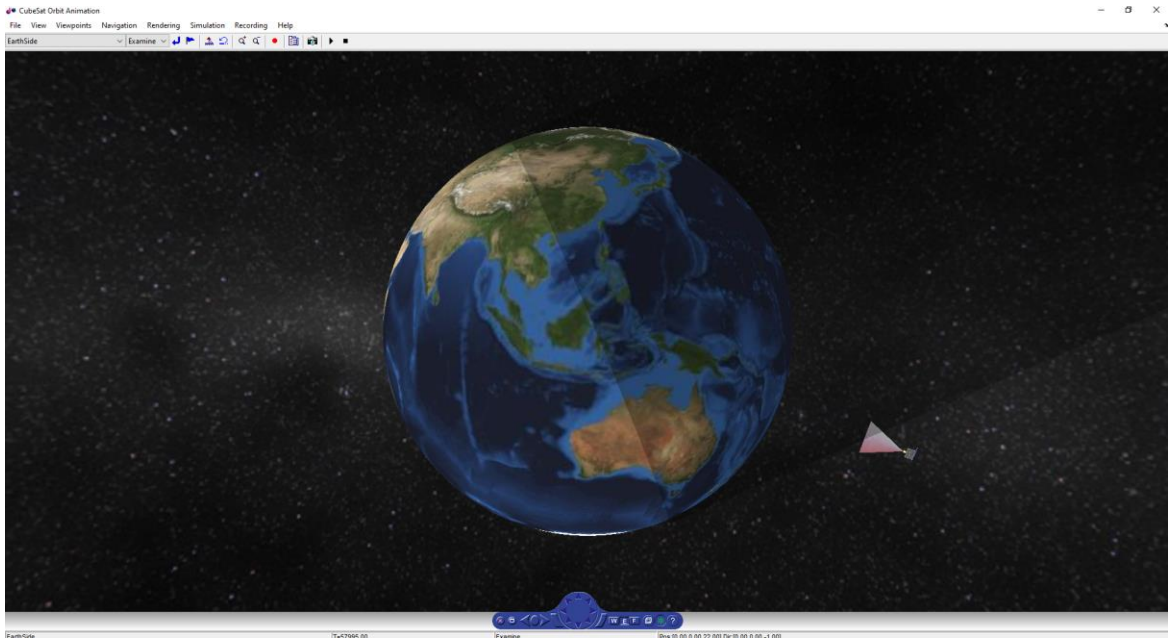
Digital Thread

Software and Systems Integrated Workflow



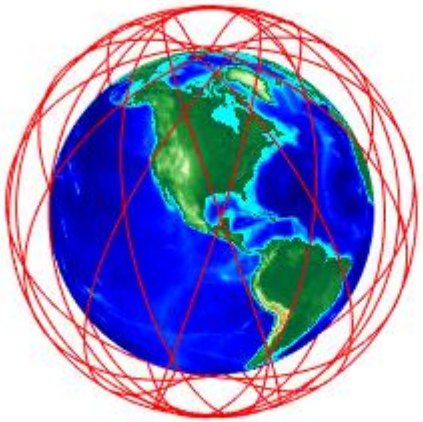
Agenda

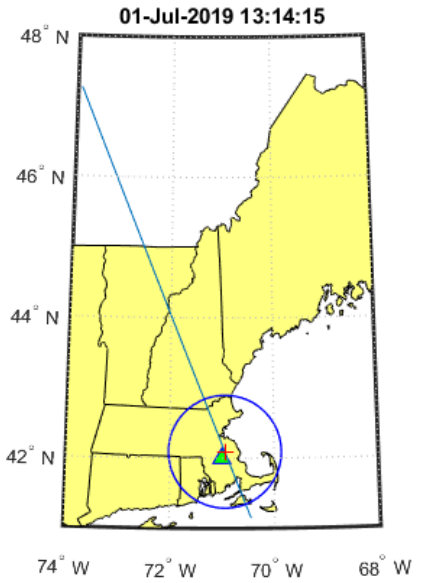
- **Explore CubeSat Mission System**
- **Discuss and Demo Model Based System Engineering**
- **Choose your own adventure ☺**



High Level Requirements/ Concept of Operations

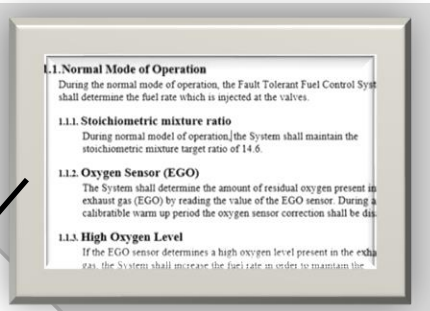
- The system shall provide and store visual imagery of MathWorks headquarters [42.2775 N, 71.2468 W] 1 time daily at 10 meters resolution.
  - The satellite shall provide for collection by the ground system visual imagery of MathWorks headquarters 1 time daily at 10 meters resolution.





System Composer OMG Satellite Model and Mission Analysis

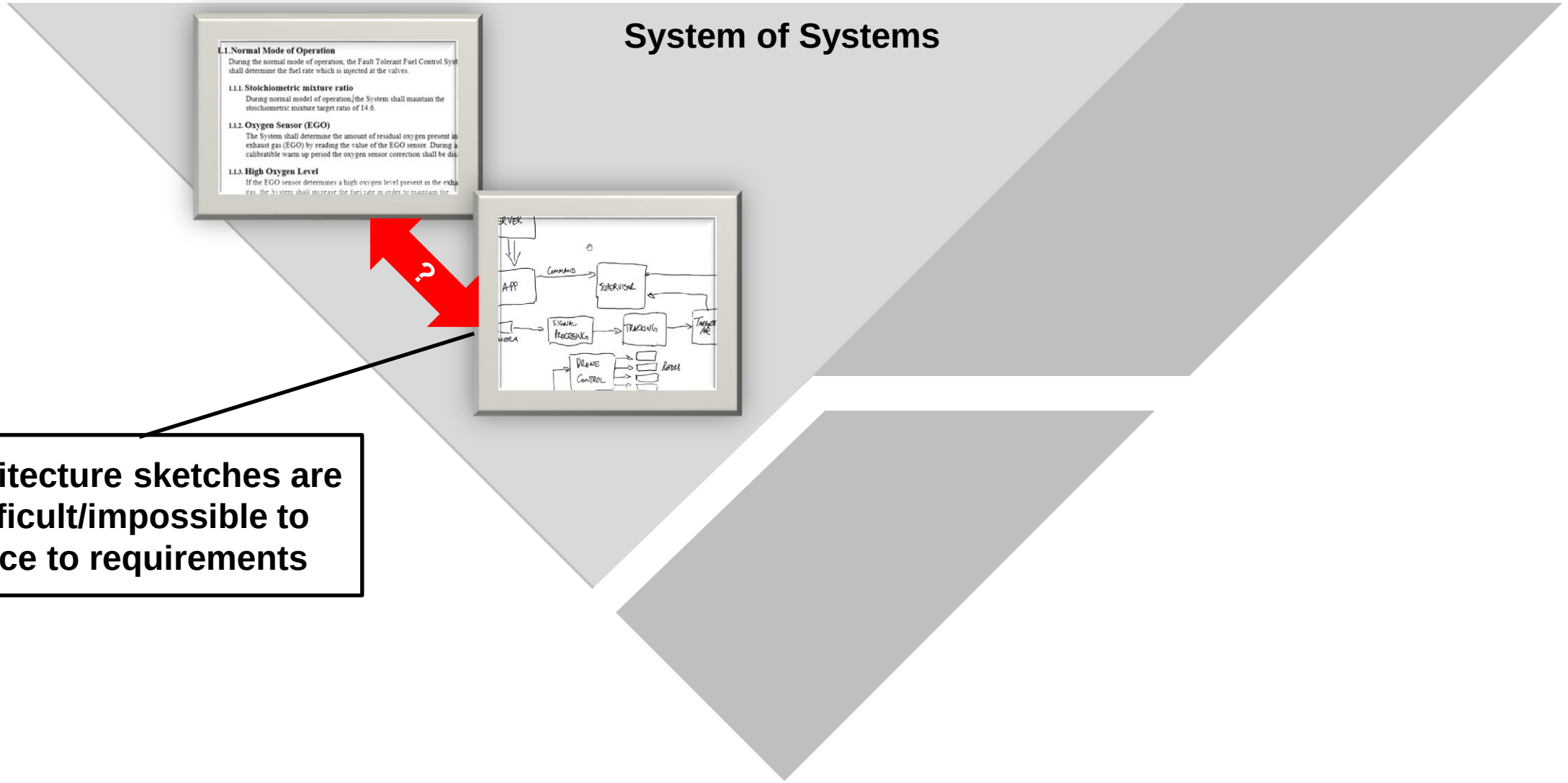
How is this done today?



Textual requirements

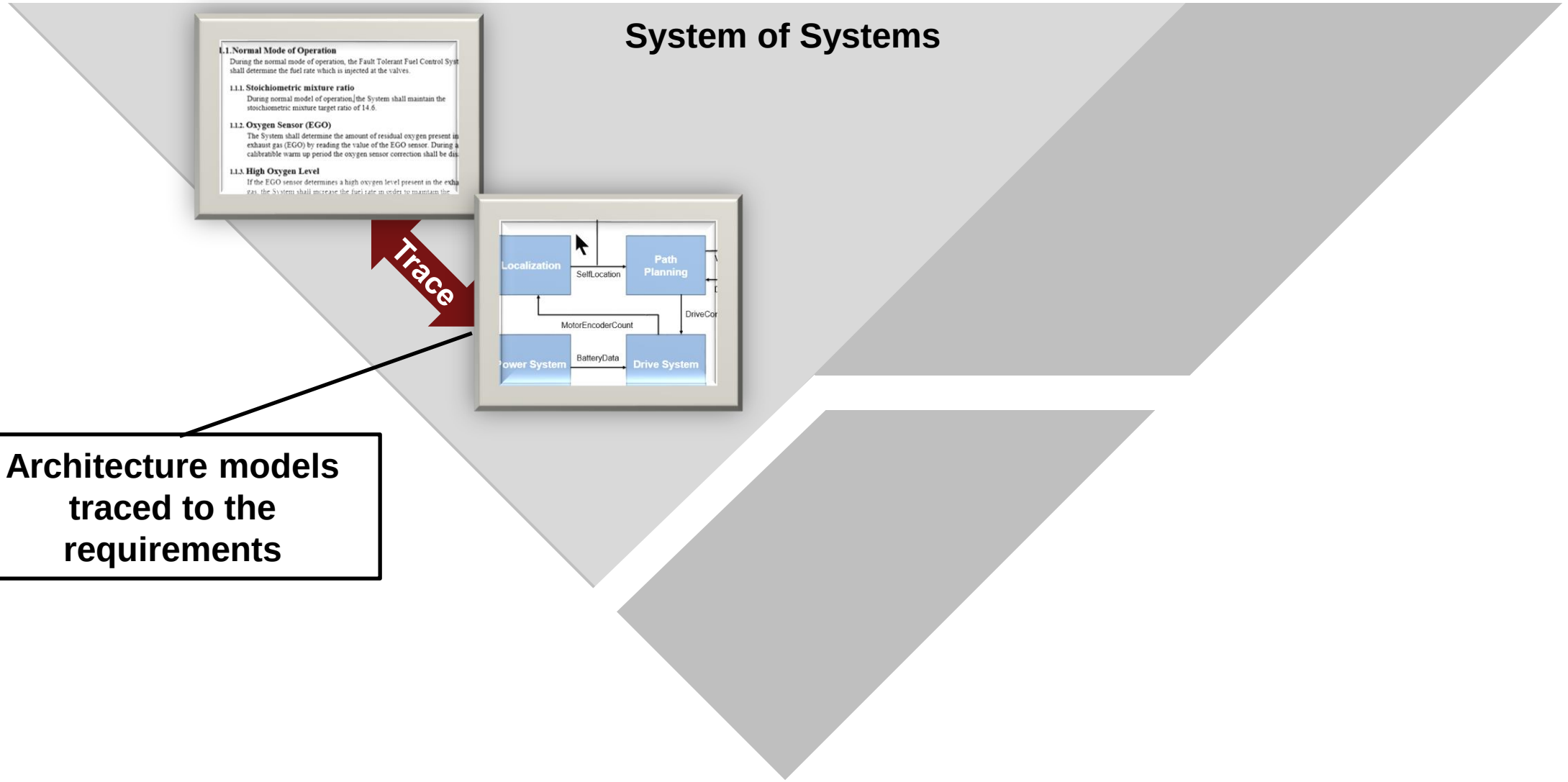
System of Systems

How is this done today?



Architecture sketches are difficult/impossible to trace to requirements

How is this done today?



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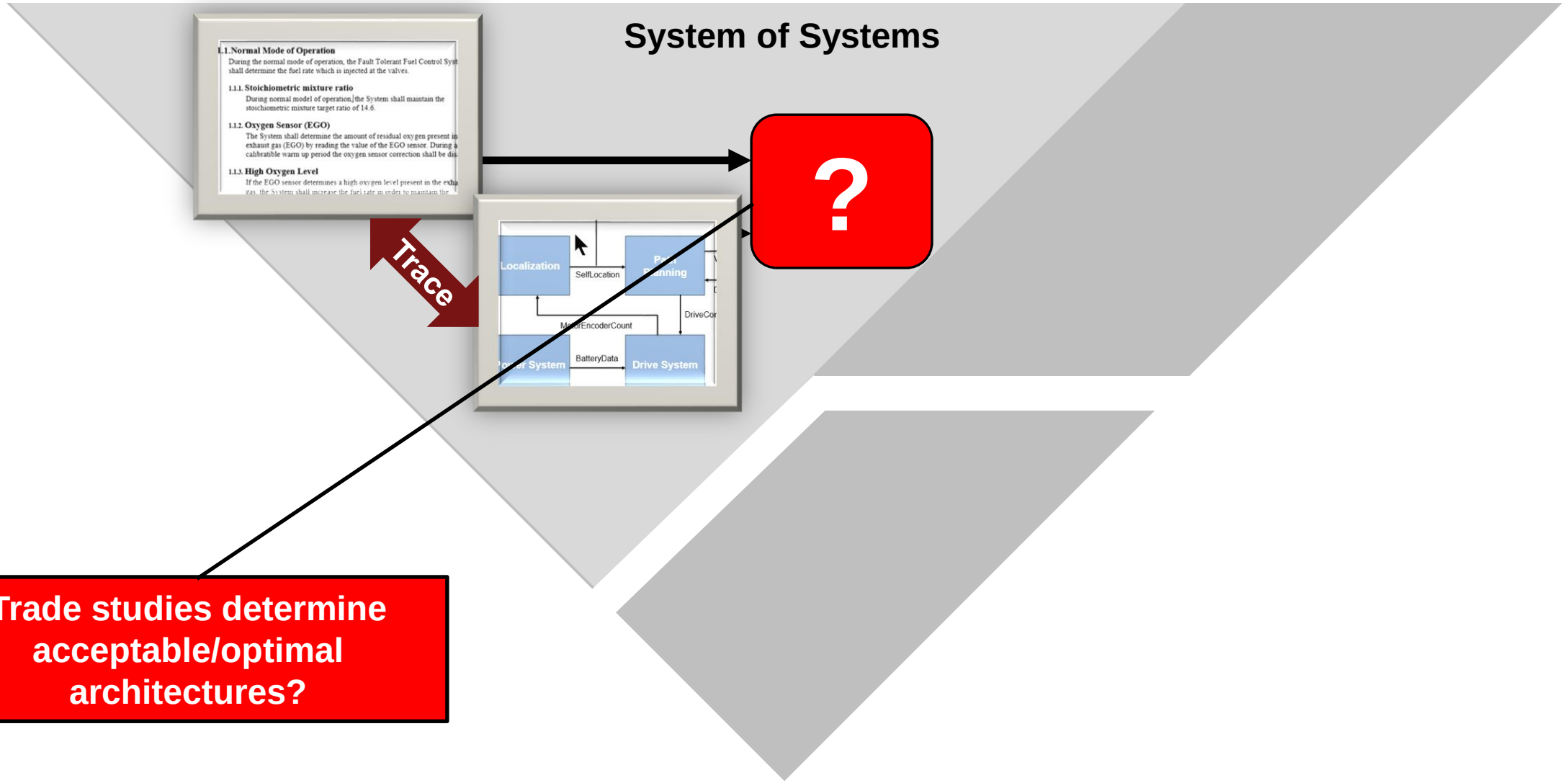

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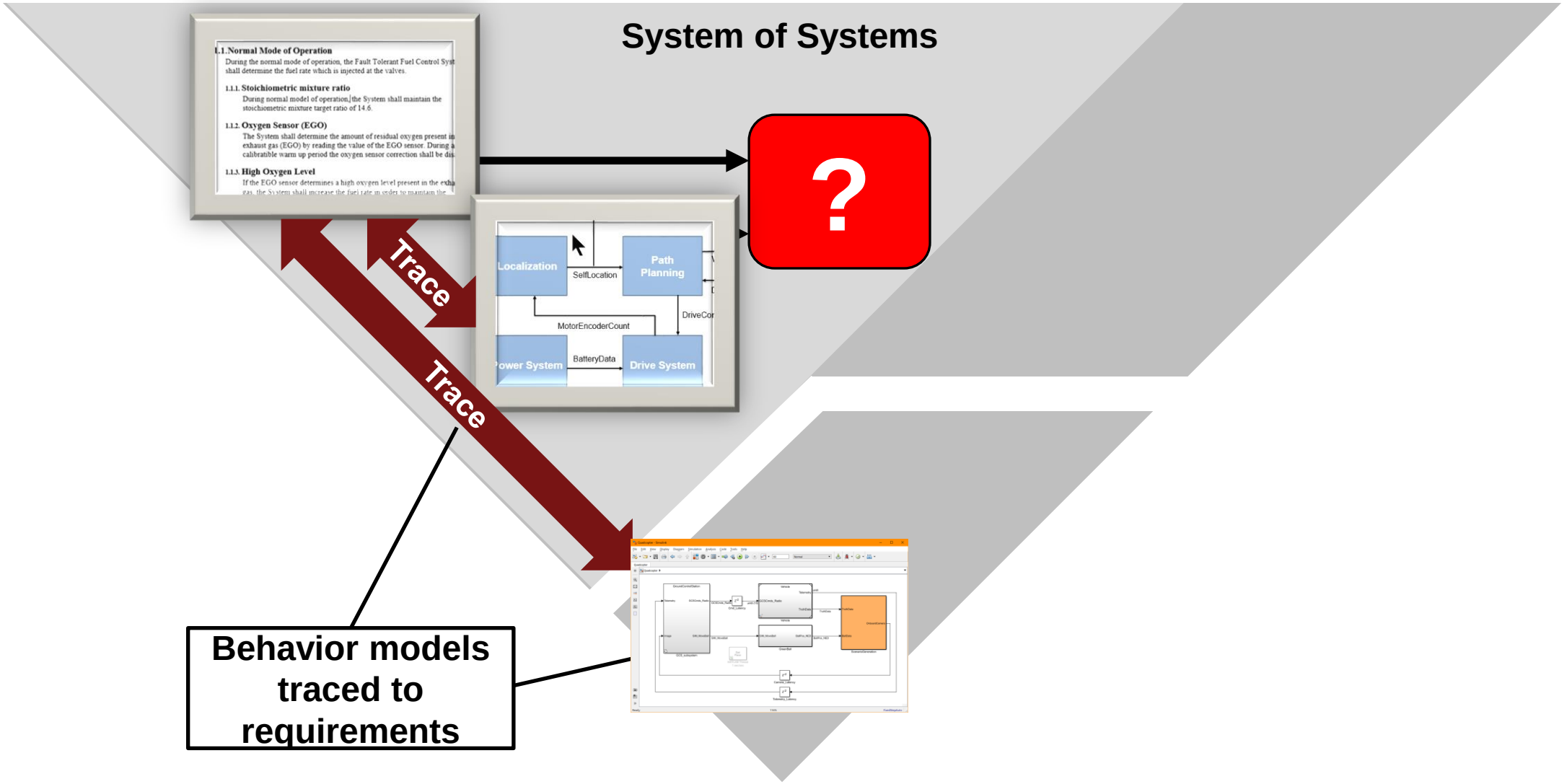

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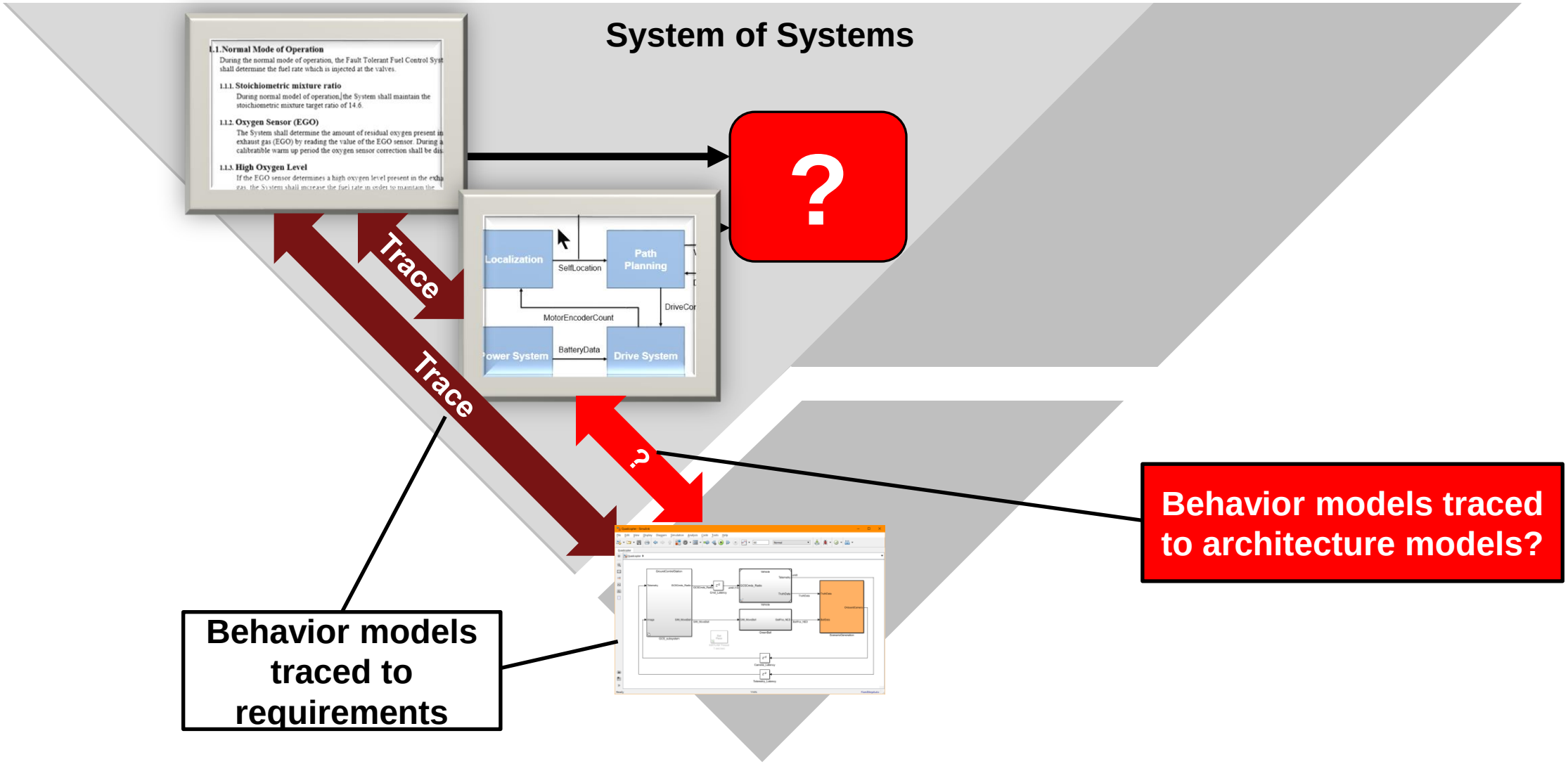

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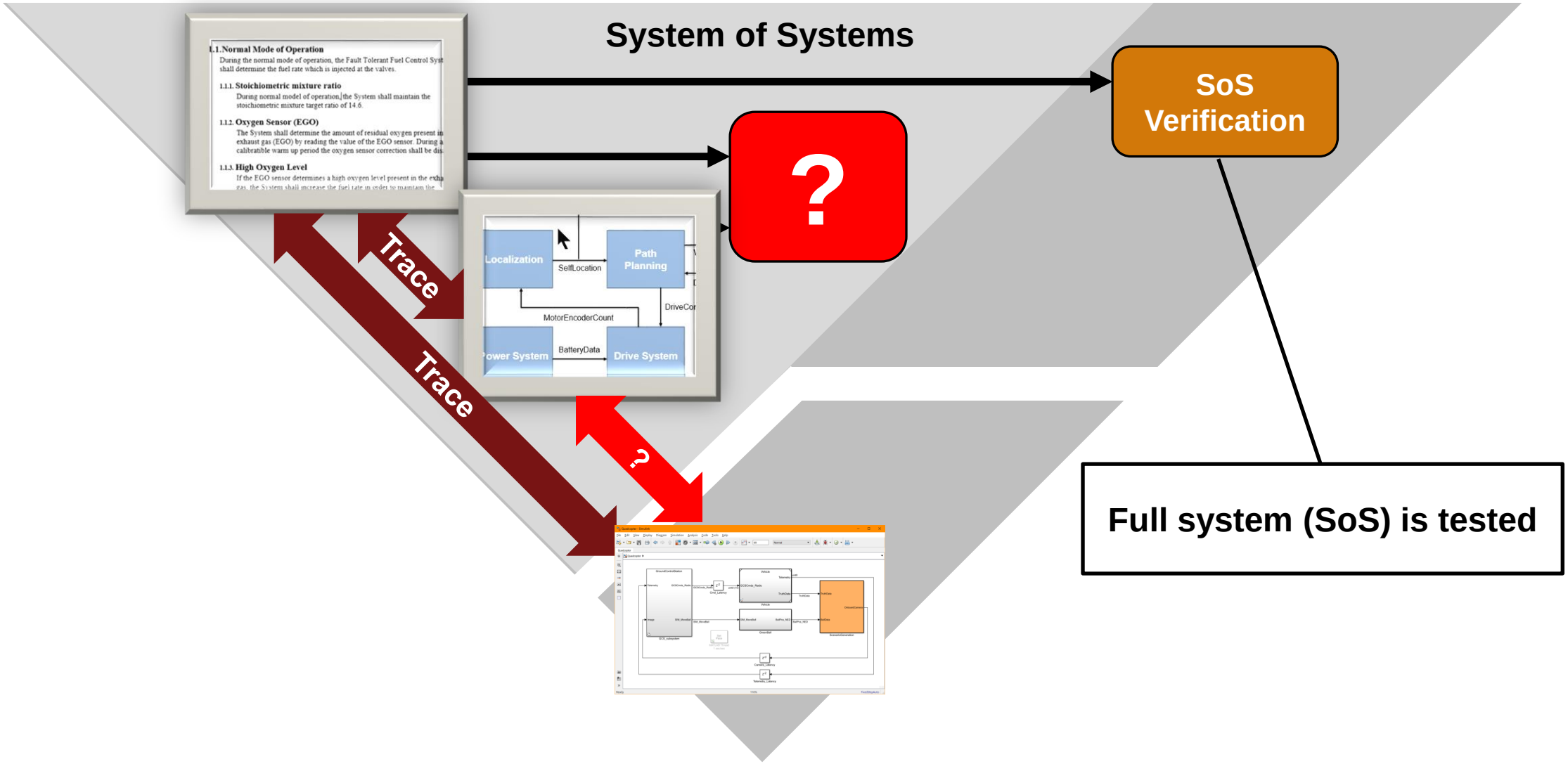
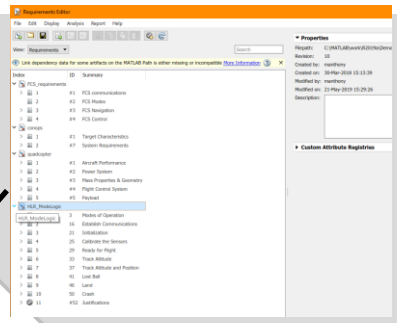
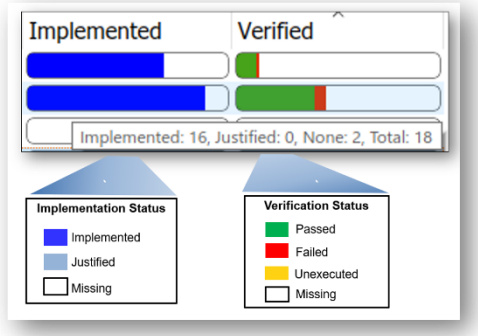


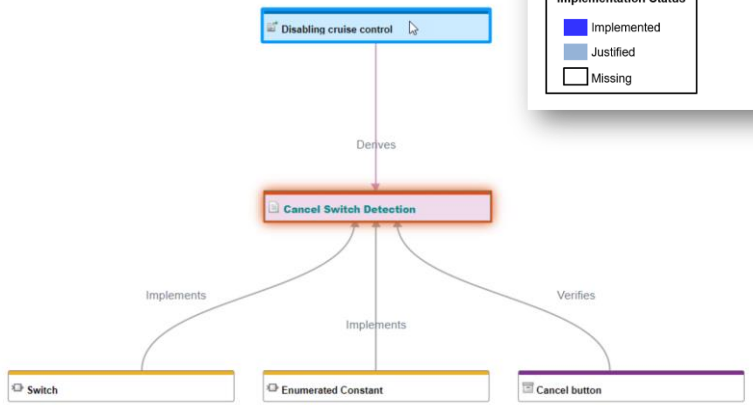
How does MathWorks do it?



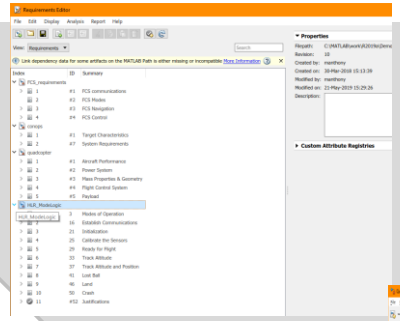
Textual requirements

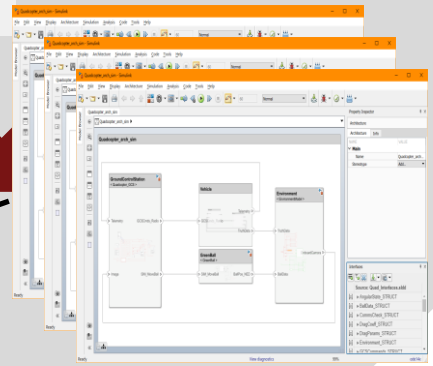
System of Systems





How can MathWorks help?

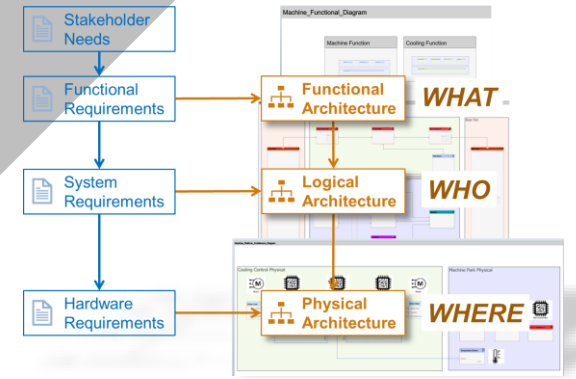


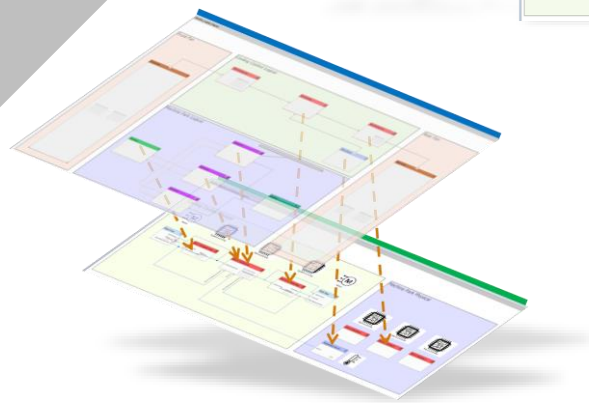


Trace

Architecture models traced to the requirements

System of Systems





How is analysis done today?

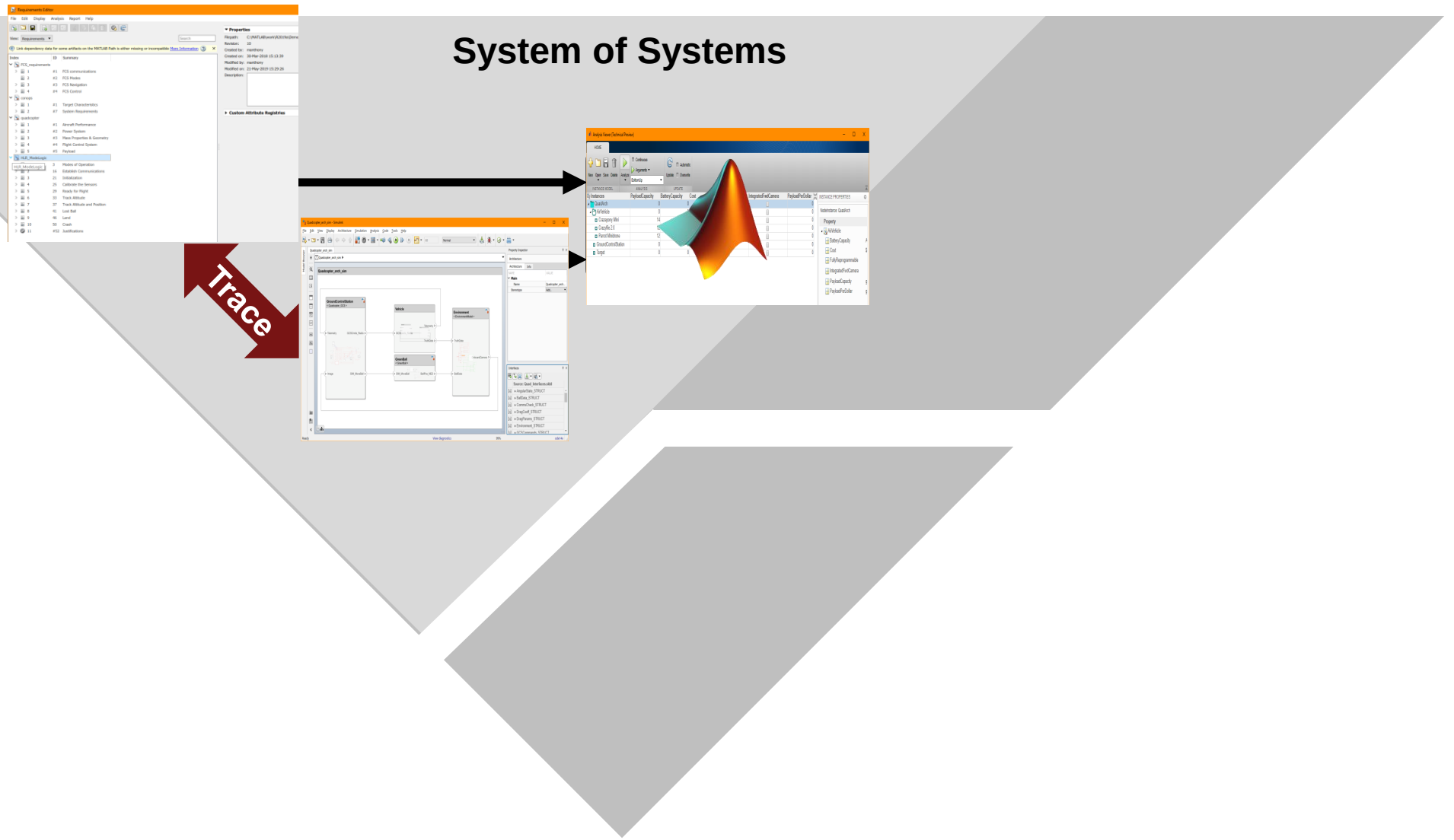
Typical Tools:

- MATLAB
- Excel
- In house / 3rd Party analysis tools

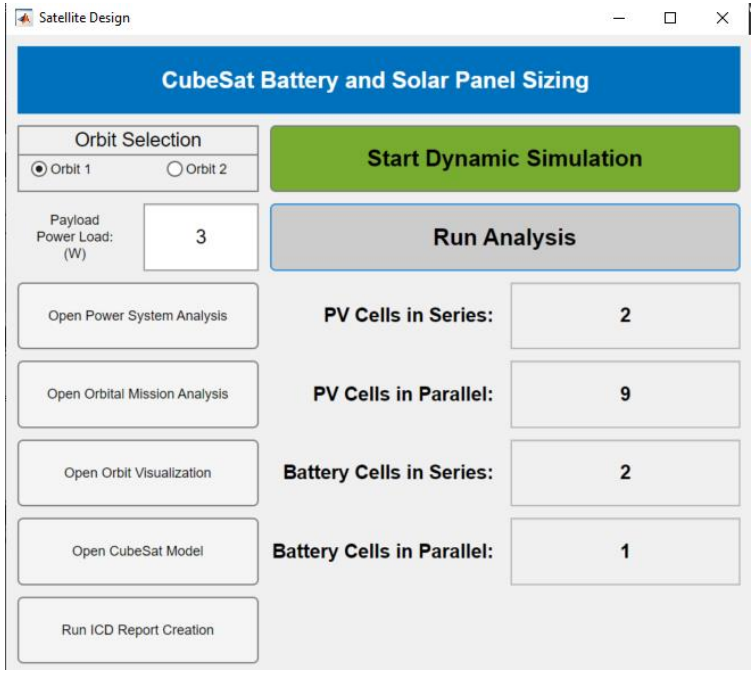
Pain Points:

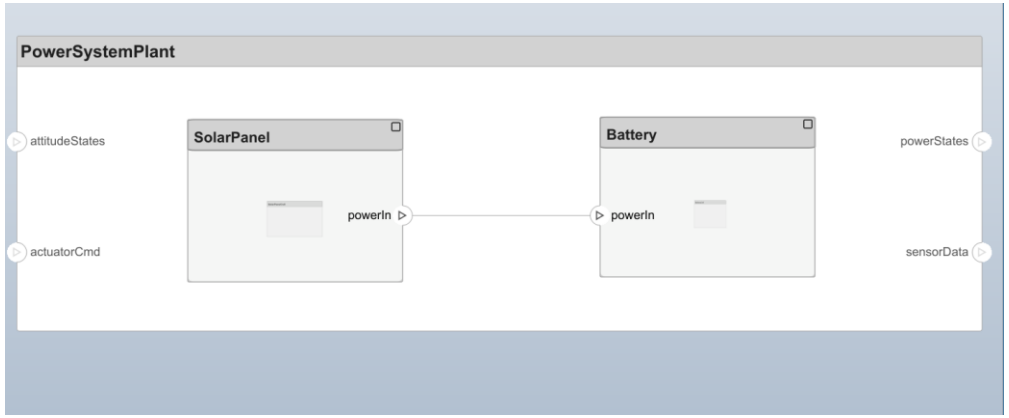
- Disjoint analysis tools
  - Difficult to bring in quantitative Systems engineering methodology (Pugh, Analytic Hierarchy, Kepler Tregoe)
- Multiple tools needed to collect data and report out
- Verbal knowledge transfer
- System Level Verification

How can MathWorks help?



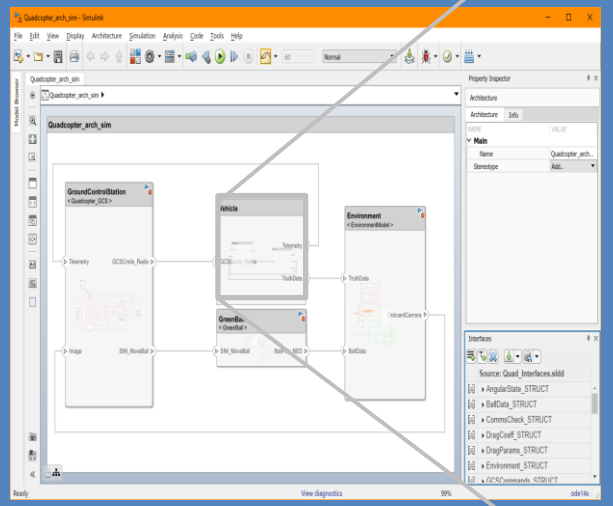
CubeSat Power System Analysis



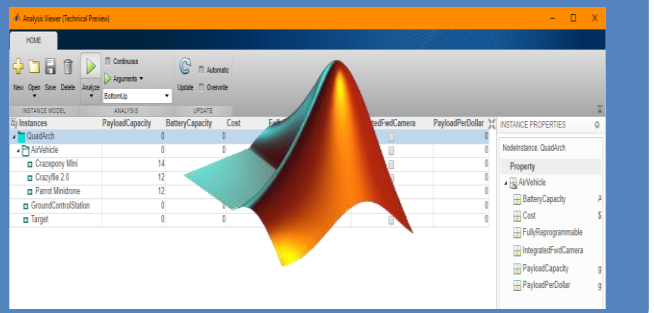


System Composer Supports Trade Study Formulation and Analysis

Architecture Model in System Composer

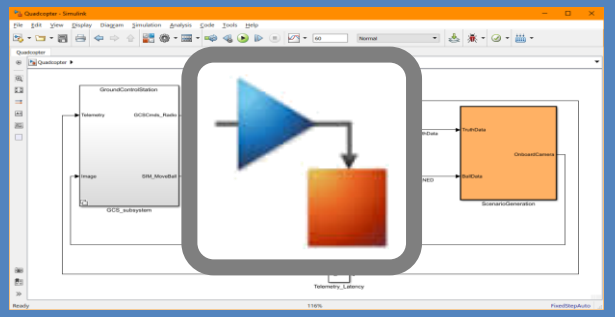


Trade Studies



Behavior Confirmation of Trade Studies via Simulation

Simulink Behavior Models



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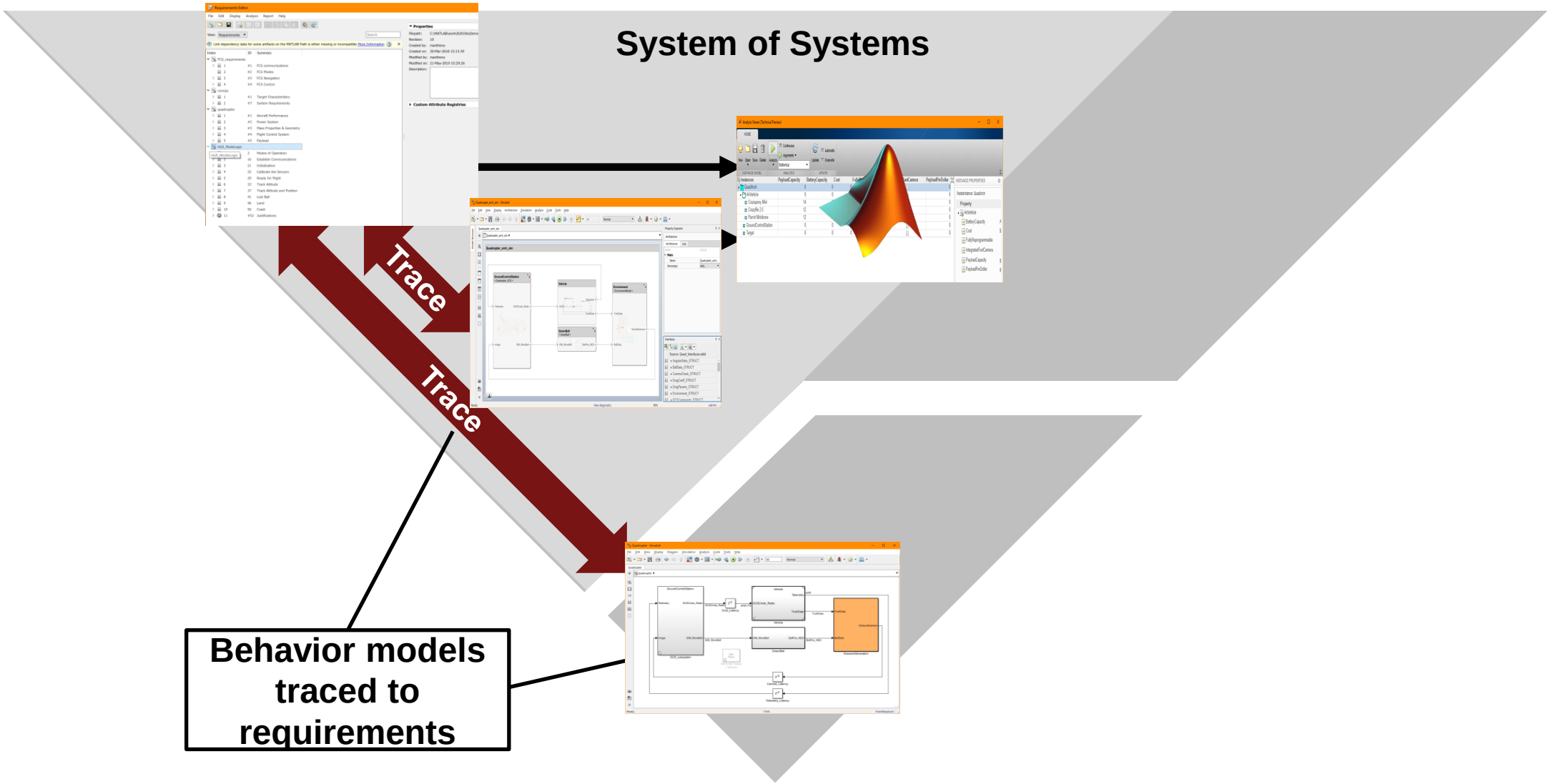

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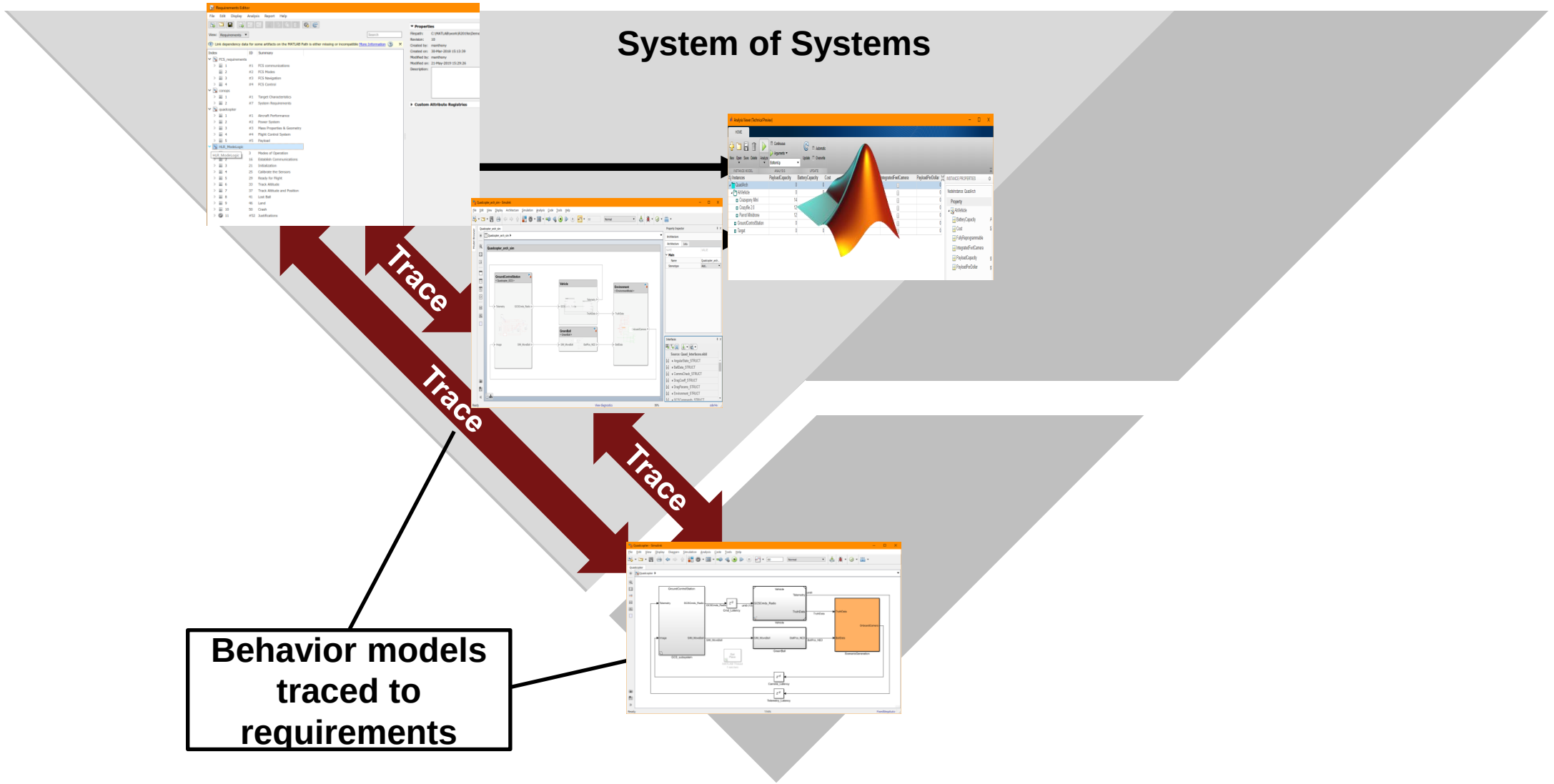

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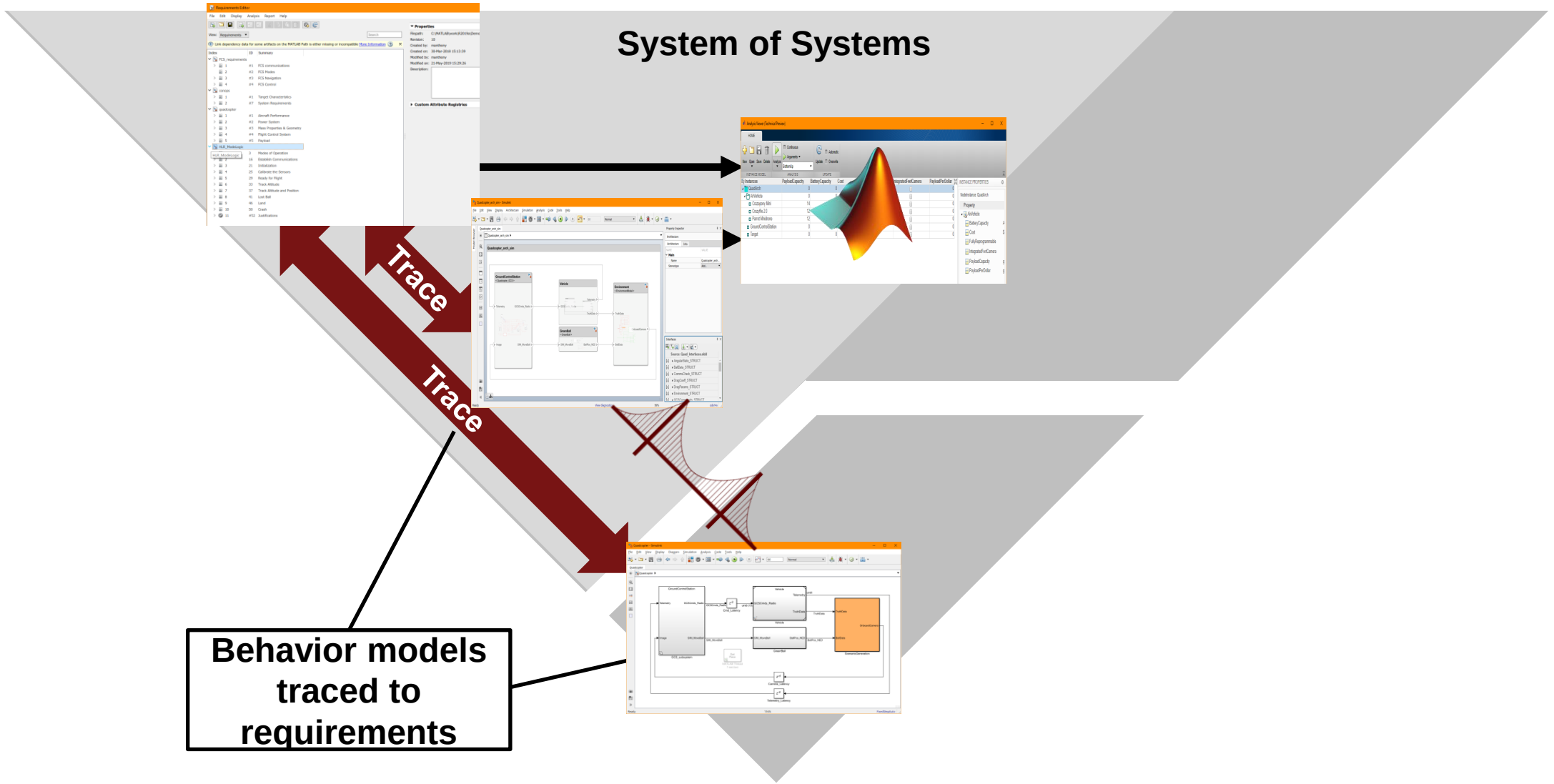

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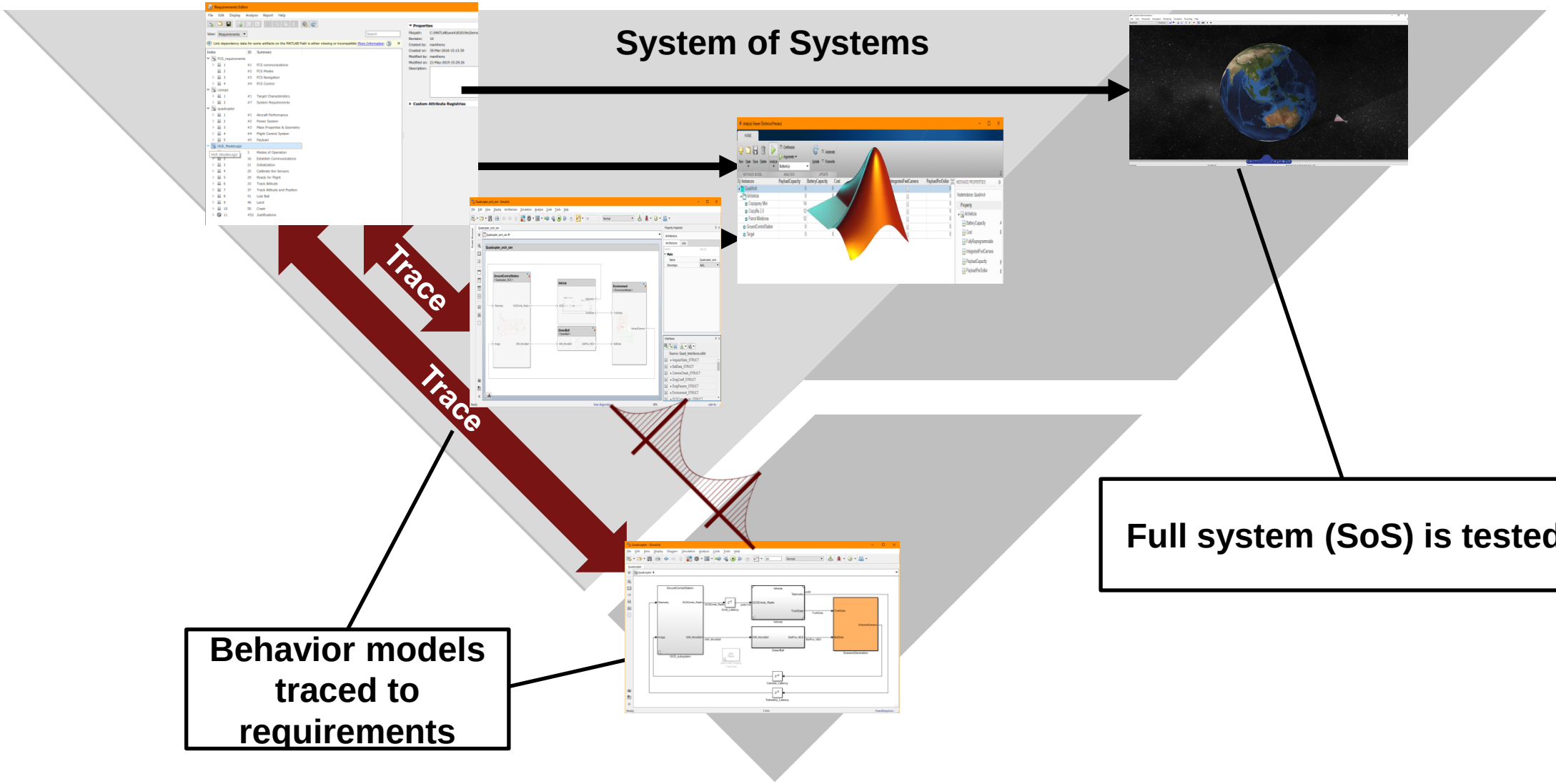

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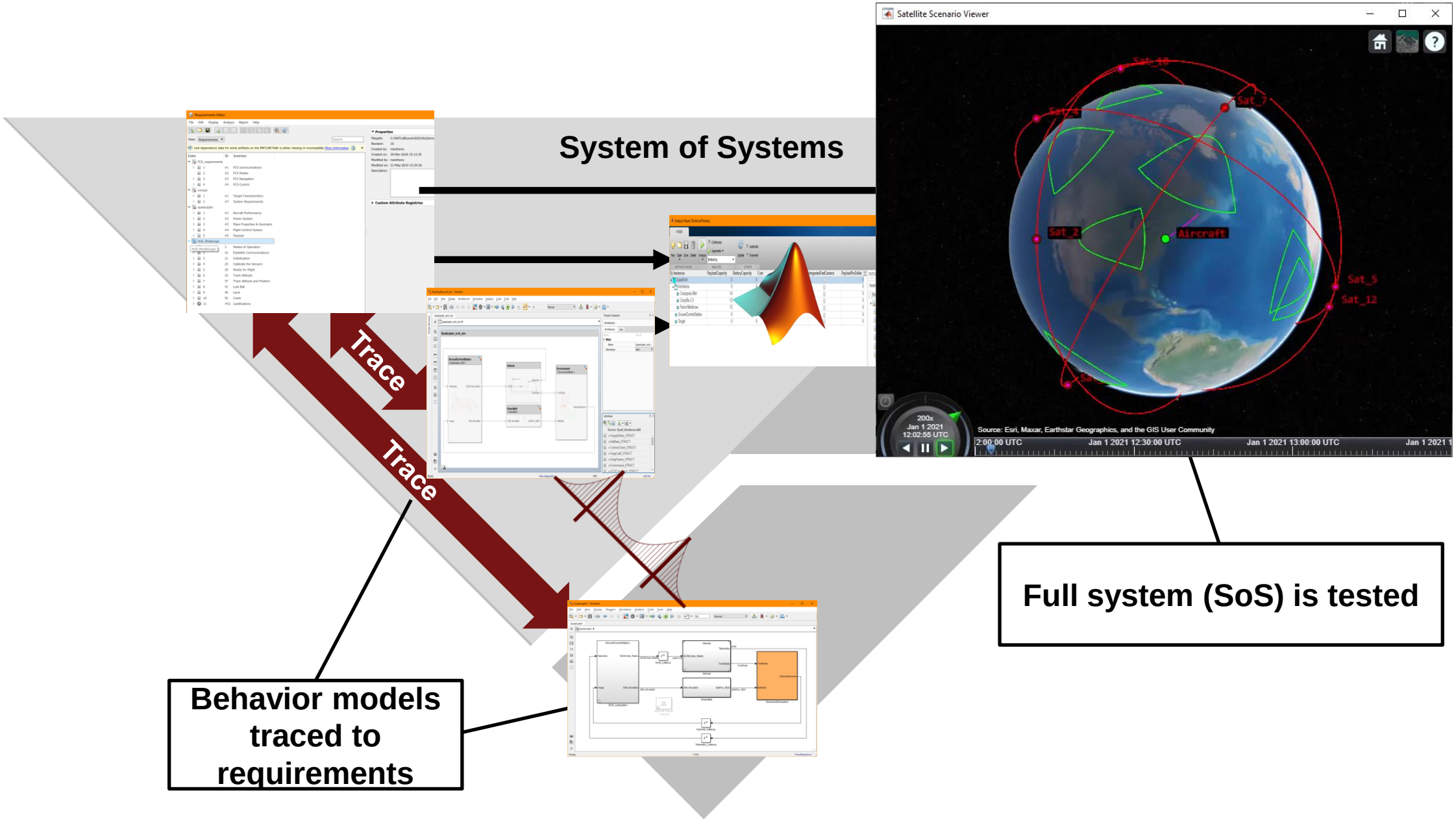
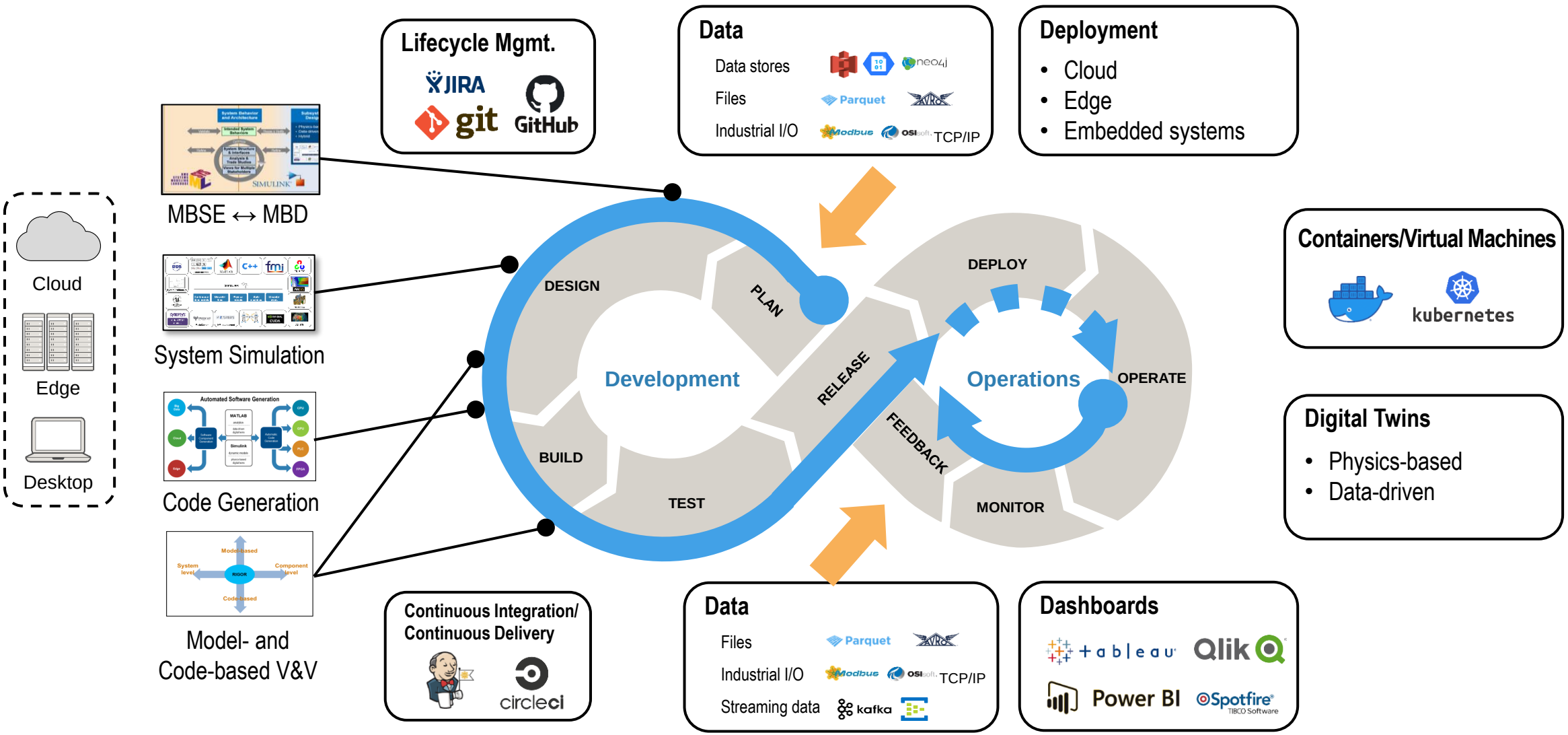


How can we start System Validation?

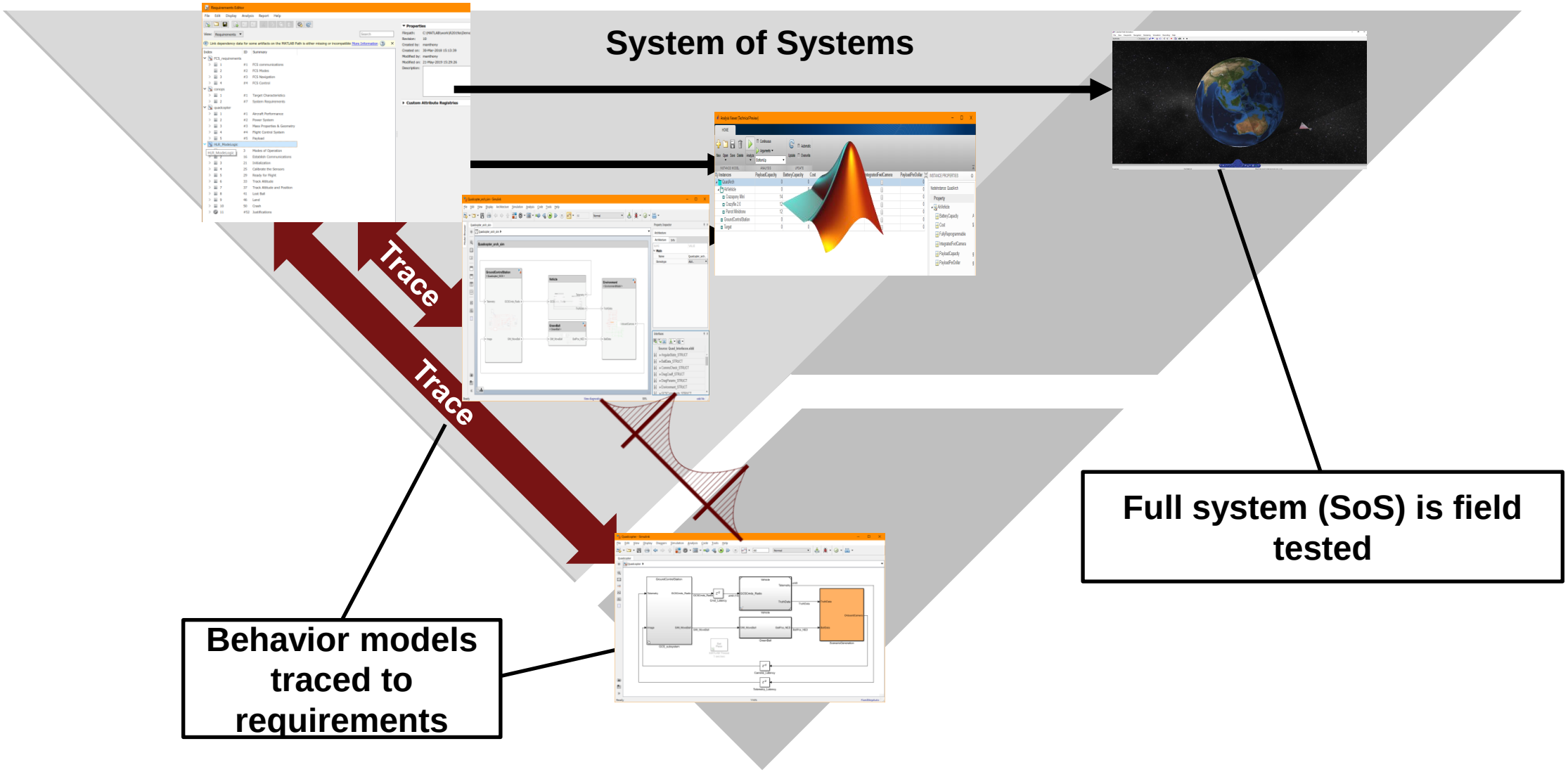
Key Takeaways

- MATLAB and Simulink products for Model Based System Engineering (MBSE)…
  - enable intuitive, scalable and adaptive modeling of architecture models
  - utilize the architectures to conduct trade studies early in the design cycle
  - provide a digital thread from architecture to behavior models

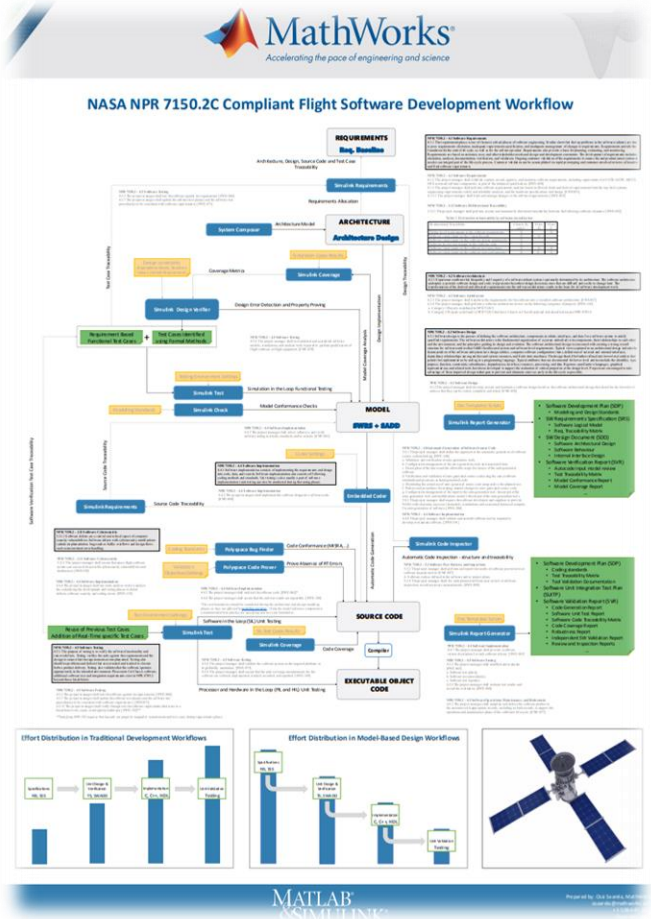
Software and Systems Integrated Workflow



Summary


System of Systems
Trace
Trace
Behavior models traced to requirements
Full system (SoS) is field tested

Interested in applying MathWorks tools to NPR 7150.2C…



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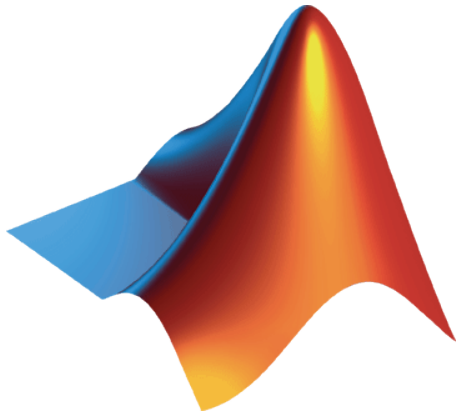

Questions?

Andrew Grabowski
Application Engineer
agrabows@mathworks.com

MathWorks Support Mechanisms: Collaboration Ensures Success

Technical Support

- Product questions
- General support
- 508-647-7000

Application Engineering

- Product/Capability demonstrations
- Lunch-&-Learns, Workshops, WebEx's, etc.
- Evaluation support

Pilot Engineering

- Complimentary, guided support for adoption of new tools/processes
- Deep engagement evaluations/ demonstrations

Training

- Paid training on specific tools and/or processes
- On-site, web-based instructor lead, & self-paced online

Consulting

- Paid engagements (custom targets, tool customization, advisory services)