

DATA & REASONING FABRIC A HOLLISTIC APPROACH TO ENABLE GLOBAL INTEROPERABILITY AND HARMONIZATION IN SUPPORT OF ADVANCED AIR MOBILITY

Request for Information - Topic 2: Critical elements of AAM requiring global interoperability and harmonization

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Background

NASA has been a pioneer in aviation research and innovation for decades and is now focused on a new vision for aviation transportation: Advanced Air Mobility (AAM). AAM is defined as an air transportation system that moves people and cargo between places previously not served or underserved by aviation – local, regional, intraregional, urban – using revolutionary new aircraft that are only just now becoming possible. A thriving AAM ecosystem will require decisions based on diverse and dynamic data, including vehicles, airspaces, weather, infrastructure, smart cities, payload, as well as customer data. Decisions need to be made where the data exist and, increasingly, data may be too large or dynamic to centralize. Moreover, data in such a diverse environment cannot be centralized and will not be interoperable and therefore cannot be easily used for machine-intelligence. The NASA team has identified several data access and decision support barriers that must be overcome to enable advanced air mobility:

- Limited interoperability & data standardization between service providers and AAM & vertiport operators.
- Insufficient accurate data where it is needed to make airspace operations & management decisions.
- Highly Reliable and low-latency access to edge computing devices in support of tools to support safety related decisions.
- Reusable reasoning (decision support) services are not easily accessible.
- Clear economic incentives for data service providers.

Therefore, critical to a successful AAM ecosystem is the development of an integrated data environment that interconnects various information sources, including airspace, governance, vehicles, environment, weather, policies, and more. This interconnected and interoperable data environment is crucial for facilitating the planning, design, and operations of AAM. To align with this objective, NASA proposes the development of a technology aimed at achieving global interoperability and harmonization in the realm of data and artificial intelligence (AI). ICAO, as the global forum to develop policies and standards, will be needed to bring states and industry together to enable seamless secure access to the data and the build aviation capacity required to support the future AAM.

Proposed Solution

AAM introduces many challenges due to far greater density of heterogeneous vehicles that must operate safely in all geographical areas within the ecosystem. The ecosystem must accommodate routine as well as contingency situations, which translates to far more decisions that are made more rapidly to support the real-time operations of these vehicles. These decisions rely on accurate, reliable, and up-to-date data, which must be made available to a combination of vehicles and human operators. Existing data platforms are inadequate for the anticipated scale of geographically dispersed and diverse entities, with their low-latency needs. Moreover, existing solutions do not facilitate distributed regulatory frameworks, innovation, and data sharing on the level necessary to address the challenges posed by AAM.

The proposed solution aims to unlock the full potential of AAM by providing comprehensive data and reasoning wherever they are needed. It introduces a distributed peer-to-peer architecture, built upon an open foundational ecosystem, enabling seamless exchange of data and AI between various systems involved in managing complex and densely populated airspace operations. The targeted level of operational density can only be attained if decision-making processes shift from being solely human-driven to being augmented by autonomous and machine-intelligent decision-making with human supervision. The Data & Reasoning Fabric (DRF) represents a pioneering methodology that seamlessly and effectively links data with decision-making. This solution will operate in a decentralized manner, without ownership by any single entity. The objective is to deliver reference architecture and development environments which will foster widespread participation from both the private and public sectors, ensuring self-sustaining development of the solution and its associated standards. Our proposition entails an interoperability framework that standardizes data exchange methods at high-level but also empowers users to utilize multiple standards. Recognizing the diverse nature of standards rooted in various countries and regions, we emphasize the integration of such standards within our framework.

The proposed solution will be developed based on the following architecture tenets:

- Enhanced monitoring and operational efficiency across the entire system.
- Reduced entry barriers and enhanced data control for participants.
- Flexible exploration, evaluation, and collaborative utilization of data and AI through a system-wide interoperability framework and data exchange standards.
- Incorporation of comprehensive security measures at every level of the ecosystem.
- Dissemination, management, and implementation of operational policies through multi-level regulatory framework.

In the absence of an ecosystem as proposed, only large companies would have the capability to establish or operate the entire ecosystem, resulting in independent vertical silos that lack coordination—a critical requirement for airspace operations. Additionally, this would hinder smaller players from participating in the market, creating a barrier to innovation, competition, and economic growth. Furthermore, without the flexibility and decentralization provided by the proposed solution, there is a risk of monopolistic control by major players, further stifling market dynamics. Finally, the proposed solution would provide government agencies with pathways for enforcing policies at multiple levels. The proposed solution offers the necessary tools for multi-

level regulatory framework, policy updates, enforcement, monitoring, and efficient system management. Our belief is that the suggested solution will facilitate AAM by directing the reasoning and decision-making processes between aerial vehicles and ground-based systems, leading to improved safety and operational efficiency. The methodology will establish a digital foundation to enable automated data and AI exchanges.

Benefits of the Proposed Solution

1. Infrastructure:
 - Seamless interoperability between air and ground systems
 - Consideration of ground system effects, such as traffic and micro-weather impacts
2. Policies and Regulation:
 - Ensuring compliance with zoning laws and regulations
 - Facilitating the dissemination and implementation of governance policies from diverse stakeholders, including cities, operators, and regulatory bodies like the FAA.
3. Business Model:
 - Facilitating access to data from non-traditional aviation sources, such as smart cities, weather services, video processing, etc., to enrich the overall ecosystem.
 - Enabling access to decision support tools that assist stakeholders in making informed choices and optimizing their operations.

Ideas to Support Implementation

The goal of the is to enable a self-sustaining distributed ecosystem where data and AI service providers can “advertise” their services which the end users can discover, vet, purchase, aggregate, and use to achieve their air mobility missions. This will be accomplished by providing a secure software infrastructure and the tools, protocols, governance, and policies to implement, administer, manage, and operate data sharing and reasoning services across all air mobility needs. The NASA team will leverage some of the existing NASA initiatives including Data & Reasoning Fabric. As part of the development, the NASA team will also partner with technology providers for implementation and to test objectives. The team will seek collaboration with external technology, and strategy organizations in the industry to develop data and AI services, applications, and expand operations as air mobility needs will evolve.

The proposed solution is specifically designed to support operations at a large scale and high density, accommodating a diverse range of mission types that can bring significant societal benefits, such as emergency survey and response, integration of advanced technologies in local and federal airspace, and healthcare transportation within the air mobility environment. The NASA team will actively seek collaborations with anticipated stakeholders to establish and sustain a thriving data & AI ecosystem. These engagements will involve identifying organizations willing to collaborate with NASA to apply the proposed solution in end-user applications and demonstrating its capabilities in dense urban environments.

Conclusion

We at NASA believe that data access and interoperability framework is one of the elements that will require global solutions. Such framework is crucial for effective governance and growth of the AAM ecosystem with multiple partners. Standardized services and open interfaces are essential for seamless interconnectivity between AAM domains, systems, and services. The main drive behind establishing a globally standardized framework is to enable data access and interoperability across different systems, enabling machines to make intelligent decisions for the safety of AAM operations. A holistic approach is necessary for the AAM ecosystem to thrive and reach its full potential. In our vision, standardization for connectivity, data access, and data security requires a global approach, whereas data governance and privacy should be addressed locally or regionally due to varying laws and regulations. A globally standardized framework for accessing, exchanging, and machine-understanding data will minimize redundant efforts and promote innovation, enhance safety, and lower costs. To achieve the envisioned goals and to tackle the complex challenge of interoperability in AAM development, collaboration among government, industry, and various organizations is essential. Over the next 3 – 5 years, ICAO will need to foster data sharing solutions and standards to meet the AAM vision. As AAM evolves over the next 6 – 10 years, ICAO will need to bring states and industry together to enable seamless secure access to the data required to support the future AAM capacity and efficiency requirements.

Point of Contact

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