Enabling Supervised Flight – Procedures, Communications, Navigation, Surveillance and Supporting Infrastructure

An Advanced Air Mobility Roadmap:

Executive Summary

A report by GAMA Electric Propulsion and Innovation Committee (EPIC)

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Introduction

This document provides a summary of a General Aviation Manufacturers Association (GAMA) members' roadmap for the future needs for Communications, Navigation and Surveillance to fully utilize the capabilities of the next generation of type certificated aircraft currently being introduced into the National Airspace System (NAS). There may also be some overlap with the newly proposed Modernization of Special Airworthiness Certification (MOSAIC) aircraft category that this roadmap may also support. Primarily the needs being driven by the new generation of aircraft are an increased utilization of vertical takeoff and landing capability and increased autonomy to support remote operations. GAMA has identified three expected phases for this next evolution:

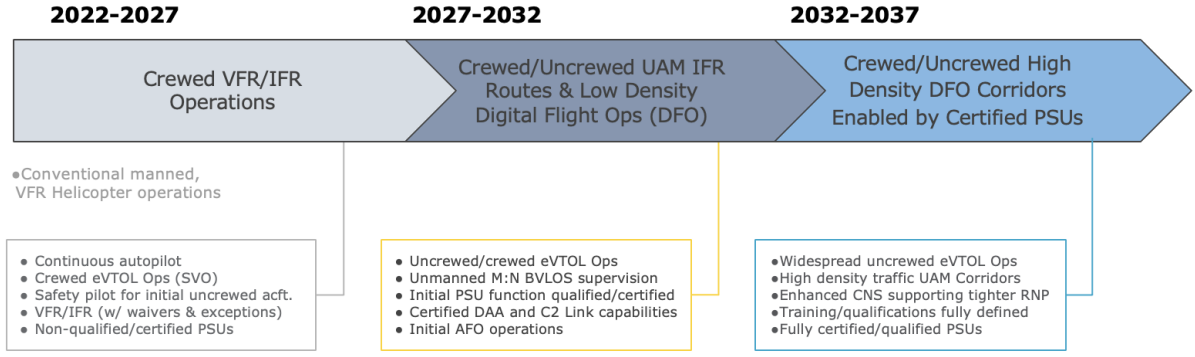
- Entry Into Service (EIS)
- Beyond EIS
- Mature State

The EIS is described in GAMA report, "Advanced Air Mobility Aircraft EIS Communication, Navigation, and Surveillance (Communication, Navigation, and Surveillance (CNS)) Typical Capabilities List (TCL)," and focuses on how the next generation of aircraft, which included vertical lift, electrically powered and remotely operated aircraft, can and will operate in the existing NAS with no or minimal changes to the NAS for the entire range of currently proposed concept of operations.

This summary adds information for the middle phase, following EIS, and the steps that are needed to move beyond initial operations.

The middle phase, detailed in "Enabling Supervised Flight – Procedures, Communications, Navigation, Surveillance and Supporting Infrastructure - An Advanced Air Mobility Roadmap," addresses the period where there is a significant increase in next generation aircraft operations. These aircraft will be driving a desire to conduct a higher density of operations in the lower altitudes of the NAS that currently has reduced surveillance capabilities and few procedures to support an increased number of vertical lift aircraft. As opposed to EIS operations which are intended to be as transparent to the NAS as possible with operations addressed with exemptions and waivers, the second phase is expected to drive an increased focus on integrating new traffic and separation technologies, procedures, and the use of third-party communications service providers.

The following graphic helps depict the expected timeline and phases. *The mature state will not be reached until an updated operational regulatory structure is established.*



Entry into Service, Phase One

The EIS equipment are summarized here.

Communications

All aircraft OEMs indicated plans to use standard VHF voice communication for interaction with air traffic control. Some OEMs also indicated plans to enable data link communications for specific functions (e.g., D-ATIS).

Navigation

The primary navigation capability will be based on WAAS-enabled, IFR-approved GPS to support terminal and enroute procedures. The survey results provided greater variability for other aircraft navigation capabilities, but OEMs are considering VOR-enabled navigation and VOR/DME-based Area Navigation (RNAV) capabilities as well as some DME/DME based RNAV. Most aircraft OEMs also plan for a standard 200 channel ILS/VOR with localizer and glideslope.

Surveillance

All aircraft OEMs indicated the intention to equip with ADS-B enabled Mode S transponder providing the aircraft air-to-ground surveillance capability and in adherence with 14 CFR 91.215 and 91.225 requirements.

Other Safety Equipment

Most, but not all OEMs, indicated plans for a Terrain Awareness and Warning System (TAWS) at different versions, including TAWS and HTAWS depending on the aircraft configuration. Some OEMs indicated plans for weather in the cockpit; either using UAT or a weather radar. Most of the OEMs also indicated plans for a Flight Data Recorder (FDR) based on the EUROCAE ED-155 flight data recorder standards.

Beyond Entry Into Service, Phase Two

The EIS provisions will support initial operations of both manned and remote operations for the aircraft that current manufacturers are currently certificating. The following is a summary of items that will allow these new aircraft to be more efficiently supported and enable more of the capabilities of the features built into the next generation of aircraft. During this phase it is expected that operators will continue to utilize exemptions, waivers, Certificates of Authorization (COAs), and Letters of Authorization (LOAs), as needed to facilitate the operation of the new aircraft and technology upgrades being produced.

Communications:

- FAA authorizes operation of PSUs and Associated Elements (AEs) including C2CSPs.
- Implement ground-based networks as part of "any-to-any" voice air traffic control (ATC) connections with the remote pilot, to provide backup voice connections and to improve latencies, particularly for satellite-connected command and control (C2).

Navigation:

- Build and expand low altitude TK routes or AAM corridors with a pathway to performance-based access for digitally enabled (remotely supervised) aircraft.
- Add curved approaches for vertiports with extensive surrounding obstructions. In support of this need, revise the ILS requirement, as ILS only works on an elongated straight-in approach.
- Update 14 CFR 135.165 to allow for other robust precision navigational technologies.
- Elimination of the visual segment in an Instrument Flight Procedures (IFP) to accommodate all-sensor based approaches and departures is needed, both at the development of IFPs, and in regulation to accept the IFPs. *
- The FAA and industry to develop and implement separation procedures for traffic traveling below 3000 ft Above Ground Level (AGL).
- Define DAA operation in low altitudes (takeoff and landing guidance) particularly at non-towered airfields.
- Continue to collaborate with industry to provide backups and secondary navigation systems to mitigate risk of GPS spoofing, jamming, and urban signal blocking.
- Provide a path to a strategic deconfliction flight plan capability for low altitude procedurally separated flights.

Surveillance:

- Using EIS operational data, review and amend the needed operational regulations, such as 91.113, to augment "see and avoid," to encompass approved digital detection methods (i.e., DAA). *
- Establish DAA standards for landing and take-offs at non-towered airports. *
- Add tactical intent information to a collaborative airborne channel, known as V2V. FAA and industry should develop a strategy for the role for V2V in the NAS.
- Share Primary and Secondary Radar between Industry and Government.
- Work to implement Ground Taxi Solutions.

* These three changes together enable elimination of a large set of waivers and exemptions.

Other Safety Equipment:

- Complete technical development, develop standards, and enable use of ACAS-X_R for rotorcraft, powered-lift, and fixed-wing aircraft.

Procedures:

- Letters of Agreement (LOAs) and waivers allowing remotely supervised flight and specific airspaces will need to mature and those that become widespread, transition into standard operational procedures and specifications.
- Further define the concept and define the Digital Flight Operations (DFO) ruleset to determine its potential role in enabling autonomous or remote flight operations, leading to DFR development.

All of the above elements represent a maturation process that is in agreement with the FAA's vision for the digital NAS and lead to Digital Flight Operations. Steps are detailed in the main paper.

GAMA and its members look forward to working through the enumerated changes requested above with the FAA, ICAO, EASA, airports, and the stakeholder community to achieve the full operational capability vision.

The mature state is the final phase. In this phase it is expected that new regulations will begin to replace the use of exemptions and waivers and clarity will emerge regarding spectrum availability use for C2. Developing the future roadmap calls for the assessment of performance-based standards. Topics that require resolution on the road to this full operational capability require more research, analysis, and consensus building than could be comprehensively addressed in the time and space for preparing this document, and will evolve based on the achievement of the elements of the full roadmap. These issues will require substantial collaboration by industry and government.

Organization of Document

The EIS section describes how operations can and will be operated by AAM aircraft in the existing NAS with no or minimal changes to the NAS.

The Roadmap Beyond EIS section presents considerations for the evolution of the NAS with specific focus on traffic and separation technologies (e.g., Detect and Avoid) and the use of third-party communications service providers.

The Mature State section summarizes an industry view of the strategic thinking needed for stable growth of the industry as supply and demand of AAM services come into balance. In this state the dynamics and uncertainties for aircraft production, market uptake, operational densities, airspace capacities, infrastructure needs, financial performance, and regulatory requirements would become increasingly predictable, even settled into more stable trends. The continuing industry growth in this state implies strategic investment by both industry and government in addressing related regulatory and policy needs prompted by continuously advancing technologies.