MBSE Avionics System Capstone

MASC

Final Demo

Shawn
B.S. Electrical Engineering, Aerospace Systems

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B.S. Software Engineering

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B.S. Software Engineering

Walter
B.S. Computer Science, Cybersecurity

MASC Project

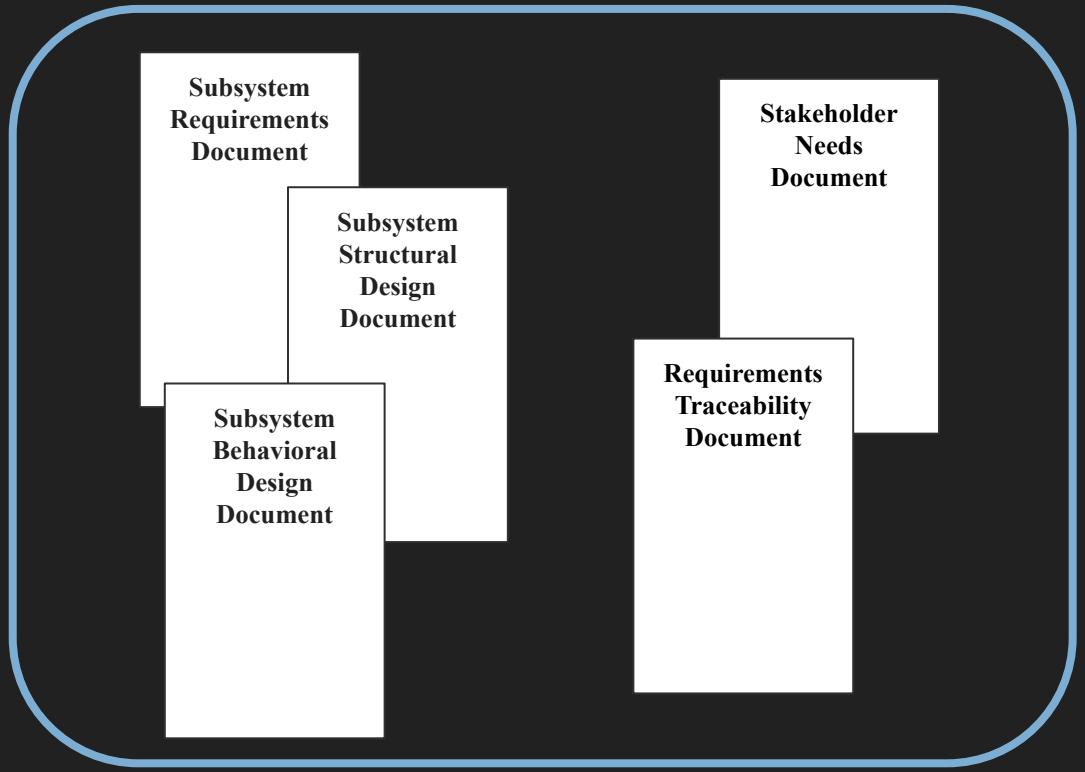
- Project derived from NASA Johnson Space Center's Spacecraft Software Branch (ER6) studying the Gateway Cislunar Space Station

- Needed to study the application of MBSE to capturing Avionics subsystem design information flow for Gateway

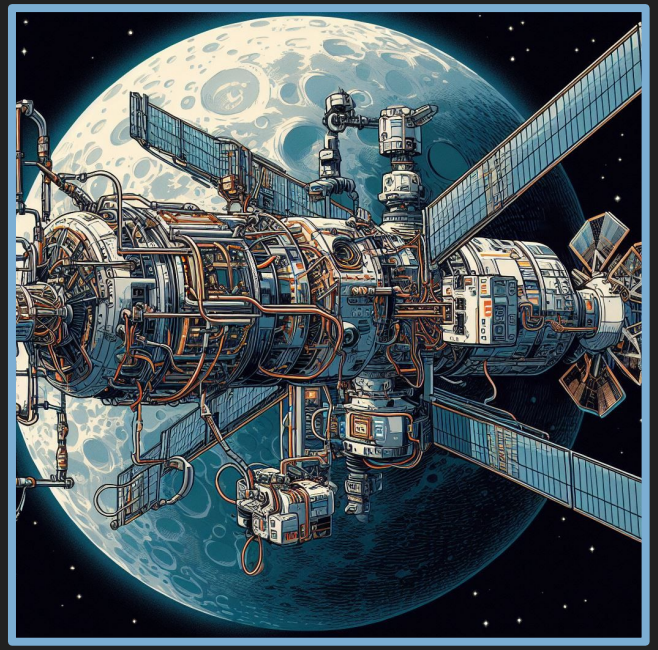
- NASA also wanted to use the system model to perform Failure Mode Effects Analysis (FMEA) on the system design

Gateway Cislunar Space Station

MASC Background, Traditional Systems Engineering

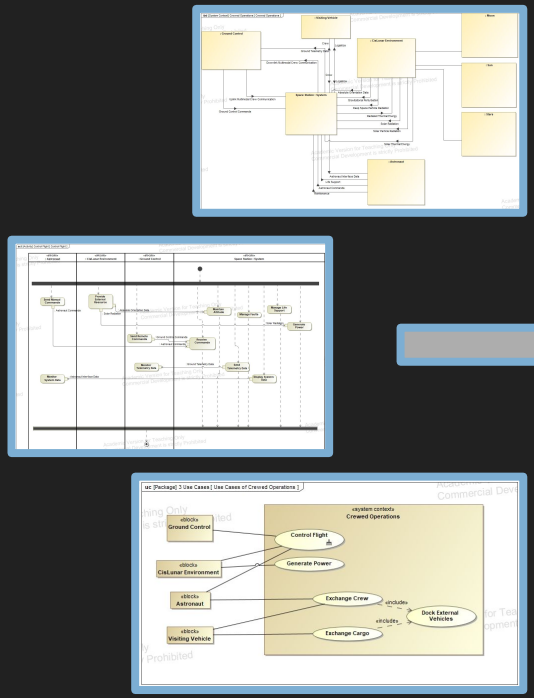


Traditional Systems Engineering uses a document based strategy to define the system

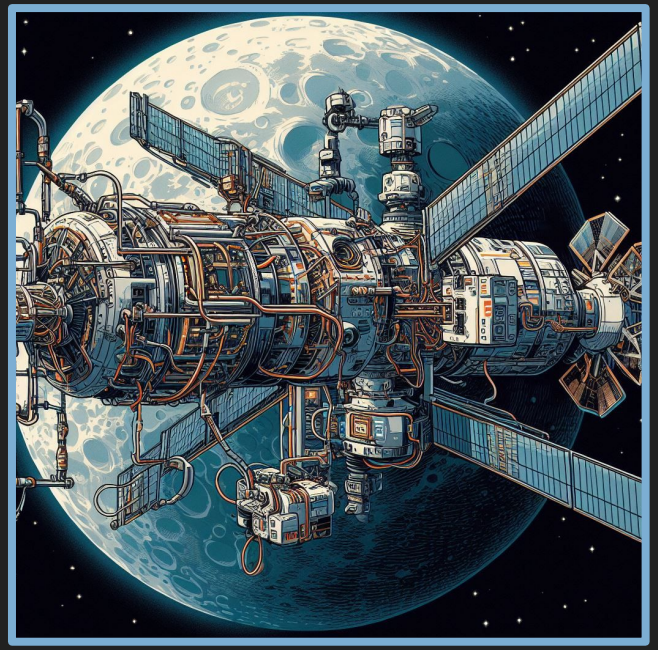


System of Interest
(*Spacecraft Avionics System*)

MASC Background, MBSE



System Model



Model-Based Systems Engineering (MBSE) uses various viewpoints to define a system with a dynamic model

System of Interest
(*Spacecraft Avionics System)*

MASC Customer Needs

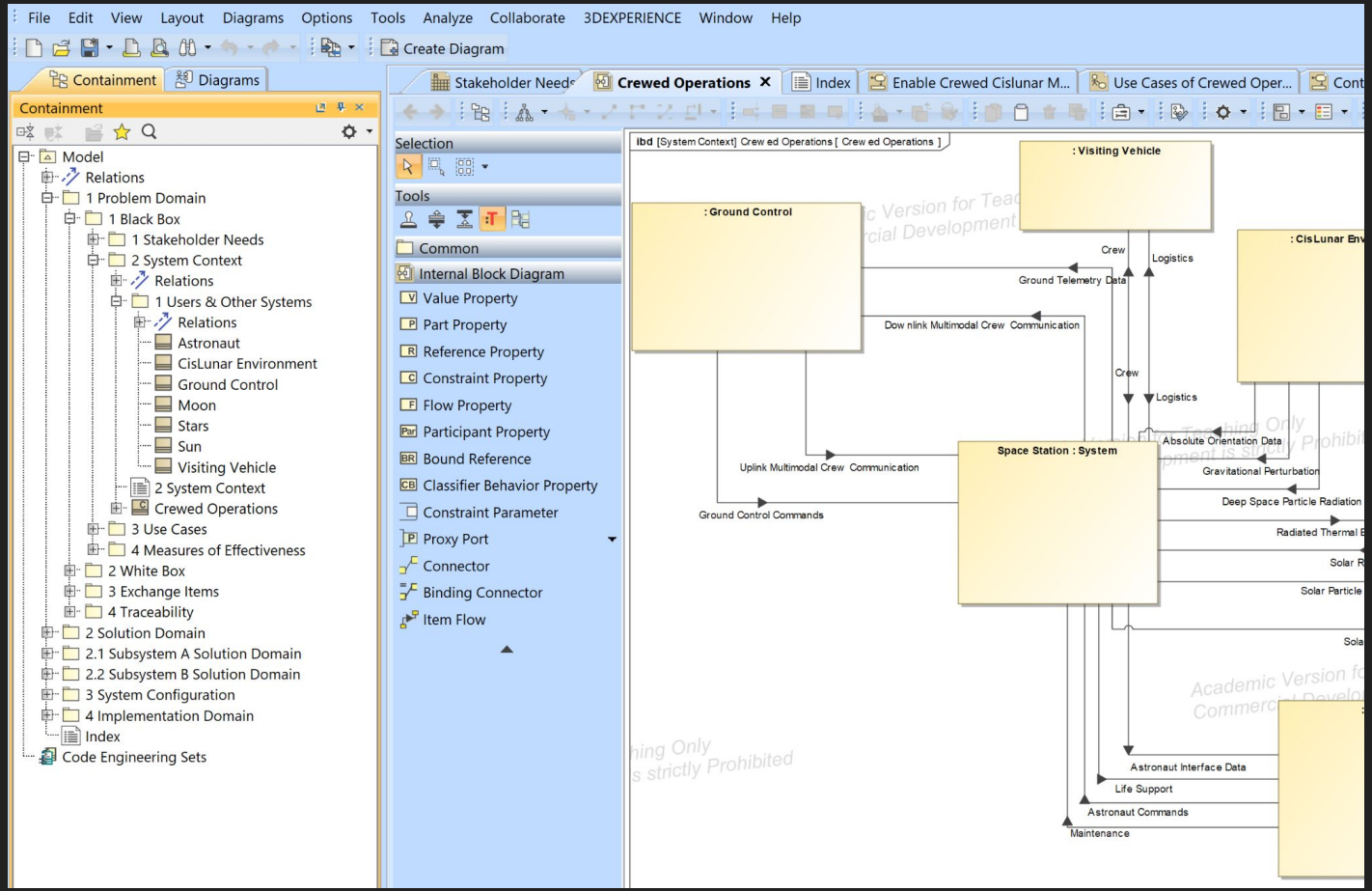
- To satisfy the customer needs, MBSE tools, process, and frameworks were researched

- Worked with ERAU Alum and MBSE Subject Matter Expert to identify
  - Dassault Systemes, Magic System of Systems Architect™ Tool
  - Dassault Systems, MagicGrid™ Framework
  - Object Management Group, System Modelling Language (SysML™)

- The MagicGrid™ Framework provided deliverables to guide model development and measure progress

- After this was determined, licensing was the final step to begin work

The MagicDraw Tool



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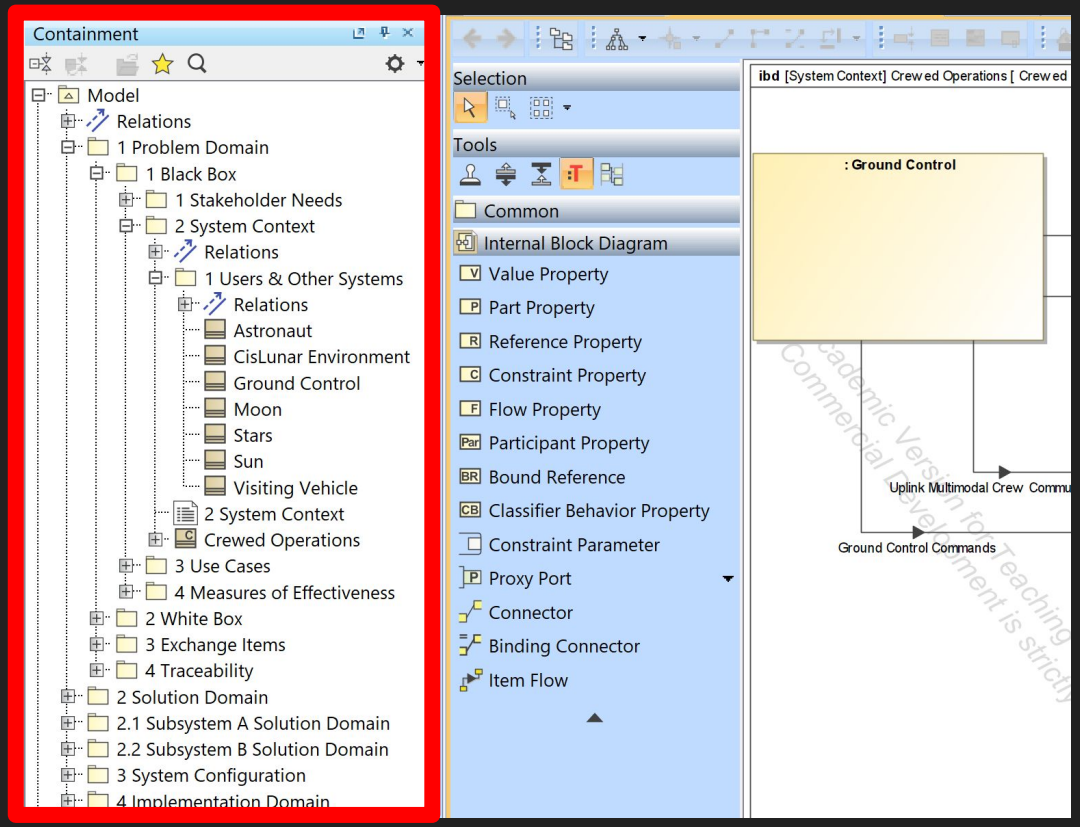

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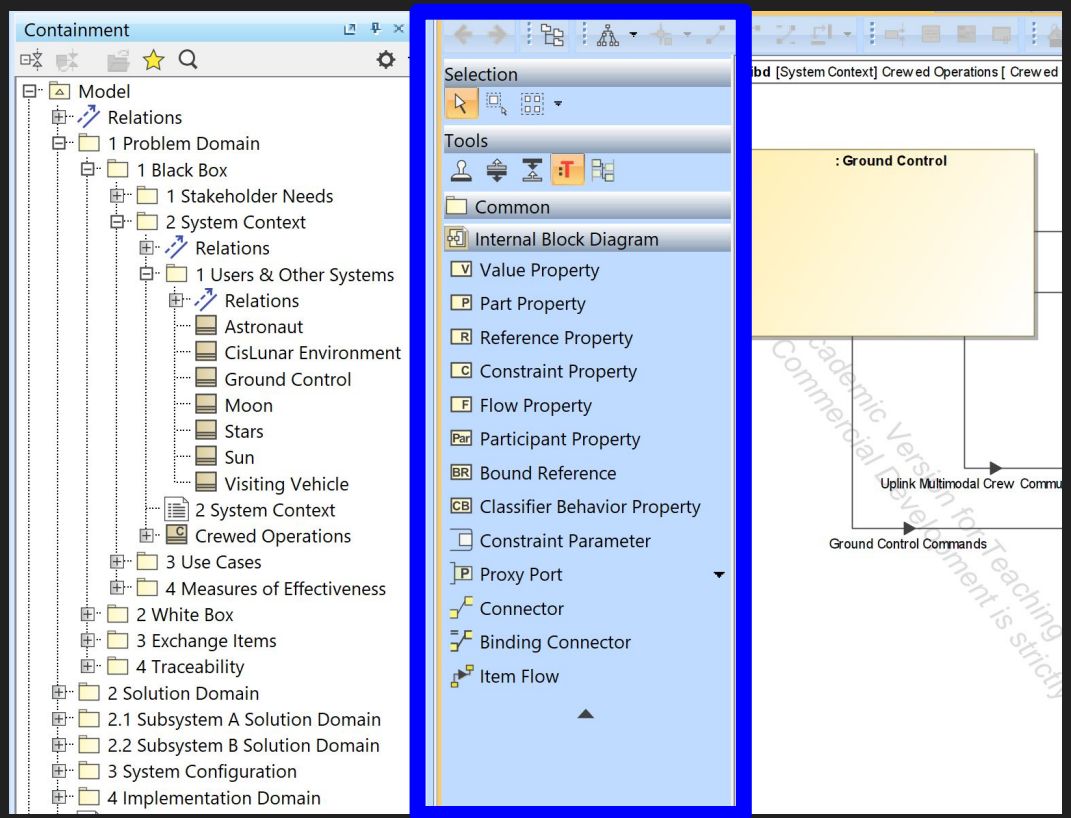

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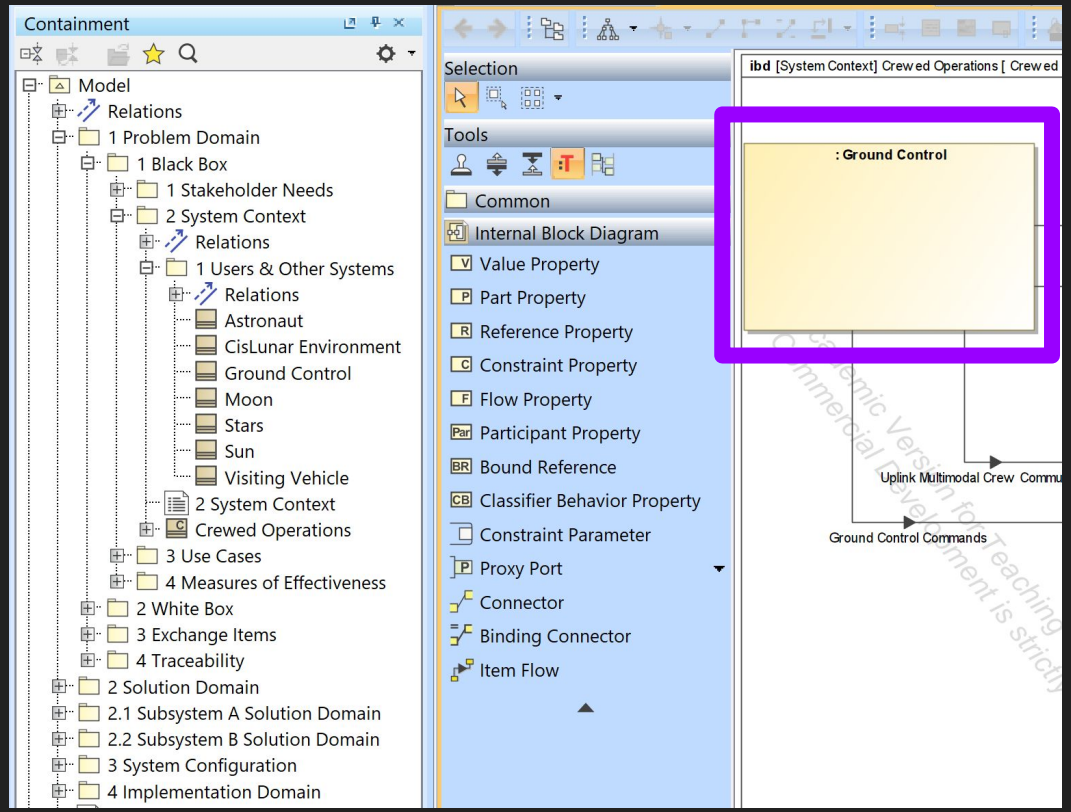

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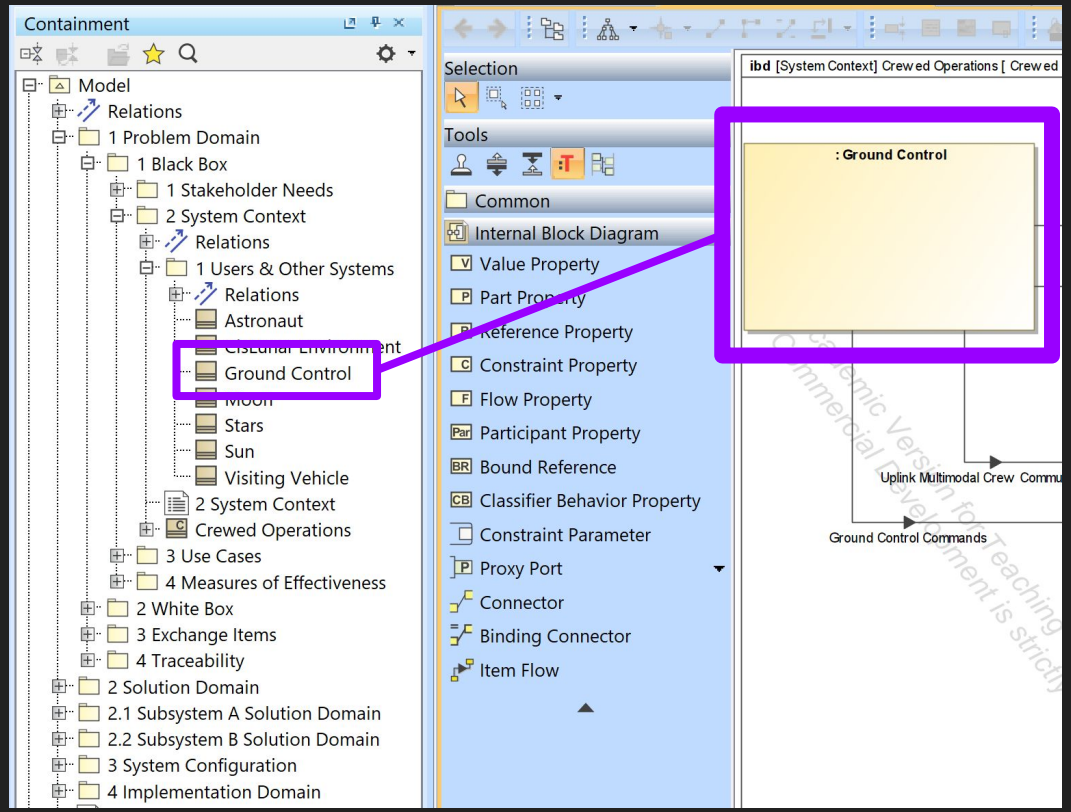
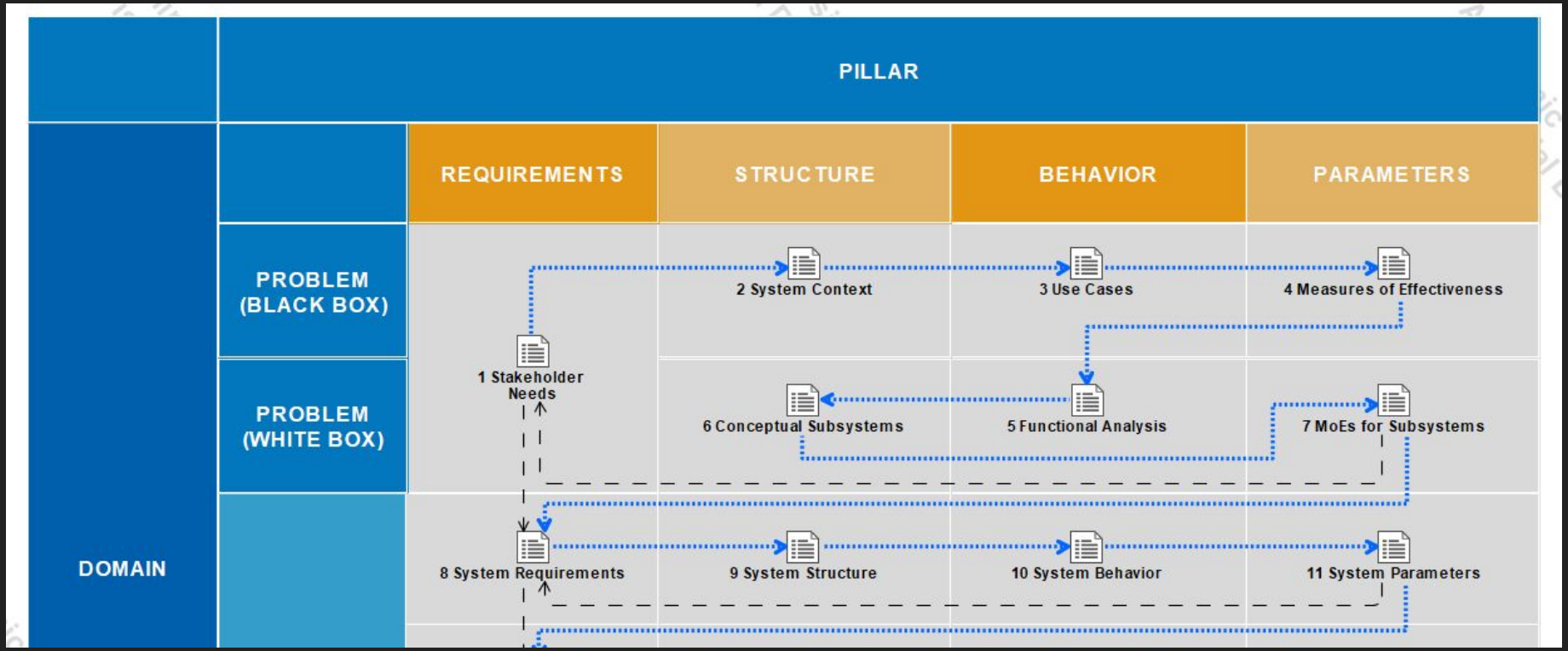


The MagicGrid Framework



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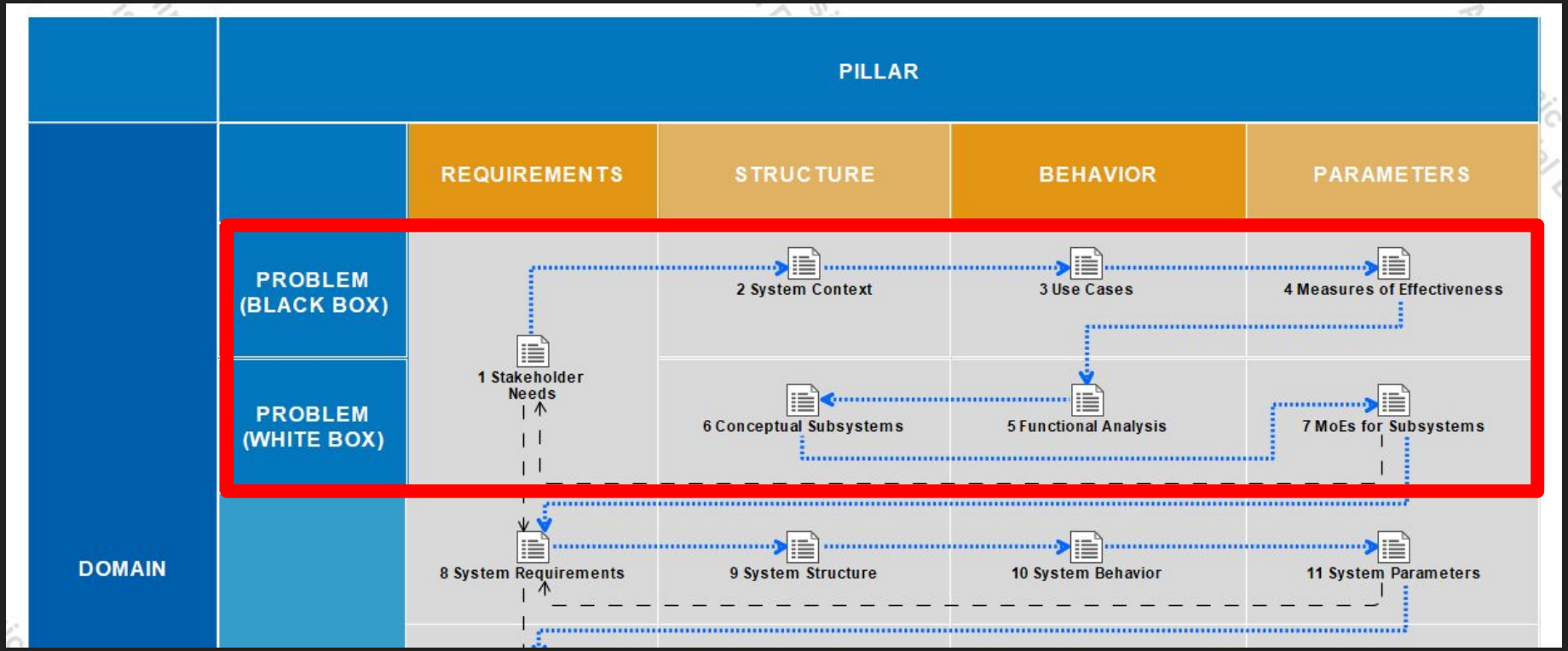

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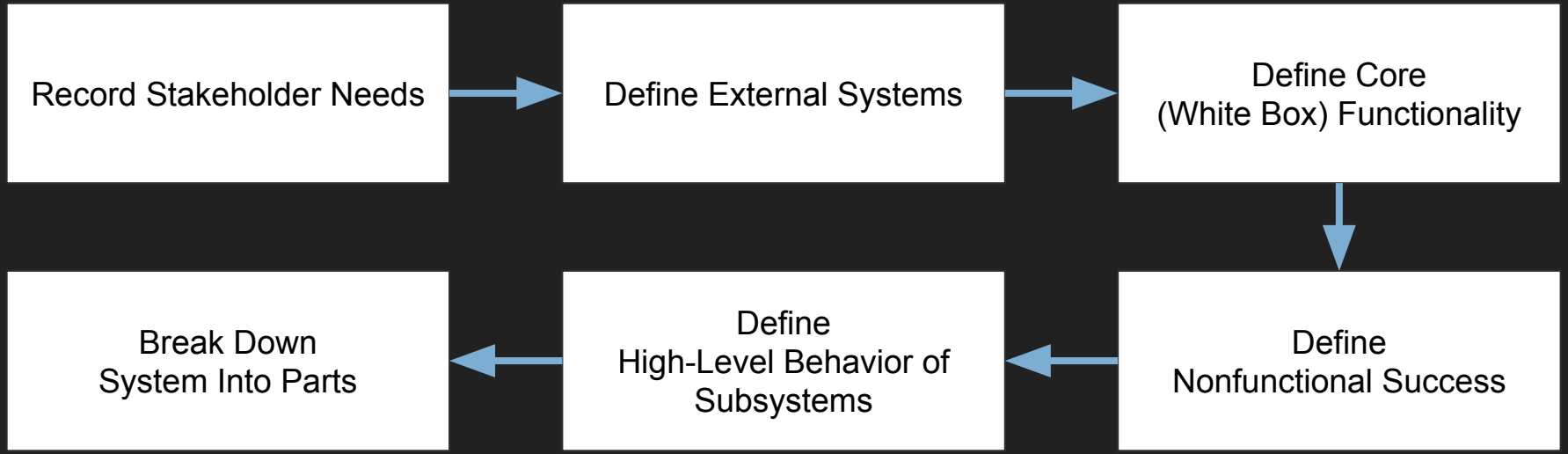

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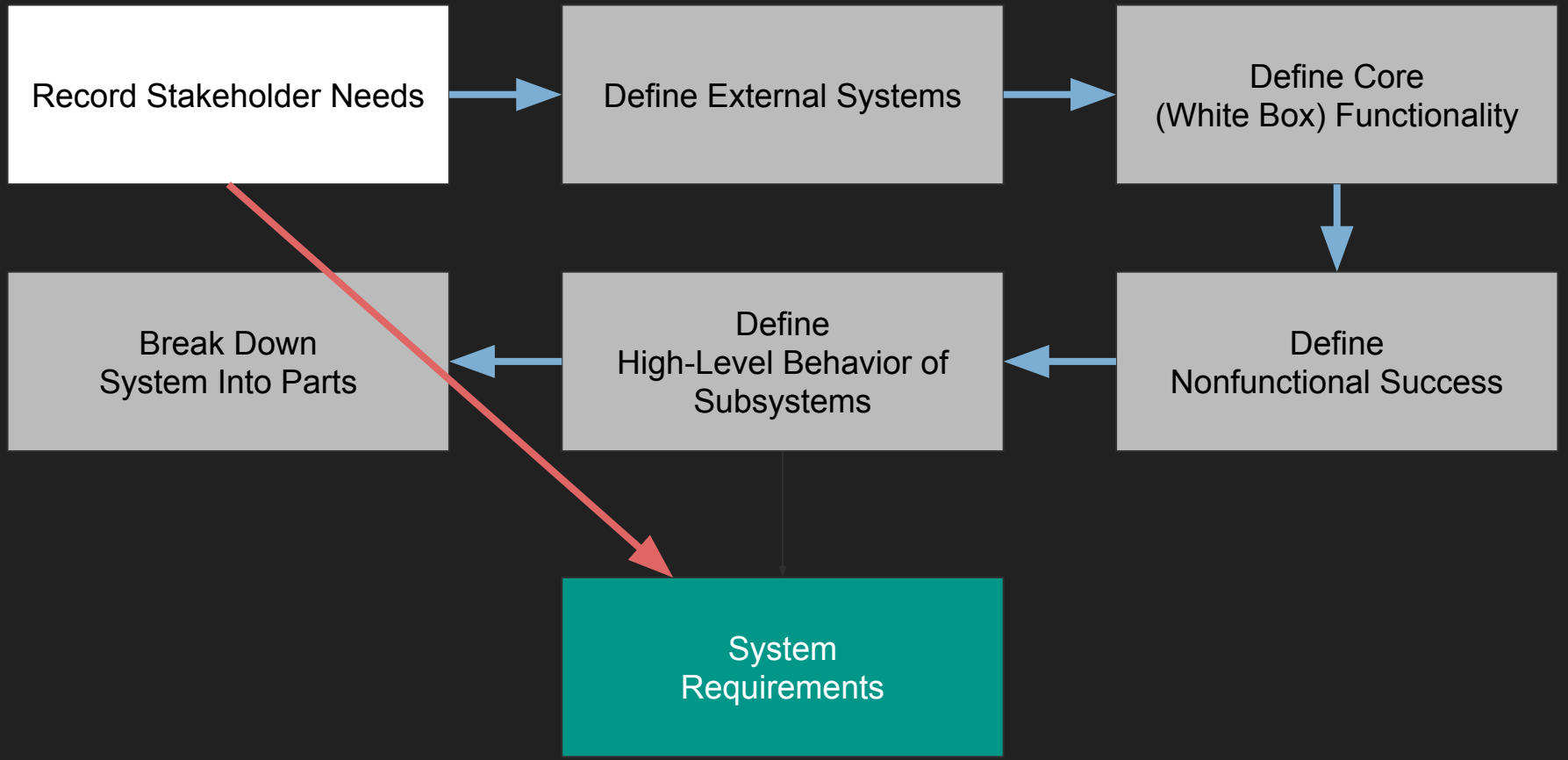

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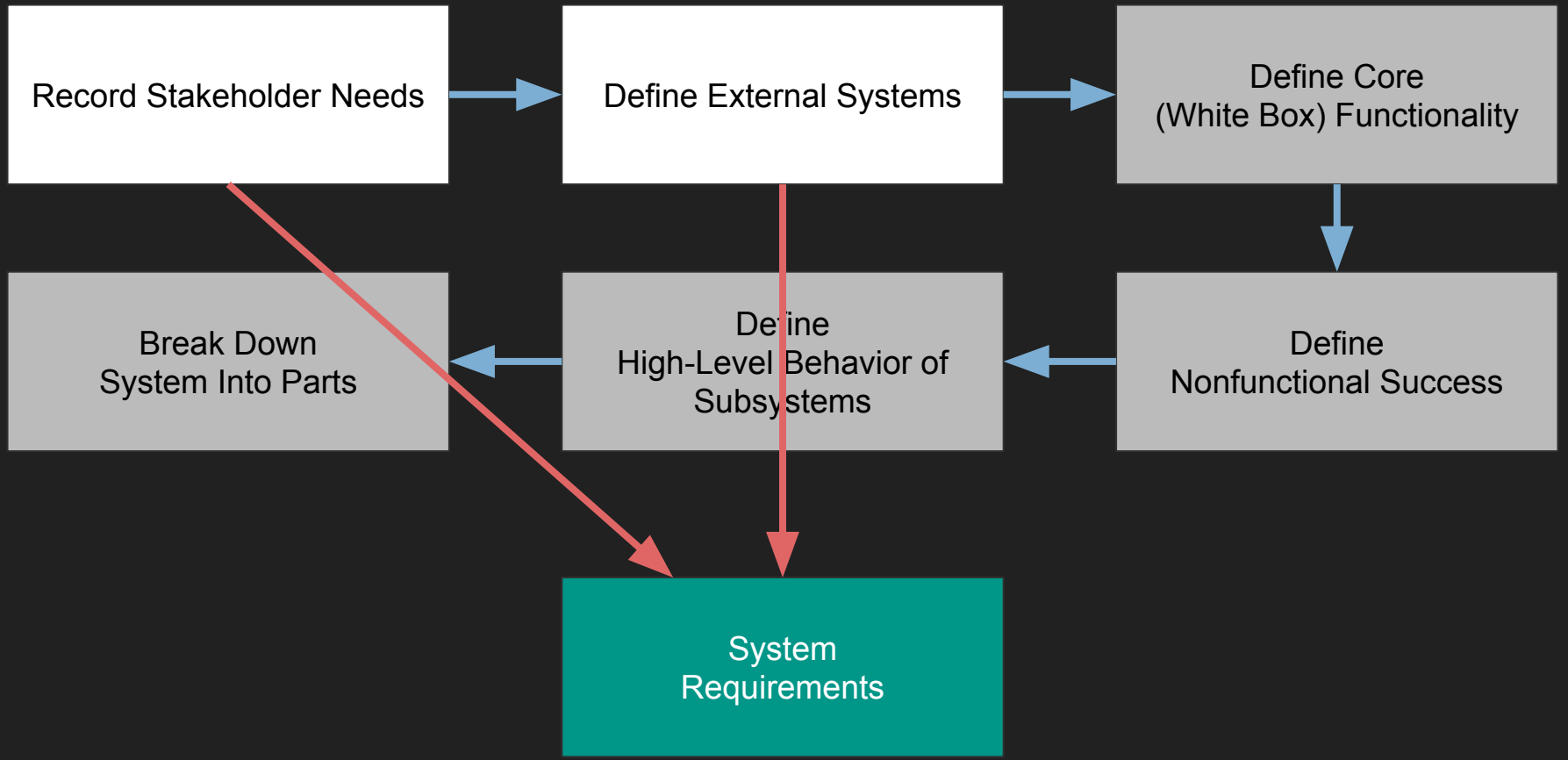

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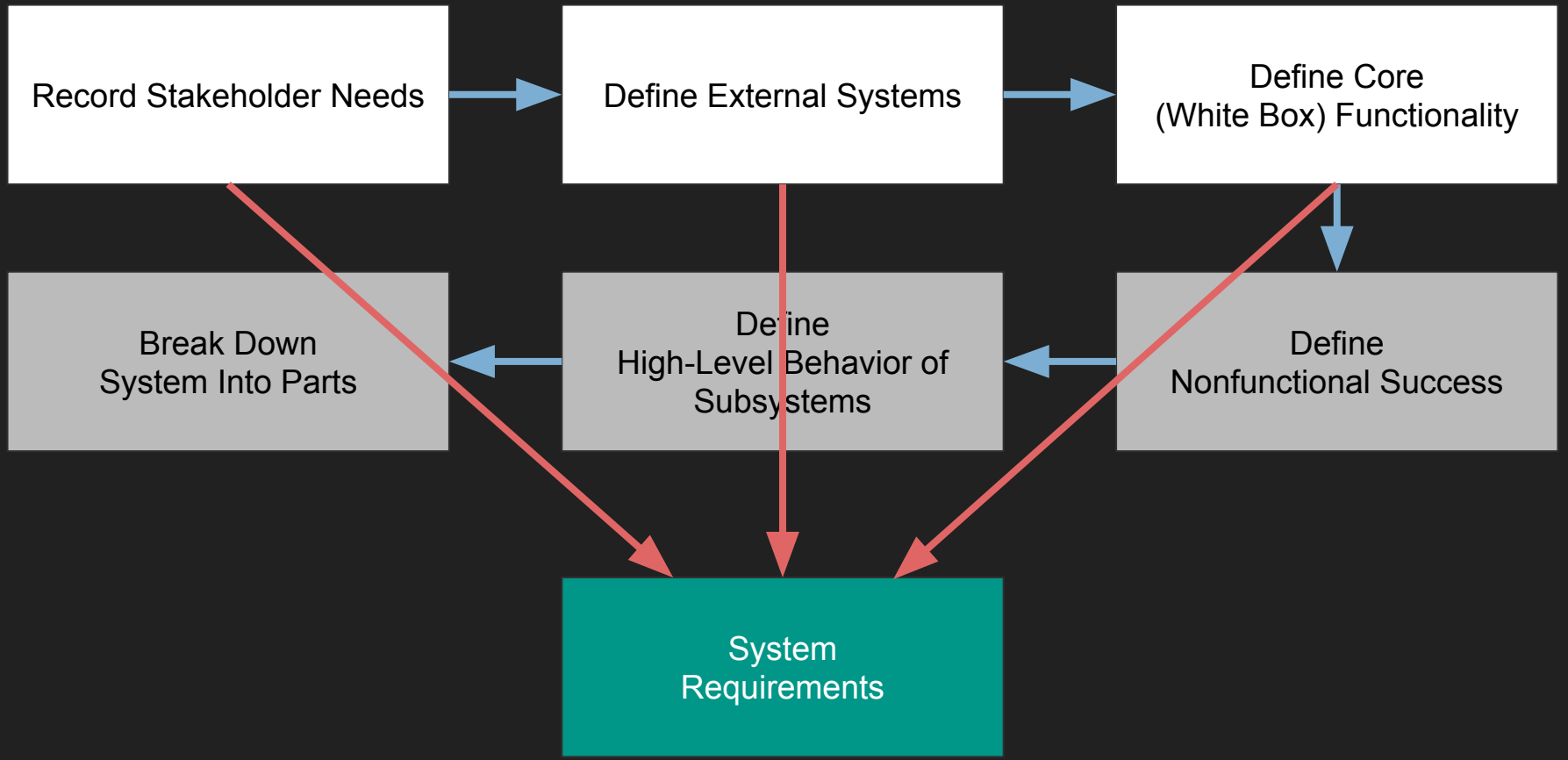
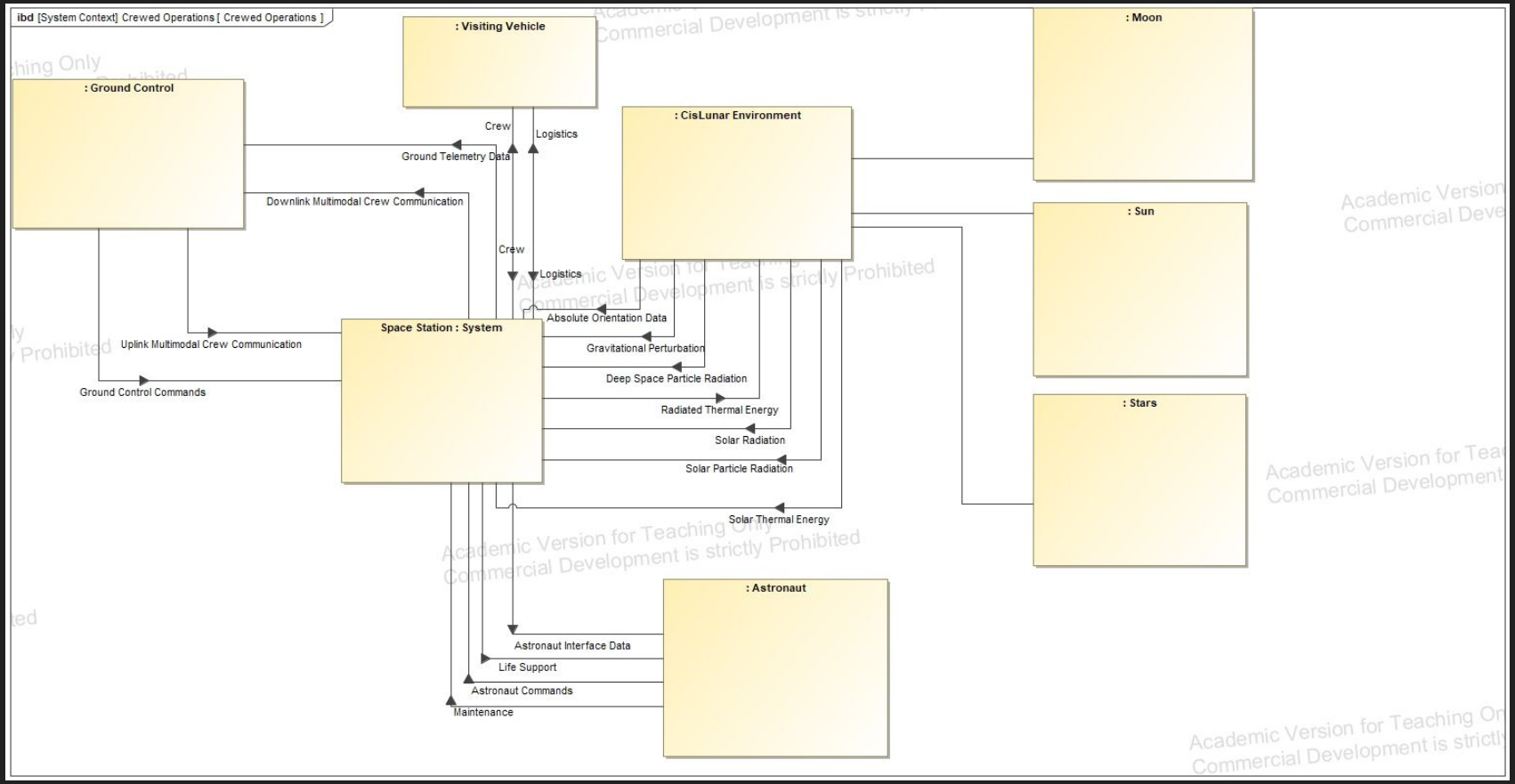


Our Project Demonstration

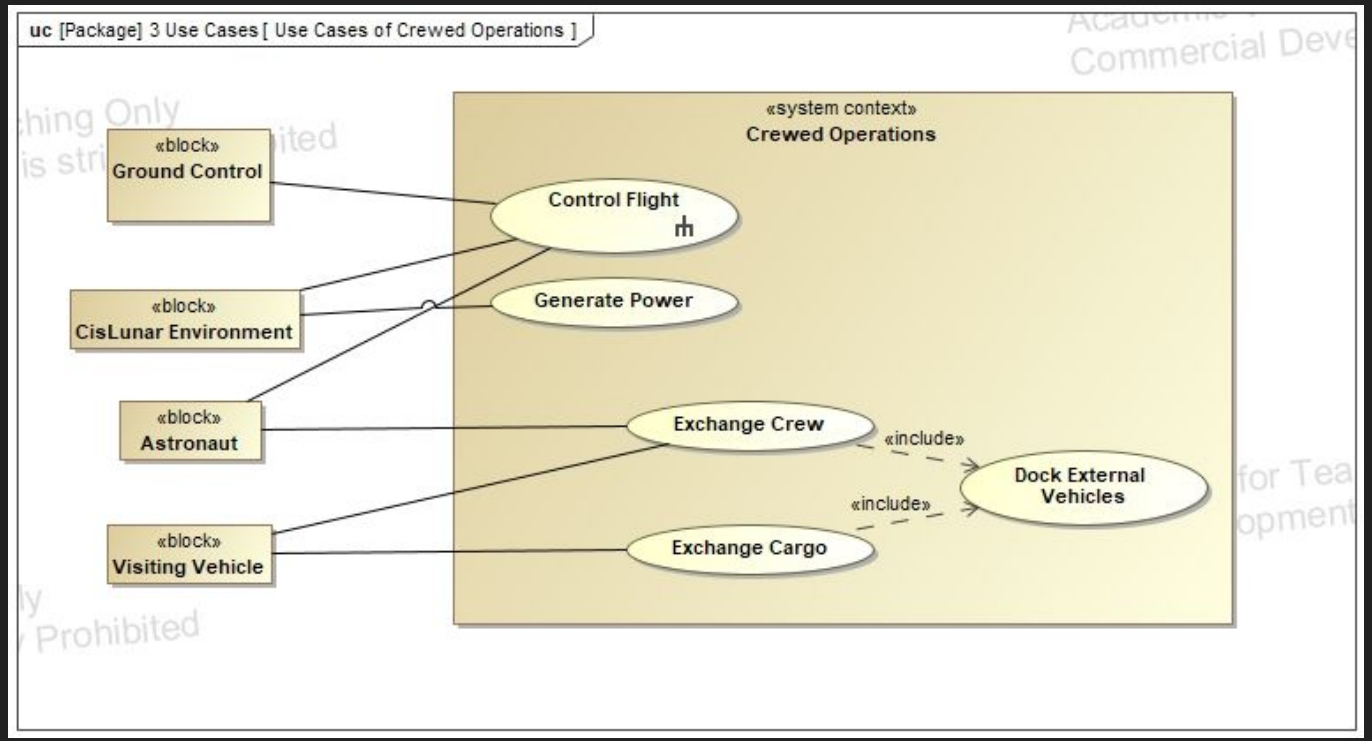
The CCS System (Needs)

#	Name	Text	Documentation
1	SN-1 User Needs		
2	SN-1.1 Cislunar Crewed Mission	The Sol should facilitate human crewed missions to cislunar space including capabilities that enable surface missions.	Add sources in this field
3	SN-1.2 Exploration Science Mission	The Sol should provide capabilities to meet scientific requirements for lunar discovery and exploration.	Add sources in this field
4	SN-1.3 Forward Compatablility	The Sol should enable, demonstrate, and prove technologies that are enabling for deep space missions.	Add sources in this field
5	SN-1.4 Manual Flight Control	The Sol should allow for manual control of flight dynamics.	Add sources in this field
6	SN-1.5 Automatic Flight Control	The Sol should be able to maintain its orbit.	Add sources in this field
7	SN-1.6 Independent Power	The Sol should produce, store, and regulate its own power.	Add sources in this field
8	SN-1.7 Crew Safety	The Sol should keep the crew alive and safe.	Add sources in this field
9	SN-1.8 Crew Mission Extensability	The Sol should accomodate extended crew mission durations.	Add sources in this field
10	SN-1.9 Extra-Vehicular Activity	The Sol should allow crew to perform extra-vehicular activity.	Add sources in this field
11	SN-1.10 Visiting Vehicle Docking	The Sol should allow for Visiting Vehicles to dock.	Add sources in this field
12	SN-1.11 Vehicular Logistical Tranfer	The Sol should accept the transferring of crew and cargo.	Add sources in this field
13	SN-1.12 Lunar Surface Communication	The Sol should provide communication to the Lunar surface.	Add sources in this field
14	SN-2 Design Constraints		
15	SN-2.1 User Interoprability	The Sol should have to ability to support multiple self, commerical, and international partner objectives.	Add sources in this field
16	SN-2.2 Crew Size	The Sol should accomodate up to 4 crew members.	Add sources in this field
17	SN-2.3 Mission Duration	The Sol should enable 30 to 90 days of crew missions.	Add sources in this field
18	SN-2.4 Orbtal Access	The Sol should be easy to access from Earth with current launch vehicles.	Add sources in this field
19	SN-2.5 Earth Communication	The Sol should have continuous communication with Earth.	Add sources in this field

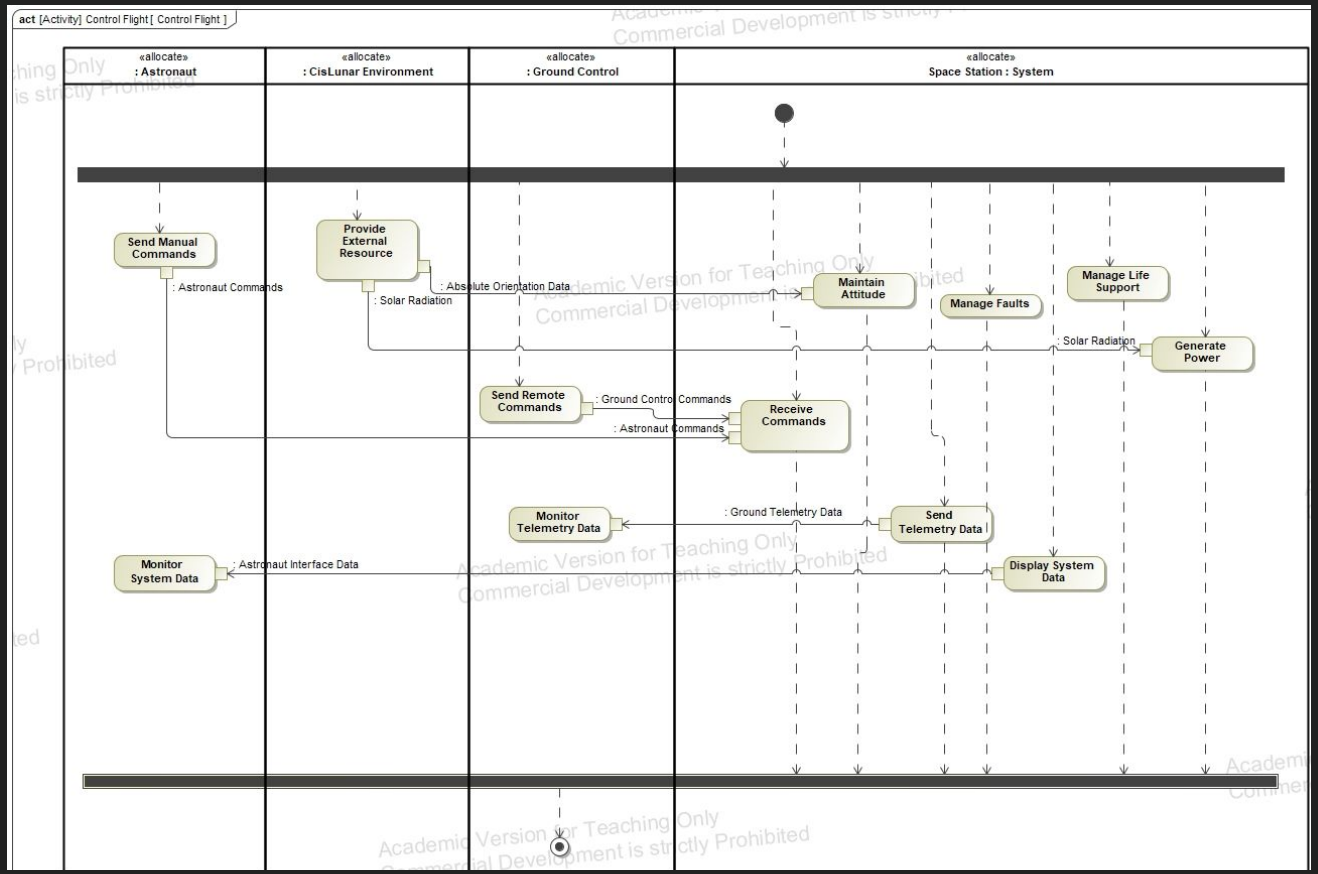
The CCS System (Context)



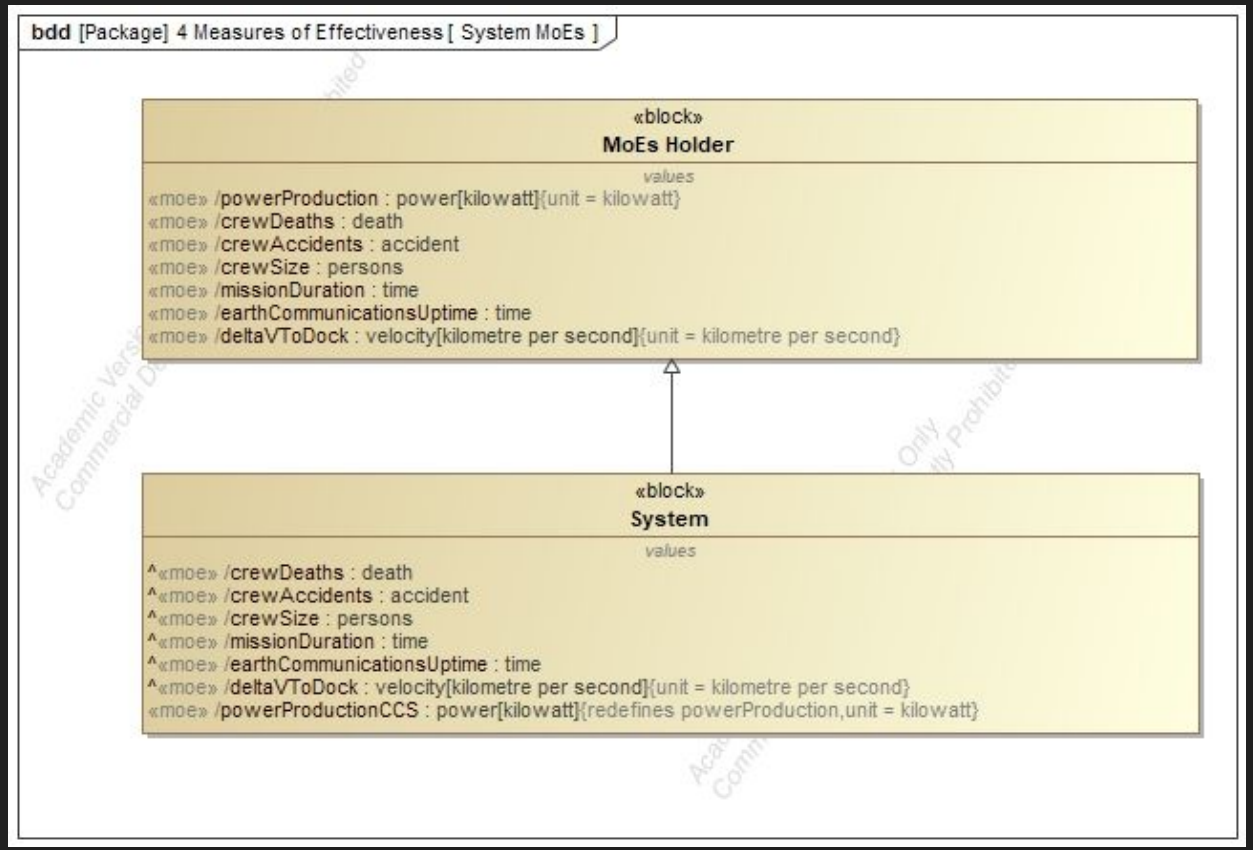
The CCS System (Use Case)



The CCS System (Scenario)



The CCS System (Measures of Effectiveness)



Lessons Learned

- New way to approach large scale design challenges
- Importance of constant iteration & feedback during each phase
- Black-Box analysis of a new domain is more difficult than initially anticipated
- Methods of scoping down our design to singular subsystem

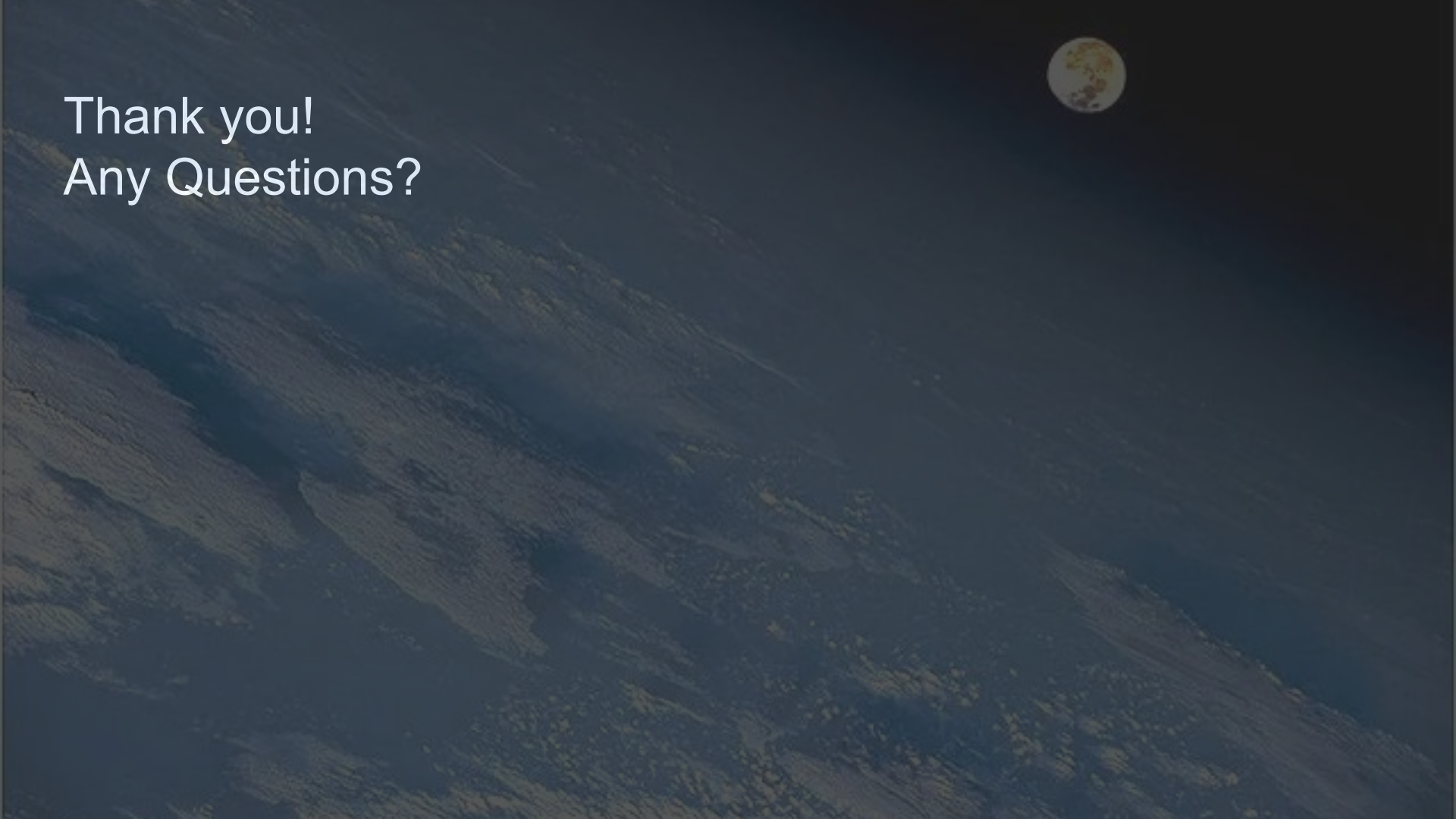
Our Experience

- Tool allows for cascading iterations (allows for testing)
- Different model views allowed for greater overall understanding of SOI
- Very easy requirements tracing

- New tool, little documentation
- High learning curve (not beginner friendly)
- Made async work difficult (no version control options)
- Small errors can require massive reworks
- Changing UML mindset to SysML

Future Work

- Begin working on Solution domain
- Fault Tree Analysis
- Possibly write paper?


Thank you!
Any Questions?