System Requirements Specification

for

MBSE Avionics System Capstone

Version 0.5.3

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Revision History

Name	Date	Reason For Changes	Version
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William P	9/26/23	Initialize Document; Section 1.2,1.3,1.5	0.1.0
Luke N	9/26/23	Section 2.2, 2.4	0.1.1
Shawn M	9/29/23	Section 1, 2, 3, 4, 5, 6, Appendix A	0.1.2
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Luke N	10/18/23	Section 4	0.1.5
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Walter H	2/3/24	Review changes	0.5.1
William P	2/4/24	Section 5	0.5.2
Shawn M	2/4/24	Changes to section 2	0.5.3

1. Introduction

1.1 Purpose

The product requirements presented in this document apply to the Model-Based System Engineering (MBSE) Avionics Senior Capstone (MASC) model. The requirements herein specified are applicable at the document's date, and are superseded by any following revisions. This SRS applies to the complete System of Interest (SOI) model and does not cover details of the SOI. The SOI covered by MASC is a generic exploration of a spacecraft's avionics system.

1.2 Document Conventions

Each section of our document follows a numbering system with the left-most number denoting the document section, the second number denoting the chapter within the section, and the third number notating specific and distinct labels within a chapter.

1.3 Intended Audience and Reading Suggestions

This document is intended to be read by developers, project managers, or educators who are new or familiar to the MBSE process The contents of this document provide a reference for the design and requirement specification process for a System of Systems (SoS) and generic spacecraft avionic systems or in the general modeling use case. Those who are looking for the full overview of our project as it pertains to the senior design capstone class will want to read sections 1 and 2 before viewing the rest of the document. Alternatively, readers who are solely interested in seeing the application of MBSE onto the developed system may only read sections 4 and 5.

1.4 Product Scope

The MASC product will include an evaluation of system modeling using the MagicGrid framework to capture the problem domain for a notional Crewed Cislunar Station (CCS), and the solution domain modeling for the avionics system. The purpose of this model is to evaluate the system behavior and determine the ability to identify failure modes to expand Failure Mode Effect Analysis capability. This product would improve understanding of failure mode identification in the system design process, with the objective of demonstrating the solution agnostic to the SOI, and demonstrating a path forward for this capability. Using a system model in this way highly aligns with industry needs and can apply to failure analysis in any complicated system. For more information, please refer to the Product Vision Statement.

1.5 References

No current references, but more will be added following integration of the literature review.

2. Overall Description

2.1 Product Perspective

The product specified in this document is the complete process followed to create a new, self-contained model of the CCS created with the Magic System of Systems tool by Dassault. This model captures the interaction of multiple external systems in relation to the spacecraft avionics system. The model of the avionics system will be defined in relation to the other subsystems of the CCS, and is meant to be developed as an evaluation of the MagicGrid process. The diagram below captures the CCS system context. This diagram exemplifies the product itself because it was generated as part of the MagicGrid process to model the system.

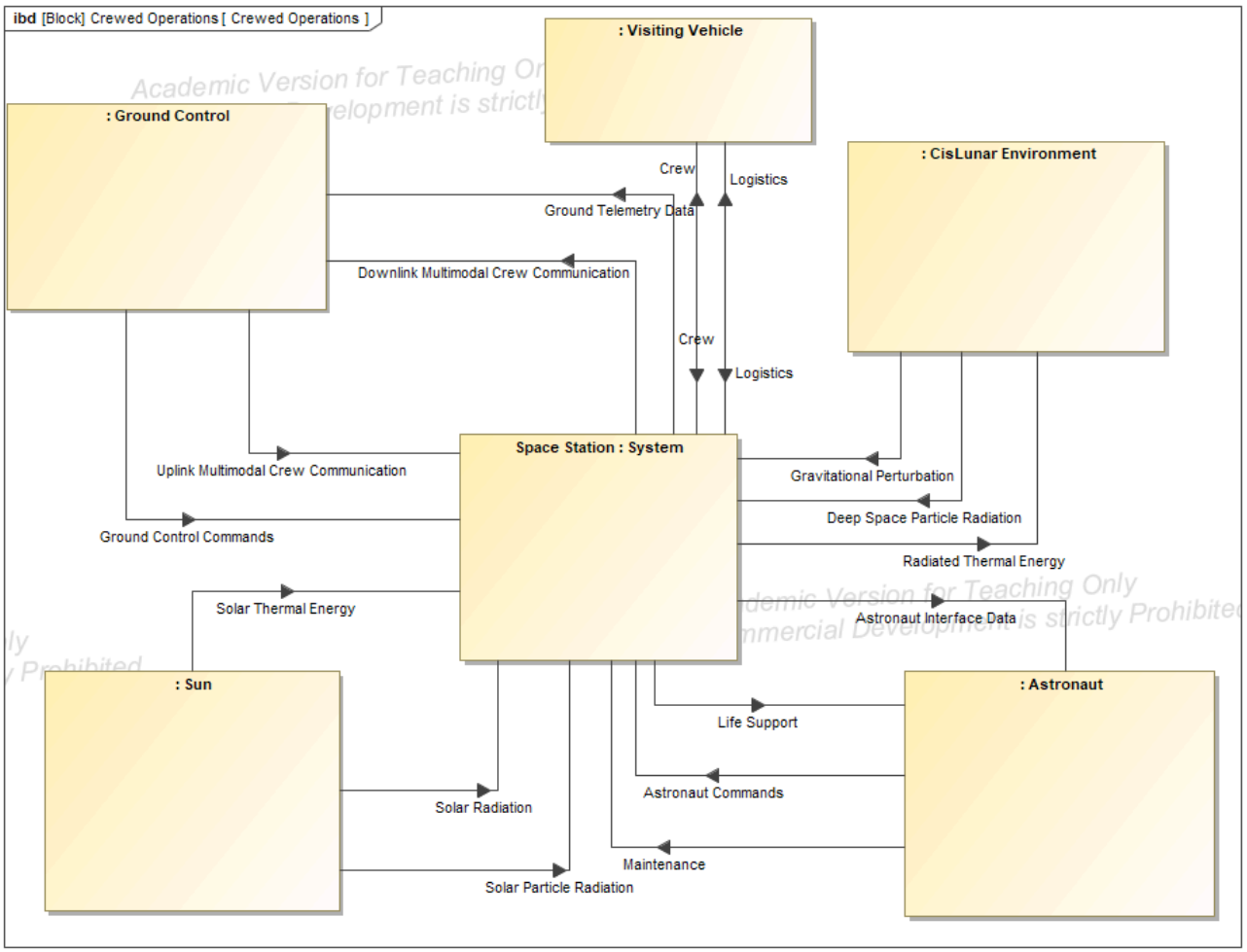

Figure 1: CCS System Context Model

2.2 Product Functions

- Functions of the methodology:
  - Follow the Zachman style matrix as defined within the MagicGrid framework.
  - Allow for failure modes effect analysis to be performed on a base model.

- Functions of our created system:
    - Function as a minimal model of a spacecraft avionics system within the context of a CCS.
    - Deliver upon both a ‘problem’ and ‘solution’ in regards to the given domain.
    - Be generic enough to provide value to any specified CCS to be modeled within the tool.

2.3 User Classes and Characteristics

Product Owner
The product owner receives the completed model and guides the implementation of the model and requirements for the SOI. The product owner will demonstrate the technical expertise on the SOI and satisfy input data requirements for the engineering team.

Responsible Engineer
The responsible engineer owns the accuracy of the model and its implementation. The responsible engineer assumes ownership of the highest level model requirements and makes decisions on the best implementation practices for the model product.

System Engineers
The system engineers are responsible for building the model to satisfy the requirements outlined in this document. Furthermore, the system engineers are responsible for using the model of the SOI to generate data for other stakeholders.

Discipline Engineers
The discipline engineers are at the boundary of the product’s functionality, and provide input and requirements for the accuracy of the data and the sub-systems contained in its construction. Furthermore, the systems engineers use products generated by the model and will impose requirements for data aggregation.

2.4 Operating Environment

The environment in which the product will operate is within the Magic System of Systems Architect 2022x software. The software will be running on Windows 10 laptops which contain greater than or equal to 8 gigabytes of RAM, and have at least 50 gigabytes of free disk space available.

2.5 Design and Implementation Constraints

The largest constraint facing the product is the licensing for the model software. The Magic System of Systems Architect requires a license to interact with the model in a meaningful way. Furthermore, the spacecraft avionics system model will be generated on an academic license, and therefore will only be able to use open source information and cannot share the product with any commercial entity. Lastly, the product will likely only be forward compatible with future versions of the modeling software, and may not be supported by most teams that aren’t using the 2022x version.

2.6 User Documentation

Currently, there are no additional documentation components other than the System Design Document.

2.7 Assumptions and Dependencies

The accuracy of the system model is highly dependent on the design decisions made for the SOI. The results from this product model will vary based on the assumptions and decisions made in constructing a generic avionics system. Niche or solution specific dependencies will not be captured by this model. The model requirements will help construct a logical representation of the SOI and will be bound by the logical assumptions made. Lastly, the system design process is highly dependent on the MagicGrid framework, and the modeling requirements will use the processes applicable to the SOI.

3. External Interface Requirements

3.1 User Interfaces

The user shall only interface with the model through the Magic System of Systems tool and its software user interface.

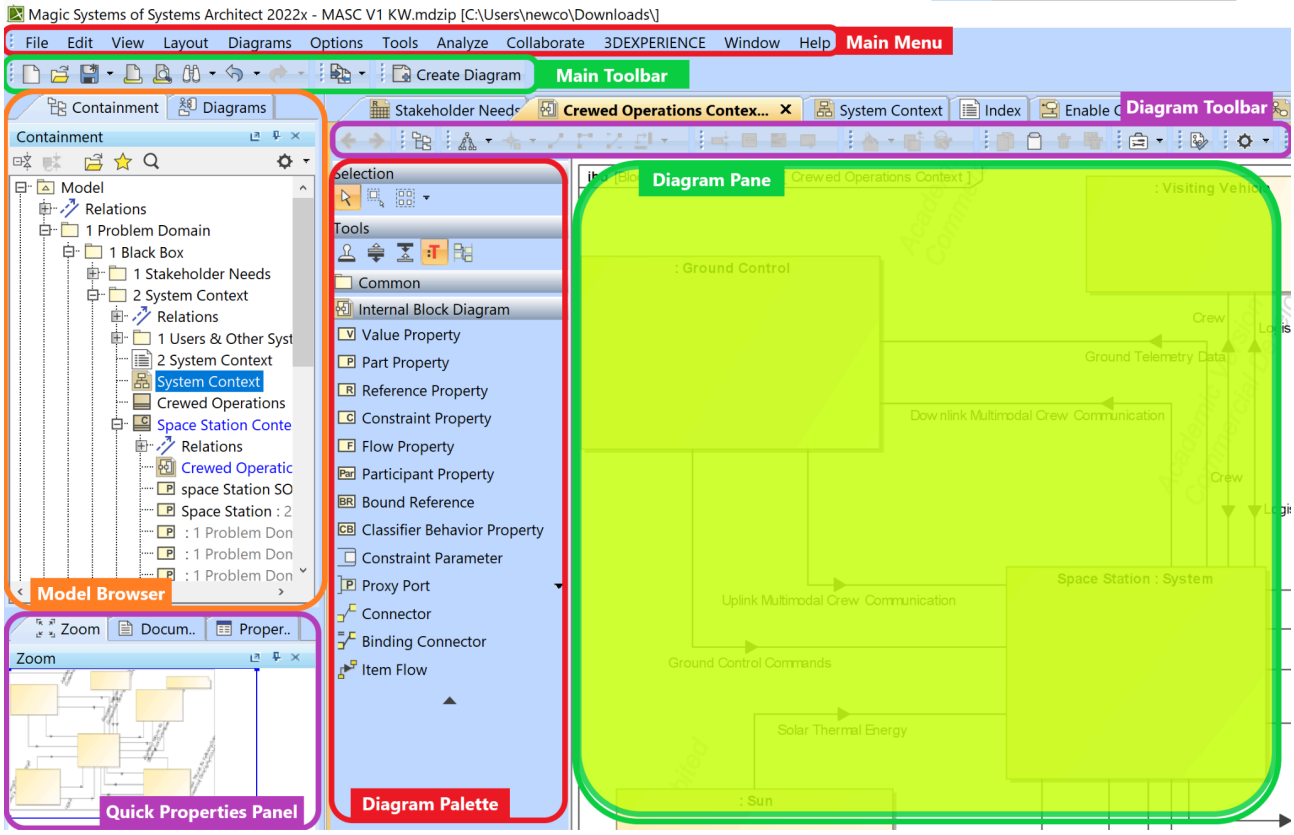

Figure 2: Magic System of Systems Architect User Interface

- **Main Menu:** The main menu located at the top of the modeling tool window and contains main functions for file management.
- **Main Toolbar:** Contains commands for basic project-related tasks and are located at the top of the modeling tool window, right under the main menu.

- **Diagram Toolbar:** Contains commands for working with diagram symbols and are located at the top of the diagram pane.
- **Model Browser:** Provides a visual representation of the hierarchy of your model elements.
- **Diagram Pane:** Provides display function of diagram or file being modified.
- **Diagram Palette:** Contains modeling elements applicable to the diagram or file being modified.
- **Quick Properties Panel:** Contains High Level overview of the diagram pane for navigation functions.

3.2 Hardware Interfaces

The product currently maintains no hardware interface requirements.

3.3 Software Interfaces

This product uses the 2022x Magic Model Analyst Plugin from Dassault Systems Inc.

3.4 Communications Interfaces

The product currently maintains no communication interface requirements.

4. Product Features

Our product is the evaluation of the effectiveness of the MagicGrid framework process as applied to the modeling of our SoI. The SoI model is a byproduct of the process which we are following. The following requirements define our process and measure the adherence to the MagicGrid framework and the effectiveness at capturing the CCS mission requirements.

4.1 Model Mission Alignment

4.1.1 Description and Priority

The system model reflects the mission of a notional CCS and describes the related context. This is a high priority.

4.1.2 Stimulus/Response Sequences

The model will be invoked through manipulation and query with the Magic System of Systems tool.

4.1.3 Functional Requirements

REQ-1.1: The model shall facilitate human crewed missions to cislunar space including capabilities that enable surface missions.

REQ-1.2: The model shall provide capabilities to meet scientific requirements for lunar discovery and exploration.

REQ-1.3: The model shall enable, demonstrate, and prove technologies that are enabling for deep space missions.

REQ-1.4: The model shall capture the need for manual control of flight dynamics.

REQ-1.5: The model shall capture the need for automatic maintenance of station orbit.

REQ-1.6: The model shall capture the need for the station to produce, store, and regulate its own power.

REQ-1.7.: The model shall capture the need to keep the crew alive and safe.

REQ-1.8: The model shall capture the need to accommodate extended crew mission durations.

REQ-1.9: The model shall capture the need to allow the crew to perform extra-vehicular activity.

REQ-1.10: The model shall capture the need to allow for visiting vehicles to dock.

REQ-1.11: The model shall capture the need to accept the transferring of crew and cargo.

REQ-1.12: The model shall capture the need to provide communications to the lunar surface.

REQ-1.13: The model shall capture the need to have the ability to support multiple self, commercial, and international partner objectives.

REQ-1.14: The model shall capture the need to accommodate up to and including 4 crew members.

REQ-1.15: The model shall capture the need to enable 30 to 90 days of a single crew mission duration.

REQ-1.16: The model shall capture the need to provide easy access from Earth with current launch vehicles.

REQ-1.17: The model shall capture the need to have continuous communication with Earth.

4.2 System MagicGrid Compliance

4.2.1 Description and Priority

The system model for the avionics system adheres to the MagicGrid framework as laid out in the MagicGrid Book of Knowledge.

4.2.2 Stimulus/Response Sequences

The model will be invoked through manipulation and query with the Magic System of Systems tool.

4.2.3 Functional Requirements

REQ-2.1: The system shall capture the stakeholder needs

REQ-2.2: The system shall represent the stakeholder needs at the context level within the System Context model

REQ-2.3: The system shall refine the functional stakeholder needs with the use case model and use case scenarios

REQ-2.4: The system shall refine the non-functional stakeholder needs in the Measures of Effectiveness (MoEs) model

REQ-2.5: The system shall identify the expected behavior of every function of the system with the Functional Analysis model

REQ-2.6: The system shall capture the conceptual subsystems

REQ-2.7: The system shall specify MoEs for one or more conceptual subsystems

5. Other Nonfunctional Requirements

Section 5 details the current known non-functional requirements associated with both the system to model and the modeling framework (MagicGrid).

5.1 Model Mission Alignment

5.1.1 *Performance Requirements*

REQ-1.1: The system model shall have captured the 7 models within the problem's domain in no more than 4 months.

REQ-1.2: The system model shall have captured the remaining 18 models within the solution's and implementation domains in no more than 4 months after REQ-3.1.

REQ-1.3: The system model shall have 1 level of functional detail on each non-avionics system component.

REQ-1.4: The system model shall have at least 2 levels of functional detail on each avionics system component.

REQ-1.5: The model shall contain 1 top-level use case scenario.

REQ-1.6: The model shall contain at least 1 top-level avionics use case scenario action functional analysis.

REQ-1.7: The model shall contain at least 2 sub-level avionics use case scenario action functional analyses.

5.1.2 *Safety Requirements*

REQ-2.1: The system model shall support the function of safely deleting and modifying existing models without any disruption of the preexisting model views or specifications.

5.2.3 *Performance Requirements*

REQ-2.1: The system model shall follow MagicGrid compliance standards by interlinking components between separate models.

RREQ-2.2: The system model shall be verified by the customer as following the MagicGrid framework.

6. Other Requirements

REQ-1.1: The work completed using the MagicDraw tool for the senior capstone class was done under an academic license provided to Embry-Riddle Aeronautical University by Dassault Systems Incorporated. Work completed under this license is not to be used for any commercial or personal purposes, but only in accordance with the university's policies.

Appendix A: Glossary

CSS - Crewed Cislunar Station
MBSE - Model-Based Systems Engineering
FMEA - Failure Mode and Effects Analysis
SOI - System of Interest
RAM - Random Access Memory

Appendix B: Analysis Models

N/A

Appendix C: To Be Determined List

N/A