NASA STEM Takes Flight Interns

A Systems Model for SWS Safety Demonstrator (SD-1): Wildfire Response Operations

Project Summary

The aim of this project is the build out of a System Safety Model for System-Wide Safety's Safety Demonstrator 1 (SD-1), which will be a demonstration of an In-Time Aviation Safety Management System (IASMS) in emerging wildfire response operations.

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NASA Missions

Aeronautics Research Mission Directorate (ARMD), Airspace Operations and Safety Program (AOSP), System-Wide Safety (SWS)

Introduction

The introduction of unmanned aerial assets to the Wildfire Fighting ecosystem reduces the risk to humans both from fatalities during aerial operations and by improving situational awareness through improved data collection. The Safety Demonstrator 1 (SD-1) is part of the Technical Challenge 5 (TC5) series devised by System-Wide Safety to develop the In-Time Aviation Safety Management System (IASMS) concept in increasingly technically complex operational scenarios, while also meeting a humanitarian need by developing the use of aerial assets in disaster-oriented operations.

Goals

In support of the upcoming TC5-03-02 gap analysis milestone, the top goal of the internship project was to review and model stakeholder requirements in order to allocate those to preliminary missions, safety and traffic scenarios, and a list of 8 IASMS SFCs (Services, Functions, and Capabilities) that are under consideration for SD-1.

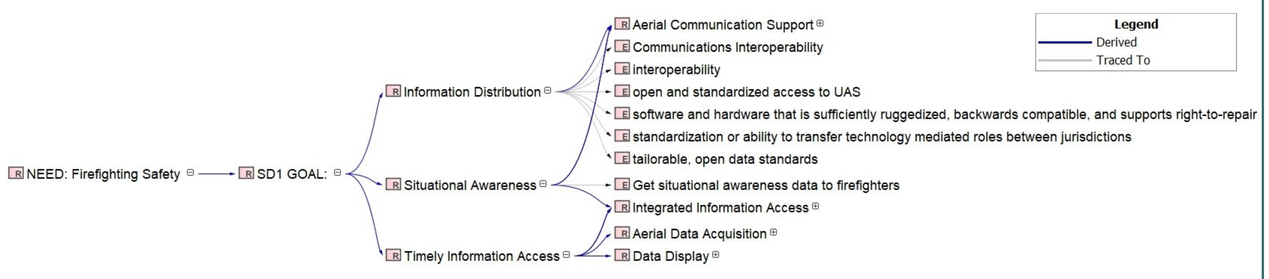
Non-NASA Sources

- MTSI/Crown Consulting
- INCOSE/OMG SysML
- NoMagic/Dassault Systèmes
- MTSI Digital Engineering Academy SysML Fundamentals Course

Method

This systems modelling project makes use of the SysML Systems Modeling language in MagicDraw software and Models-Based Systems Engineering (MBSE) principles.

A first list of stakeholder requirements, covering the needs of the firefighting community with respect to data, communications, and aerial safety, was captured by reviewing the report from the Spring 2022 NASA System-Wide Safety Wildland Firefighting Operations Virtual Workshop (https://nari.arc.nasa.gov/sws-wildfire). The workshop leaders had derived a list of 3 major stakeholder requirements that could be addressed by Safety Demonstrator 1 (SD-1) with respect to aerial safety. These derived requirements were modeled and connected to the SWS IASMS (In-Time Aviation Safety Management System) and the Goals of SD-1 and the Needs of Aerial Safety and Firefighting Safety. The overlap of stakeholder requirements and the SD-1 scope and the scope of SWS and IASMS was further evaluated in a series of meetings and model iterations allowing the requirements traceability to be further refined.



Requirements Derivation Map showing requirements traced to a Firefighting Safety Need, produced in Dassault Systèmes MagicDraw tool

The preliminary list of SFCs (Services, Functions, and Capabilities) and mission scenarios under consideration for SD-1 were gathered from developing project documentation, the recent TC-5 Annual TechTalk, and conversations with project leaders. Traffic scenarios were considered with reference to concept of operations documentation from the related STEReO and SMARt STEReO projects which focus on traffic management in aerial wildfire fighting.

Results

Building upon previous modelling efforts in wildfire fighting operations and communications, work for the internship project included refining the modeling of top-level aerial operations to include preliminary aerial mission scenarios, and safety and traffic scenarios, to which the stakeholder requirements could be allocated, within in the Wildfire Scenario system context. Requirements are also directly allocatable to IASMS (In-Time Aviation Safety Management System) SFCs (Services, Functions, and Capabilities), which are currently modeled at a very high-level in the Systems Safety Model.

Results continued

Model diagrams created using SysML (Systems Modelling Language) in the MagicDraw software platform:

- Requirements Tables
- Derived Requirements Flow
- Requirements Trace Matrices
- Requirements Allocation Matrices
- Requirements Maps
- High-level diagrams of mission scenario use cases and activities
- High-level modeling of Real-Time Risk Assessment (RTRA) as an implementation of Risk Assessment and Risk Management

Conclusions/ Future Research

Systems models and the systems modeling process can work as a dynamic, living tool throughout the development process of any system. The main benefits are traceability and the ability to validate the model that remain visible throughout the design process.

This is an early phase in the project, and the connections between mission and traffic scenarios, stakeholder requirements, and SFCs (Services, Functions, and Capabilities) modeled in this phase will be built on over the next 2.5 years leading up to the SWS Safety Demonstrator scheduled for early 2025. In the near future, the model will also connect to high-level operational concepts diagrams visualizing preliminary planned operations.

Acknowledgements

Samantha Infeld, Hannah Walsh, Lukman Irshad, Natasha Neogi, Summer Brandt, Ersin Ancel, Patricia Revolinsky, Kyle Ellis, and Joey Mercer of NASA, Jadeira Savanh Lu, Cameron Johnson, and Sean Conway of Crown Consulting (MTSI), and Nicole Shaw and Debbie Murray of STEM Takes Flight and VSCG