IFAR | INTERNATIONAL FORUM FOR AVIATION RESEARCH

OPERATIONS AND INTEGRATION

Presented by Adriana Andreeva-Mori (JAXA)

Scientific Assessment on Urban Air Mobility

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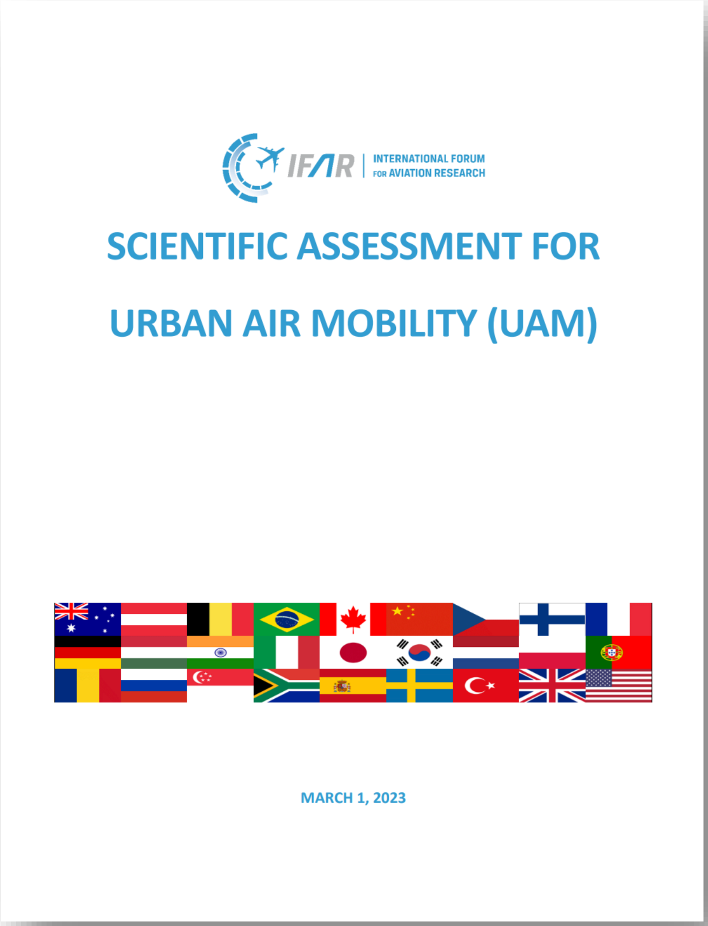
- IFAR: **27 countries** representing 6 continents, more than 35000 researchers
- A **global perspective from a research point of view for the topic of UAM** based on the broad expertise IFAR researchers.
- Scientific Assessment for Urban Air Mobility (UAM) represents a **consensus view from the 27-member organizations**

Focus Area	Focus Area Title	Supporting Agencies (leads in **bold**)
1	Vehicle Overview	**NRC**, KARI, NASA, BME, ILOT, VZLU, INCAS, CSIR
2	Propulsion and Energy	**NASA**, KARI, NRC, ONERA, BME, ILOT, VZLU, INCAS
3	Autonomy	**NASA**, JAXA, NRC, DLR, ONERA, NLR, BME, ILOT, VZLU
4	Airspace Integration and UTM	**JAXA**, NRC, NASA, NLR, BME, CIRA, ILOT
5	Safety Management Systems	**DLR**, NASA, VZLU, NLR, ONERA, CIRA, ILOT, CSIR, INCAS
6	Infrastructure	**NASA**, KARI, NLR, VZLU
7	Security	**NASA**, CIRA, DLR
8	Communication, Navigation and Surveillance	**NASA**, KARI, NRC, DLR, ONERA, CIRA, ILOT
9	Weather Tolerance	**NRC**, JAXA, DLR, ILOT
10	Environmental	**NRC**, KARI, NASA, ONERA, ILOT
11	Maintenance	**NASA**, DLR
12	Safety and Security	**NASA**, DLR, VZLU, NLR, ONERA, CIRA, ILOT, CSIR, INCAS
13	Intersection with Infrastructure	**NASA**, DLR, ILOT, VZLU
14	Data Protection and Security	**NASA**, CIRA
15	Autonomy	**ONERA**, NRC, NASA, DLR, ILOT
16	Environment	**NRC**, NASA, DLR, ONERA, CIRA, ILOT
17	Safety	NRC, NASA, DLR, CIRA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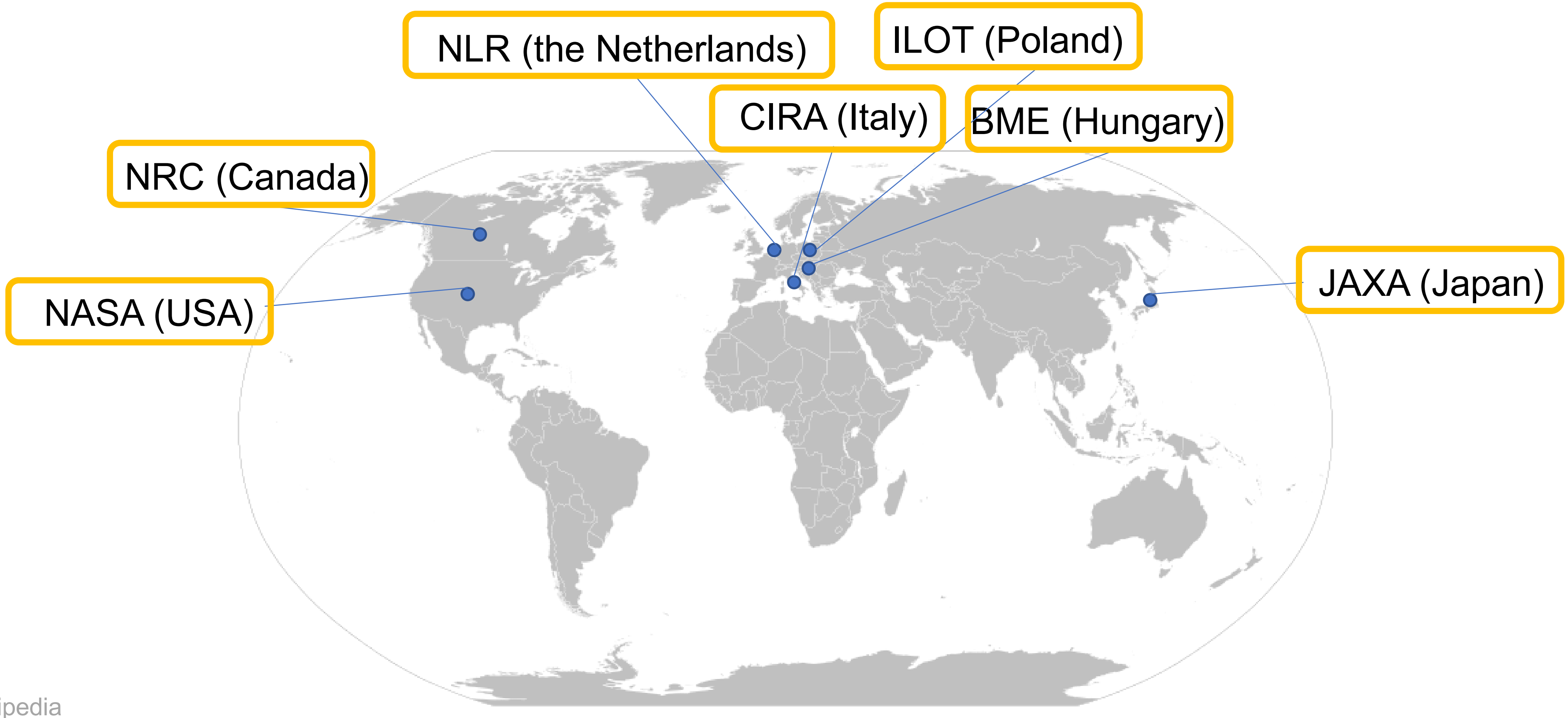
SCIENTIFIC ASSESSMENT FOR URBAN AIR MOBILITY (UAM)

MARCH 1, 2023

https://ifar.aero/attachments/article/57/ifar-scientific-assessment-for-uam.pdf

Team members

- Team members from 7 organizations (countries): this work would not have been possible without the dedication and hard work of all team members- an enormous THANK YOU to all!



Map source: Wikipedia

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4. Airspace Integration and UAS Traffic Management Technology Area Overview

Overview of Technology Area

The Urban Air Mobility (UAM) concept is focused on, but not limited to, rules, procedures, and technologies that enable the movement of cargo and passenger aircraft in the urban environment. The FAA and NASA have defined a broader term, Advanced Air Mobility (AAM) [1], which covers regional and interregional operations as well. There are many concepts of operations in development, as given by the FAA UAM ConOps v1.0 [2], the NASA UAM Vision ConOps v1.0 [3], and U-Space ConOps created by the CORUS-XUAM Project in Europe [4], which outline various airspace integration implications and solutions. While harmonization is required at an international level for these ConOps, a key characteristic emphasized across these documents is that the growth of the UAM industry will increase traffic density and frequency in certain areas. This growth and unique set of performance characteristics will introduce operational challenges that current global ATM systems are unable to support. This technology area is focused on identifying procedures, constructs, and technologies needed to seamlessly integrate UAM operations into existing airspace environments while allowing for regional considerations.

State-of-the-Art Assessment

Novel airspace integration policies and constructs for passenger-carrying UAM vehicles, either crewed or uncrewed, do not currently exist and require significant research and assessment to develop. Globally, early UAM entrants will most likely utilize existing flight rules, procedures, and ANSP interactions to complete initial missions. Public good operations, such as disaster response, air ambulance, emergency good delivery and police operations have been in the spotlight as initial UAM use cases. While unmanned aircraft system (UAS) Traffic Management (UTM) [5] concepts have begun to be implemented across the globe, these systems are focused on enabling small, unmanned drones to access low-altitude airspace beyond visual line of sight (BVLOS) with minimal impact to the existing aviation system; however, the line between UTM and UAM operations is blurry and needs further discussion in the research community.

Gap Analysis

The UAM airspace structures, procedures, and definitions (such as enabling the use of corridors) require development and description to enable scalable operations. The UAM separation requirements are not currently standardized, and therefore will need to be researched and defined to support UAM operations. Technology, methods, and data structures for intent sharing must be defined for UAM operations. While lessons learned from UTM can be leveraged, there are significant differences for higher altitude and passenger-carrying operations that may imply different risk ratios for ANSPs. Identification of other data services, such as weather data for the urban canyon, must be outlined along with information exchange protocols. Alongside the development of intent sharing methods and other data, a comprehensive system architecture that can be applied across the globe may be required to ensure that operations can occur effectively across nations. Additionally, roles and responsibilities between different UAM ecosystem entities should be defined for varying levels of automation (including UAS and Remotely-piloted Aircraft Systems (RPAS) operations) to enable long-term UAM operations.

Open Research Areas

1. What are the information requirements, procedures, and technologies needed between UAM operators and existing ATM services to enable early and long-term operations? How do airspace systems or supporting services interoperate for diverse operations in the same geographic areas?
2. Can airspace integration methods, systems, and data structures be extrapolated from sUAS, UTM, and other relevant operations (e.g., Part 121, Part 135, disaster response practices [6])?
3. What are the navigation and surveillance performance requirements and accuracy of these capabilities needed to enable airspace integration and monitoring of UAM operations?
4. Can separation minima be defined for UAM-UAM, UAM-sUAS, and UAM-traditional traffic?
5. What new regulations and rules will be required to establish new airspace structures and procedures for UAM operations to make them scalable while preventing overburden of existing ATM services?

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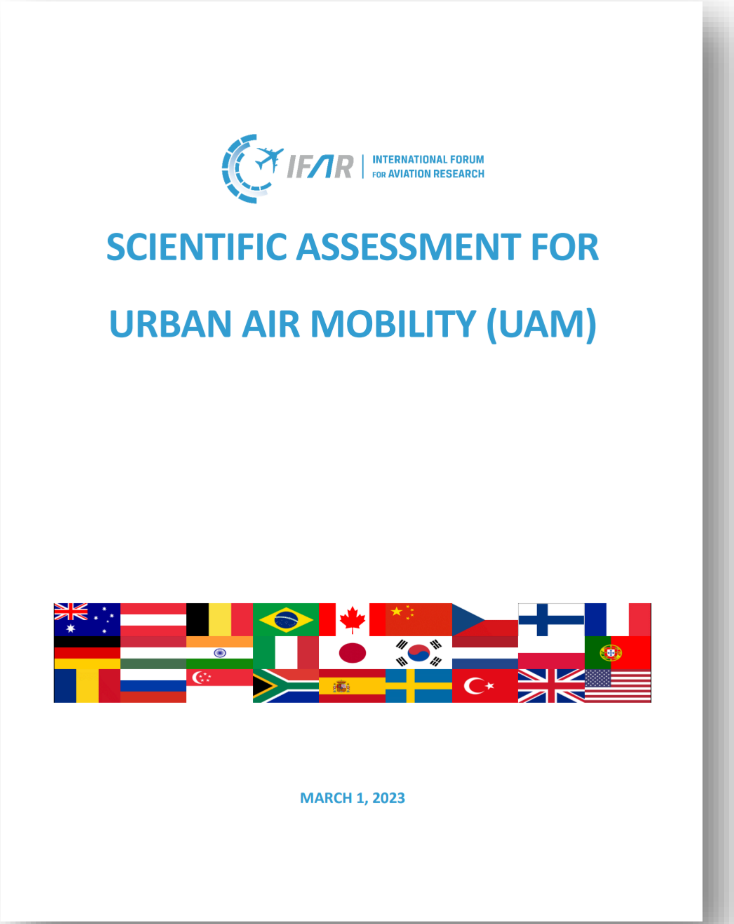

Airspace Integration Challenges

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Today

	VFR	IFR
Operation	Flight operation defined by visual references	Flight operation defined by reference to instruments
Certification	Minimum equipment dictated by airspace	Minimum equipment dictated by certification and NAVAIDS intended to be used.
Separation	Responsibility of separation maintained by the pilot	Responsibility of separation maintained procedurally or manually by ATC and the pilot

Future

- Unique operation characteristics
- Increased **traffic density** and **tempo**
- Increased level of automation

More details here: https://www.icas.org/ICAS_ARCHIVE/ICAS2022/data/papers/ICAS2022_0948_paper.pdf

UAM Use Cases

Early or Near-Term Use Cases

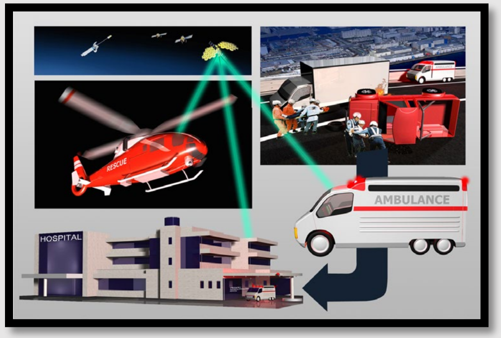
2025-2035

Point to Point Transfer of Goods & Passengers

- Cargo services can pave the way for passenger transport
- Established routes (no air taxi from your home to your office, for example)
- Remote locations (transport to remote islands, suburban areas)

Public Good Operations

- Disaster response
- Medical transport
- Rescue



Long-Term Use Cases

after 2035

- On demand operations
- Increasing complexity of operations
- Higher levels of automation
- Higher volumes of traffic

Key Areas of Research for UAM Airspace Integration

Intent Sharing

Collaborative Conflict Management & Separation Minima

Airspace Design and Procedures

Communication, Navigation, & Surveillance

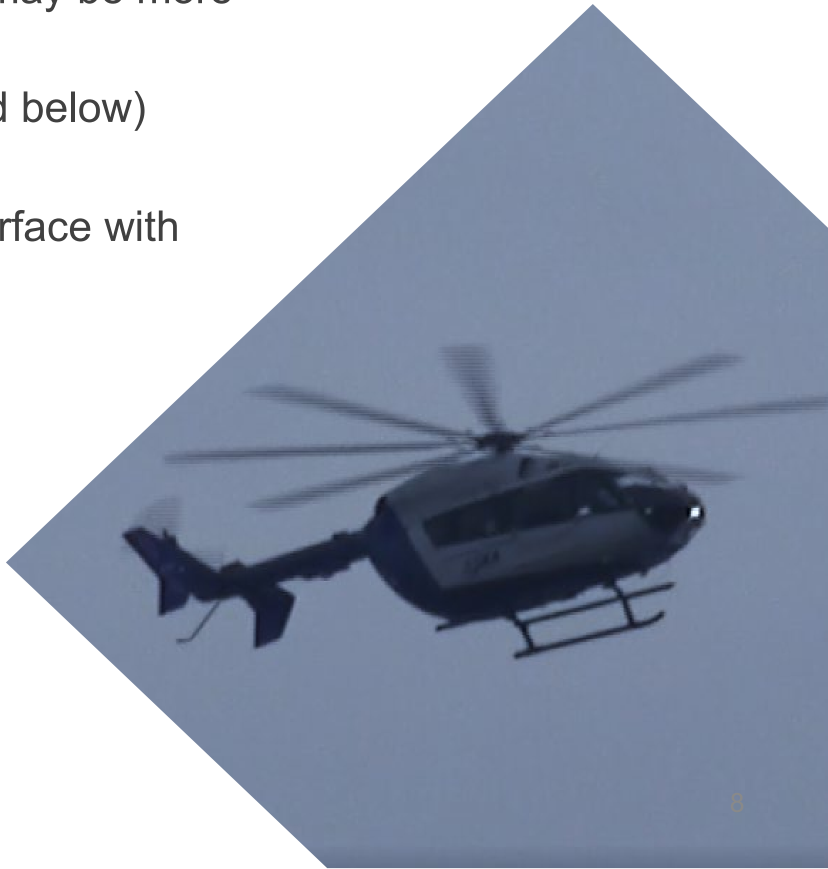
Airspace and Vertiport Interactions: another expert team focused on this area

Airspace integration: where is it necessary?

- UAM vehicles are expected to operate in airspace ranging from 2000 ft to 10,000 ft AGL depending on vehicle configuration and performance characteristics
- Integration is needed where demand exists:
  - With traditional ATM (in particular, 3000 ft and below (Class G)+ airport vicinity (Class B, C))
  - Solutions necessary to limit interaction with ANSPs and air traffic controllers to prevent burdening existing air traffic management systems
  - Challenges in integrating UAM operations in uncontrolled airspace where there may be more aircraft flying under visual flight rules (VFR)
- With UTM (sUAS operations are usually in very low airspace (400 ft/ 150m/ 500 ft and below)
  - Expected interactions between UTM systems and UAM operations
  - Some concepts envision UAM managed by UTM (U-space and UTM should interface with ATM)

While UTM focused on parts of the airspace which were rarely used by traditional aviation, UAM vehicles will fly in airspaces which are already occupied by existing users, so the necessary level of integration is significantly higher (e.g., public good operations).

- Multi-layer approach
  - Integration of information from traditional traffic and new entrants needs investigation
  - Increased level of automation is needed



Intent sharing is paramount

- Intent sharing with UAM flights and with UTM and traditional low-airspace users
- Traditional aviation including current VFR operations flying in the vicinity of UAM operations will need to meet performance requirements (example: 4D trajectory prediction and flight intent sharing)
- Robust Situational Awareness (SA), reliable flight planning and de-confliction
- Coordination at all levels
  - Strategic: novel airspace structures (U-Space, UTM operational volumes, UAM corridors)
  - Tactical: requires self-separation technologies
  - Collision Avoidance (e.g. DAA)

Collaborative Conflict Management & Separation Minima

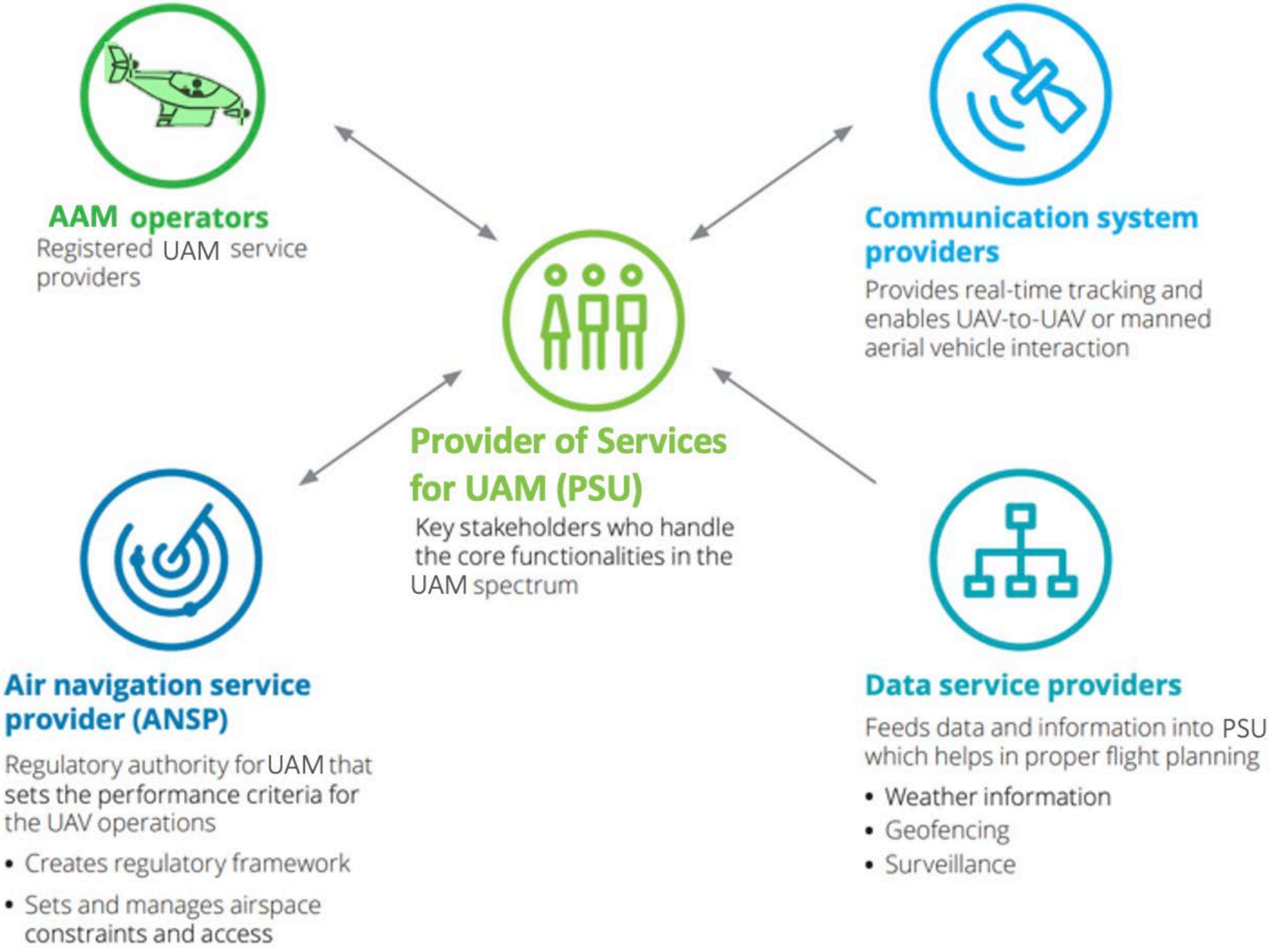
- Collaborative Conflict Management: both strategic and tactical
  - UTM concepts can be leveraged but with appropriate risk-based approach for passenger carrying operations and severity of occurrence
  - Demand-capacity balancing and flow management will be necessary
- Separation minima needs to be established based on vehicle performance
  - Separation minima is not analogous to existing definitions in manned aviation
    - Diverse configurations and various operational environments call for new approaches
    - Airspace configuration, integration with UTM and ATM, vehicles’ capabilities and risk assessment should all play a role
- Traffic density needs to be defined

Navigation/surveillance can be challenging

- Resilient and secure communication, navigation, and surveillance (CNS) infrastructure is a key enabler for UAM operations and airspace integration
- Existing CNS capabilities are limited or inadequate for low flying (500-3000 AGL) UAM operations
  - Remote/rural areas: Limited **availability, accuracy** and **reliability** of CNS capability (cellular networks, GPS etc.)
  - Metro areas: Tall buildings in cities make traditional radar surveillance impractical
  - Low level weather and secondary surveillance radar (SSR) technology are not sufficient
- Regular updates of the vehicle's own positions are required, but enabling technologies are not ready/mature yet

Evolution of Roles and Responsibilities for Actors

- Traditional human-centered air traffic management and control may not be able to fulfil the requirements posed by UAM business models and projected traffic density.
- New traffic service providers will be introduced, but integration with traditional ATM needs discussion
- Cities will need to play a role in traffic management and control to achieve integration with existing urban processes (e.g., surface multimodal transport)



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