An Approach for Defining IASMS Services, Functions, and Capabilities

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Assuring safety in the NAS with the inclusion of new entrants, such as Advanced Air Mobility (AAM), will require overcoming unique safety challenges that result from combining innovative technologies with novel airspace concepts for moving people and cargo using autonomous vehicles. The focus of the In-time Aviation Safety Management System (IASMS) is to overcome AAM's safety assurance challenges. The IASMS Concept of Operations (ConOps) describes an interconnected set of services, functions, and capabilities (SFCs) designed to manage operational risks, identify unknown risks, and inform system designs.

This paper describes an approach for defining SFCs based on technology trends in research, assessment of known and unknown risks in voluntary safety reports, and causal and contributing factors in aviation accidents and incidents. This approach would identify potential SFCs that further expand the Monitor, Assess, and Mitigate (M-A-M) functionality that represents the enabling framework of the IASMS.

Safety implications that will result from integration of AAM in the transformation of the National Airspace System (NAS) were addressed in National Academies committees reports on AAM and IASMS. Development of a ConOps for IASMS was a top recommendation and can be represented as a reframing of safety assurance that builds on real-time alerting such as the Traffic Alert and Collision Avoidance System, and adds the more encompassing in-time temporal parameter in recognition of the different timelines for collecting and assessing safety data for risk mitigations. For example, mining for safety trends from data sources such as the Aviation Safety Information Analysis and Sharing system occurs over a longer time period.

Research on AAM operations poses that SFCs can be designed to monitor the safety margin appropriate for AAM including with regards to the distance between current flight parameters and nominal ideal conditions. These in-time comparisons will become more complex as the density of operations increases at least in certain areas and can include planned and actual 4D trajectory, and in-time comparisons having implications on conflict modeling and prediction including expected and actual departure time, fix/waypoint crossing times, and arrival time. These comparisons would be integrated as part of SFCs that redefine and inform new safety margin. An increased safety margin improves management of operational risks while reducing

the potential for anomalies. An increased safety margin also has implications for operator confidence in the certainty of its operations and trust in automation. Technology trends in research could be used to refine existing SFCs and define needs for additional SFCs that provide safety improvements to the design and operation of vehicles, airspace design, and operator performance requirements.

NASA is developing innovative approaches to safeguard against major accidents and incidents that have occurred in the NAS and those anticipated with the inclusion of envisioned AAM operations. The innovations use operational performance data to monitor, detect, and predict flight variations exceeding safe nominal patterns, such as would be caused by navigational error, severe weather complications, or hijacking of UAS controls. These innovative approaches have high potential to prevent accidents and incidents in the new AAM era. It is anticipated that elements of the innovations will evolve into SFCs for the IASMS.

Voluntary safety reports can be monitored to identify anomalies related to design or operational performance risks. Reports could be periodically monitored and assessed for specific topics. Reports might serve as weak signals or precursors indicative of emergent risk such as when combined with other safety information. The architecture could include SFCs that are based on voluntary safety reports recognizing the periodic temporal nature of data analysis.

As previously mentioned, aviation accidents with their causal and contributing precursors can inform the need for SFCs in the IASMS. Accidents and incidents at San Francisco International Airport such as Asiana 214 and Air Canada 759 illustrate how combinations of different factors lead to increased risk. These types of precursors and different factors have implications on the types of SFCs that could be needed to monitor and manage different sources and types of design and operational risk.

Continuing to assure the safety of AAM as designs and operations gain in complexity can be accompanied by defining SFCs that also increase in complexity. These SFCs can leverage information from findings and recommendations synthesized across on-going research, voluntary safety reports, and accident and incident reports. These SFCs can serve to refine accuracy of algorithms and resolve limitations with current practices. The IASMS architecture represents the framework for the SFCs and their critical role in safety assurance.