Informing New Concepts for UAS and Autonomous System Safety Management using Disaster Management and First Responder Scenarios

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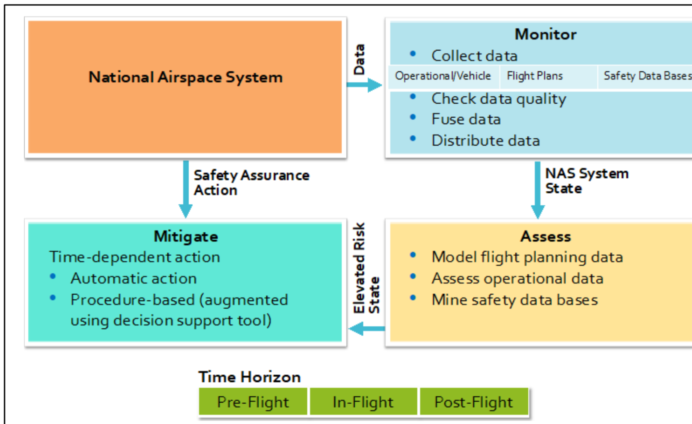
As emerging flight operations become more prevalent and increasingly automated and distributed, the capabilities for managing safety of vehicles and operations will also need to evolve. To address this challenge, the National Academies has envisioned an In-Time Aviation Safety Management System (IASMS) capability for a wide range of aviation operations including current commercial operations as well as new entrants envisioned with advanced air mobility (AAM). The suite of IASMS services, functions, and capabilities (SFCs) would be implemented in a federated approach and would address trends as well as individual operations. Through predictive modeling and data analysis, IASMS is envisioned to identify arising risks so that they can be mitigated, in-time, before a safety incident occurs.



IASMS High-Level Architecture

IASMS and its requisite set of SFCs must leverage a wide range of information to perform. To better understand these new needs, FSF worked with the aviation and humanitarian communities to develop and validate scenarios that include traditional aviation operations and UAS operations intermingled as they are deployed for disaster management and first responder (DMFR) situations. The three scenarios developed include:

- **Post Natural disaster response**, such as a hurricane, involving multiple parties utilizing traditional aviation and UAS to support rescue operations, surveil damage, and locate survivors needing assistance.
- **Wildfire fighting** in remote locations with traditional aircraft for transport and fire-retardant delivery combined with UAS for surveillance of fire locations as well as to track individual firefighter locations.
- **Medical Operations and AAM in Urban Environments** including passenger-carrying helicopters and AAM vehicles, medical missions (such as transport of radio-pharmaceuticals), and other UAS delivery operations (such as the delivery of defibrillators).

Each scenario was developed and validated by representatives with expertise in humanitarian operations, urban and rural emergency response, air traffic management, UAS operations, and traditional flight operations. The scenario definitions address roles and responsibilities of individual actors, the appropriate utilization of UAS, and the actions taken by those actors to appropriately manage risks associated with the mission and environment.

The risks to aviation traffic and to people on the ground explored included potential risks arising from incompatibilities in calculating reference altitudes (eg, differing uses of AGL, MSL, barometric, or GPS-derived values), loss of command and control (C2) communications, rapid changes in weather and winds, and physical interference. For each risk, IASMS SFCs were postulated in the context of monitoring services, risk assessment capabilities, and identifying appropriate mitigation strategies. The identified SFC capabilities were envisioned from known services postulated for IASMS and for UTM. For these unique environments, IASMS SFCs are needed to address conditions such as hazardous payloads, micro-climates and urban canyons, and the need to keep uninvolved air traffic out of the area where DMFR operations are being conducted.

The second phase of analysis focused on inferring the specific information needs and the SFCs for IASMS, utilizing a structure of 16 information classes to organize requirements. For each of the risks identified in the workshops, it was postulated what data sources would be necessary to monitor critical aspects of the risk (eg, surrounding air traffic, ground population, terrain, etc). to be directly measured as well as data that would be derived, which implies additional SFCs for different actors to understand what information would likely be exchanged between parties.

For an IASMS to be effective, additional research is needed to develop the advanced algorithms that can address the increasingly autonomous and complex operations in differing environments and to develop means of identifying unknown risks.

Looking at these scenarios highlighted a number of research issues. These include the ability to quickly "cordon off" airspace thru temporary flight restrictions (TFRs) or other means, developing clear definitions to enable automation-based algorithms for prioritizing operations, defining airspace density metrics, standardization of altitude reporting, and establishing a basis for safety data metrics definition and collection. This paper seeks to outline the development of an IASMS in the context of the DMFR scenarios and resulting demonstrations. Utilizing this contextual approach, NASA will generate recommendations for an assured safety framework for AAM operations that enables AAM operations to safely access the NAS.