**System Design Document**

**For**

**MBSE Avionics System Capstone**

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**SYSTEM DESIGN DOCUMENT**

*Overview*

*The System Design Document describes the system requirements, operating environment, system and subsystem architecture, files and database design, input formats, output layouts, human-machine interfaces, detailed design, processing logic, and external interfaces.*

# **INTRODUCTION**

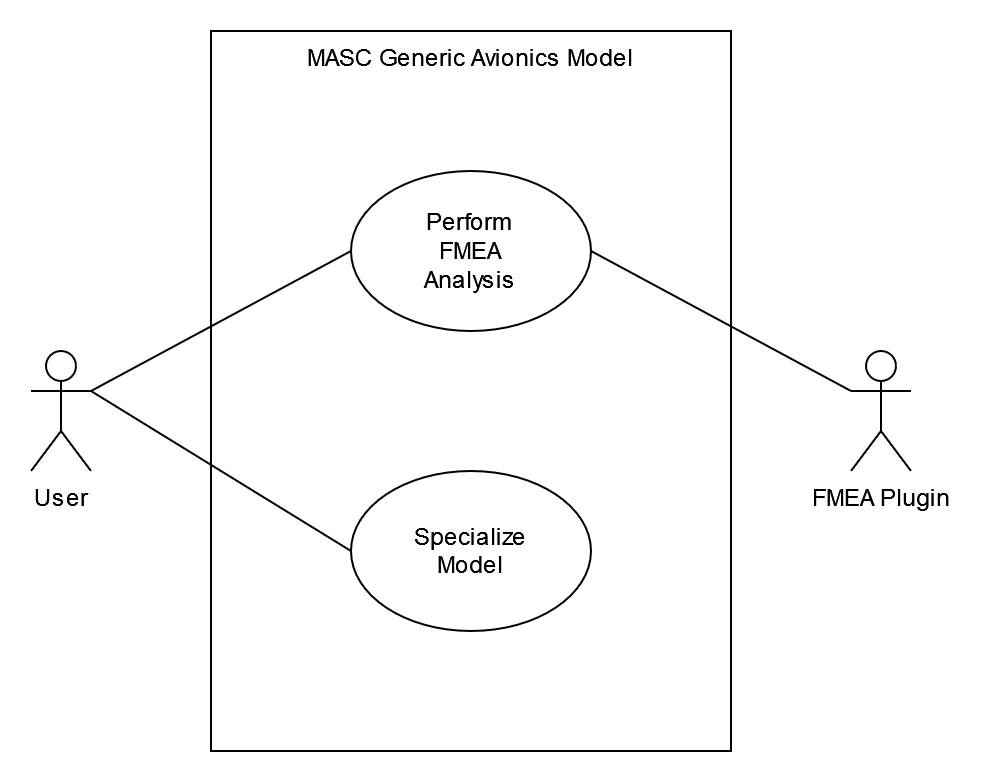
## **Purpose and Scope**

This document describes the system requirements, operating environment, system and subsystem architecture, files and database design, input formats, output layouts, human-machine interfaces, detailed design, processing logic, and external interfaces for the MBSE Avionics project.

## **Project Executive Summary**

The following section provides a description of the MBSE Avionics project from a management perspective and an overview of the framework within which the conceptual system design was prepared.

### System Overview



This use case diagram describes the system as a completed model which is produced using the process that the team is exploring. All engineering user classes are combined here into a User actor which will perform two actions on the system: Perform FMEA Analysis, with the support of the FMEA Plugin, and the option to specialize the model into a real system model which can be used for a spacecraft design.

### Design Constraints

### Future Contingencies

At the moment the constraints of the Magic System of Systems software and the constraints of the MagicGrid framework are unknown. These could both influence the direction and depth of the project by a great amount.

## **Document Organization**

The following sections will provide information on what the product does, limitations, interactions, interfaces, hardware and software designs, and security.

## **Project References**

* + 1. MagicGrid Book of Knowledge, 2nd Edition, from https://discover.3ds.com/magicgrid-book-of-knowledge

## **Glossary**

MBSE - Model-Based Systems Engineering

FMEA - Failure Mode and Effects Analysis

SOI - System of Interest

RAM - Random Access Memory

# **SYSTEM ARCHITECTURE**

In this section, describe the system and/or subsystem(s) architecture for the project. References to external entities should be minimal, as they will be described in detail in Section 6, External Interfaces.

## **System Hardware Architecture**

In this section, describe the overall system hardware and organization. Include a list of hardware components (with a brief description of each item) and diagrams showing the connectivity between the components. If appropriate, use subsections to address each subsystem.

## **System Software Architecture**

In this section, describe the overall system software and organization. Include a list of software modules (this could include functions, subroutines, or classes), computer languages, and programming computer-aided software engineering tools (with a brief description of the function of each item). Use structured organization diagrams/object-oriented diagrams that show the various segmentation levels down to the lowest level. All features on the diagrams should have reference numbers and names. Include a narrative that expands on and enhances the understanding of the functional breakdown. If appropriate, use subsections to address each module.

## **Internal Communications Architecture**

In this section, describe the overall communications within the system; for example, LANs, buses, etc. Include the communications architecture(s) being implemented, such as X.25*,* Token Ring, etc. Provide a diagram depicting the communications path(s) between the system and subsystem modules. If appropriate, use subsections to address each architecture being employed.

**Note:** The diagrams should map to the FRD context diagrams.

# **HUMAN-MACHINE INTERFACE**

This section provides the detailed design of the system and subsystem inputs and outputs relative to the user/operator. Any additional information may be added to this section and may be organized according to whatever structure best presents the operator input and output designs. Depending on the particular nature of the project, it may be appropriate to repeat these sections at both the subsystem and design module levels. Additional information may be added to the subsections if the suggested lists are inadequate to describe the project inputs and outputs.

## **Inputs**

This section is a description of the input media used by the operator for providing information to the system; show a mapping to the high-level data flows described in Section 1 .2.1, System Overview. For example, data entry screens, optical character readers, bar scanners, etc. If appropriate, the input record types, file structures, and database structures provided in Section 3, File and Database Design, may be referenced. Include data element definitions, or refer to the data dictionary.

Provide the layout of all input data screens or graphical user interfaces (GUTs) (for example, windows). Provide a graphic representation of each interface. Define all data elements associated with each screen or GUI, or reference the data dictionary.

This section should contain edit criteria for the data elements, including specific values, range of values, mandatory/optional, alphanumeric values, and length. Also address data entry controls to prevent edit bypassing.

Discuss the miscellaneous messages associated with operator inputs, including the following:

* Copies of form(s) if the input data are keyed or scanned for data entry from printed forms
* Description of any access restrictions or security considerations
* Each transaction name, code, and definition, if the system is a transaction-based processing system

## **Outputs**

This section describes the system output design relative to the user/operator; show a mapping to the high-level data flows described in Section 1.2.1. System outputs include reports, data display screens and GUIs, query results, etc. The output files are described in Section 3 and may be referenced in this section. The following should be provided, if appropriate:

* Identification of codes and names for reports and data display screens
* Description of report and screen contents (provide a graphic representation of each layout and define all data elements associated with the layout or reference the data dictionary)
* Description of the purpose of the output, including identification of the primary users
* Report distribution requirements, if any (include frequency for periodic reports)
* Description of any access restrictions or security considerations

# **DETAILED DESIGN**

This section provides the information needed for a system development team to actually build and integrate the hardware components, code and integrate the software modules, and interconnect the hardware and software segments into a functional product. Additionally, this section addresses the detailed procedures for combining separate COTS packages into a single system. Every detailed requirement should map back to the FRD, and the mapping should be presented in an update to the RTM and include the RTM as an appendix to this design document.

## **Hardware Detailed Design**

The hardware constraints for the system are that the model must be contained within the Magic System of Systems Architect 2022x software. The software will be running on Windows laptops which contain greater than or equal to 8 gigabytes of RAM, and have at least 50 gigabytes of free disk space available. As no hardware is being used in this project, the computer required to run the software is the only hardware involved.

## **Software Detailed Design**

A software module is the lowest level of design granularity in the system. Depending on the software development approach, there may be one or more modules per system. This section should provide enough detailed information about logic and data necessary to completely write source code for all modules in the system (and/or integrate COTS software programs).

If there are many modules or if the module documentation is extensive, place it in an appendix or reference a separate document. Add additional diagrams and information, if necessary, to describe each module, its functionality, and its hierarchy. Industry-standard module specification practices should be followed. Include the following information in the detailed module designs:

* A narrative description of each module, its function(s), the conditions under which it is used (called or scheduled for execution), its overall processing, logic, interfaces to other modules, interfaces to external systems, security requirements, etc.; explain any algorithms used by the module in detail
* For COTS packages, specify any call routines or bridging programs to integrate the package with the system and/or other COTS packages (for example, Dynamic Link Libraries)
* Data elements, record structures, and file structures associated with module input and output
* Graphical representation of the module processing, logic, flow of control, and algorithms, using an accepted diagramming approach (for example, structure charts, action diagrams, flowcharts, etc.)
* Data entry and data output graphics; define or reference associated data elements; if the project is large and complex or if the detailed module designs will be incorporated into a separate document, then it may be appropriate to repeat the screen information in this section
* Report layout

## **Internal Communications Detailed Design**

If the system includes more than one component there may be a requirement for internal communications to exchange information, provide commands, or support input/output functions. This section should provide enough detailed information about the communication requirements to correctly build and/or procure the communications components for the system. Include the following information in the detailed designs (as appropriate):

* The number of servers and clients to be included on each area network
* Specifications for bus timing requirements and bus control
* Format(s) for data being exchanged between components
* Graphical representation of the connectivity between components, showing the direction of data flow (if applicable), and approximate distances between components; information should provide enough detail to support the procurement of hardware to complete the installation at a given location
* LAN topology

# **EXTERNAL INTERFACES**

External systems are any systems that are not within the scope of the system under development, regardless whether the other systems are managed by the State or another agency. In this section, describe the electronic interface(s) between this system and each of the other systems and/or subsystem(s), emphasizing the point of view of the system being developed.

## **Interface Architecture**

In this section, describe the interface(s) between the system being developed and other systems; for example, batch transfers, queries, etc. Include the interface architecture(s) being implemented, such as wide area networks, gateways, etc. Provide a diagram depicting the communications path(s) between this system and each of the other systems, which should map to the context diagrams in Section 1.2.1. If appropriate, use subsections to address each interface being implemented.

## **Interface Detailed Design**

For each system that provides information exchange with the system under development, there is a requirement for rules governing the interface. This section should provide enough detailed information about the interface requirements to correctly format, transmit, and/or receive data across the interface. Include the following information in the detailed design for each interface (as appropriate):

* The data format requirements; if there is a need to reformat data before they are transmitted or after incoming data is received, tools and/or methods for the reformat process should be defined
* Specifications for hand-shaking protocols between the two systems; include the content and format of the information to be included in the hand-shake messages, the timing for exchanging these messages, and the steps to be taken when errors are identified
* Format(s) for error reports exchanged between the systems; should address the disposition of error reports; for example, retained in a file, sent to a printer, flag/alarm sent to the operator, etc.
* Graphical representation of the connectivity between systems, showing the direction of data flow
* Query and response descriptions

If a formal Interface Control Document (ICD) exists for a given interface, the information can be copied, or the ICD can be referenced in this section.

# **SYSTEM INTEGRITY CONTROLS**

Sensitive systems use information for which the loss, misuse, modification of, or unauthorized access to that information could affect the conduct of State programs, or the privacy to which individuals are entitled.

Developers of sensitive State systems are required to develop specifications for the following minimum levels of control:

* Internal security to restrict access of critical data items to only those access types required by users
* Audit procedures to meet control, reporting, and retention period requirements for operational and management reports
* Application audit trails to dynamically audit retrieval access to designated critical data
* Standard Tables to be used or requested for validating data fields
* Verification processes for additions, deletions, or updates of critical data

Ability to identify all audit information by user identification, network terminal identification, date, time, and data accessed or changed.