Concept of Operations for Advanced Air Mobility
(ConOps for AAM)

※The Japanese version is the original and the English version is for reference purposes only.

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Public-Private Committee for Advanced Air Mobility

Preface

Our country faces many challenges, such as the concentration of population in urban areas and the exhaustion of regional economies due to population decline, falling birthrates, and aging populations, as well as the need to respond to severe international competition resulting from the advance of globalization, the risk of natural disasters such as large-scale earthquakes, and the need to address global-scale climate change and the Sustainable Development Goals (SDGs). In addition, people's behavior patterns and values are diversifying as the economy and society mature and as we move toward a post-COVID society, and new values and services are needed to meet diverse needs.

Advanced Air Mobility (AAM) will contribute to solving the various social issues mentioned above and to realizing a future society in which people can enjoy the rich experience of safe and flexible transportation in the sky in their daily lives.

In order to promote the development and growth of AAM in Japan, it is essential to provide necessary information on the main elements of AAM and the phases of its gradual introduction to all parties concerned. It is also important to share and cooperate with other parties concerned. To this end, this document summarizes the concept of operation for AAM in Japan.

Table of Contents

1 Introduction

1.1 Purpose

This document presents a Concept of Operations (CONOPS) for realization and further expansion of the scale and operations of the Advanced Air Mobility (AAM) in Japan, which is expected to become the next generation of air mobility. It outlines the key components and stakeholders, and describes the phases of gradual implementation.

AAM is an accessible and sustainable next generation means of air transportation, made possible by aeronautical technologies such as electrification and automation, as well as vertical take-off and landing and other modes of operation[1]. In this document, a distinction may be made between AAM operations in urban areas over short distances and at low altitudes which is referred to as Urban Air Mobility (UAM) and AAM operations over longer distances which is referred to as Regional Air Mobility (RAM).

To enable the development and growth of AAM operations, active discussion among stakeholders on regulations and system design and specifications for AAM operations is needed. Therefore, this document aims to provide industry stakeholders who are considering entering the AAM industry in Japan with necessary information and shared awareness.

The AAM industry is still developing and is expected to evolve further in the future. As such, this document is based on current knowledge and projections regarding future AAM operations and is expected to constantly evolve based on technological advances, overseas trends, and feedback from stakeholders. Other topics may be included that need to be considered in order to realize AAM, such as social acceptability, in the next and subsequent revisions of the document.

1.2 Scope

In order to promote the development of AAM industry in Japan through steady progress in environmental and technological development as outlined in the roadmap by the Public-Private Committee for Advanced Air Mobility (Appendix 1), this document describes the overall ecosystem while focusing on the main components of AAM: the aircraft, ground infrastructure and Air traffic management. It also introduces relevant use cases for Japanese AAM operations, including passenger carrying and cargo transport operations that use Electric Vertical Take-off and Landing (eVTOL) aircraft as well as the roles and responsibilities of the parties involved. In addition, it describes the likely phases of AAM operations from initial introduction to mature, high-density and autonomous operations.

This holistic approach is important for the development of AAM operations. It is important to consider both short- and long-term objectives to minimise the amount of rework and cost that could arise at a later stage due to initial decisions.

[1] AAM does not include drones. (Ref. Appendix 4)

This document also considers the Air traffic management mechanism that AAM needs to achieve harmonized flight with other low-level airspace users. Other low-level airspace users include drones, general aviation aircraft, and commercial operations on approach or departure, etc.

1.3 Reference Documents

This document is built in accordance with the Japanese operating environment and legal system, and it has been prepared with reference to regulations related to Japan Civil Aeronautics Act and materials from the Public-Private Council for the Air Mobility Revolution, as well as overseas ConOps, etc. (see Appendix 5) to ensure international harmonization and consistency.

Where practical, references have been included in the document to show the source of material used. These publications provide additional detail about some of the concepts described in this document and should be considered appropriately in any development and implementation activities.

2 Overview of Advanced Air Mobility

AAM encompasses a range of innovative aviation technologies to transform aviation's role in everyday life and achieve a revolution in air mobility, including the movement of goods and people [4]. Central to AAM is the development, operation and evolution of new types of aircraft. eVTOL aircraft use electric power for their operation, and take-off and land vertically. They have a number of potential benefits over traditional air mobility aircraft including zero emissions during operations, lower operational costs and lower noise profile. These benefits and their impacts are described in more detail later in this document.

The various benefits of eVTOL aircraft will enable the utilization and expansion of new air mobility for both passenger-carrying and cargo operations. In the initial stage, either passenger transport with a pilot on board or remotely piloted cargo transport is envisioned. However, over time, greater use of remotely piloted and autonomous operations is expected for both passenger-carrying and cargo use cases.

AAM operations will require new infrastructure, both on the ground and for airspace and traffic management. At present, the AAM market is still in an early stage of development, whilst showing increasing momentum. Many companies are emerging across the entire value chain. Business is expected to spread to various fields in the future.

This chapter provides further detail on each component that will form part of new AAM enabled by eVTOL aircraft.

2.1 Aircraft

Aircraft intended for AAM (Hereinafter referred to as AAM aircraft) are currently at various levels of technology readiness. Although, the most likely types of aircraft to commence commercial AAM operations in Phase 1 (Refer to the chapter 3 for definition of phases) are eVTOLs powered by rechargeable batteries, hybrid types (e.g. gasoline-electric hybrid types) could also be introduced in Phase 1. Hydrogen fuel cell-powered aircraft may also provide AAM operations, but this type of aircraft is expected to be introduced in Phases 2 or 3, or later. As a rough estimate of range, the aircraft are expected to be able to fly from a few kms to several hundred kms.

In the initial stage, aircraft which carry about 1-5 persons with a pilot on board manually or automatically and aircraft remotely piloted without a pilot on board, mainly for cargo transport are envisioned. In the future, it is envisioned that aircraft with a larger number of passengers will emerge, and that aircraft including passenger transport, will be operated by automated flight operations or autonomous operations, with only remote monitoring and no pilot on board.

Although AAM aircraft are initially expected to operate under Visual Flight Rules (VFR), it is expected that progress toward higher density and automation/autonomy will occur, as well as the development of aircraft capable of flying in more severe weather.

2.1.1 Aircraft Concept Types[2]

AAM eVTOL aircraft can be categorised into three types mainly:

- Multirotor
- Lift + Cruise
- Vectored Thrust

Multirotor

This concept provides the main lift and propulsion by means of three or more electric powered rotors rotating around a nearly vertical axis. By changing the “rotation speed” of these multiple motors, each rotor blade (rotor) generates thrust and counter-torque in accordance with its rotation speed, which becomes torque in various directions depending on structural factors such as rotor positioning, direction of rotation, and positive or negative rotor pitch. These combined forces change the aircraft's attitude to achieve flight. Due to a high battery drainage for the cruise phase, these aircraft are limited to short-distance journeys.

Lift + Cruise

This concept has multi rotors, fixed wings for cruise, and propellers for thrust, and uses different electric propulsion systems for vertical take-off and landing and for cruise. During take-off and landing, multi rotors are used to generate upward thrust. During cruise, the upward rotors turn off and using forward-facing propellers wings for level flight create the necessary lift. This concept can enable greater energy efficiency than multirotor AAM aircraft in cruise due to the use of wing-based lift and is therefore suited to longer distances.

Vectored Thrust

This concept has fixed wings for cruise and uses the same electric propulsion system for vertical take-off and landing and for cruising. At take-off and landing, the vertically positioned propellers, etc. generate lift. During cruise, the propellers, etc. tilt to generate forward thrust and lift is generated by the wings. This concept is suited to longer distances than multirotor AAM aircraft. It can potentially enable higher cruise speeds and distances than other concepts.

2.1.2 Comparison with existing air mobilities

AAM aircraft have the following characteristics compared to existing air mobility.

[Environmental Burden]

- The use of batteries as the power source is expected to reduce emissions during operations.
- The aircraft is expected to reduce noise during take-off/landing/cruise because it is battery-powered and equipped with rotors that are smaller in size than those of a helicopter.

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[2] Definitions and meanings of terms used in this section include those given for ease of reading. Formal terms used in the evaluation for type certification are determined by consideration of individual design features.

[Design/Performance]

- High redundancy is expected due to the multiple motors/rotors and other features.
- Features such as vertical take-off and landing are expected to enable take-off and landing in confined spaces.
- Designs suitable for remote-pilot and autonomous operation are expected to become mainstream and operational control is also expected to be simplified.
- It is expected that efficiency will improve in the cruise phase of flight, where wing-based lift is used compared to rotorcraft such as helicopters.

[Energy Source]

- Infrastructure and requirements for battery powered operation such as battery swapping or fast charging, will be required.
- Currently developed batteries have lower energy density than liquid fuels, which may limit AAM aircraft range and others.
- Battery-powered operation can be ready for operation in a shorter time after start-up (power-on).

[Cost]

- The cost of maintenance may be reduced by reducing the frequency and simplifying process of parts replacement and maintenance practices, while maintaining safety.
- Aircraft production and operating costs may be reduced over the long term because of reduced number of parts used, etc.

2.2 Use Cases

The use cases presented in this section are based on the Use Case Review Meeting under the Public-Private Council for the Air Mobility Revolution. The use case of cargo transport has much in common with drones. Utilisation of AAM aircraft is expected to deliver some of the following benefits compared with conventional helicopter operations and/or other transport options:

- Passenger: Increased availability (locations and frequency), time saving (compared to other transport modes), quieter comfortable cabin, potentially lower cost, simple boarding procedure, improved multi-modal transport connectivity.
- Community/Society: Lower noise, lower emissions, larger network of operations, vitalization of local economy, improved remote area access, increased emergency response capability, reduced infrastructure costs (compared to other ground/surface based transport modes).

2.2.1 Passenger Carrying

1. Airport shuttle: Transporting passengers from/to airport and their onward destination.
2. Intra-urban: Transporting passengers within urban areas.
3. Routes to suburban areas: Transporting passenger from urban centres from/to suburban/remote areas.

4. Entertainment: Excursion flights around recreational facilities and tourist destinations.
5. Access to tourist areas: Transporting tourists, etc. from/to recreational facilities and tourist destinations.
6. Routes connecting remote islands or mountainous areas: Transporting passengers between remote islands and the mainland, between islands and between mountainous and urban areas.
7. Emergency Medical Transport (EMT) (for doctors): Transporting doctors for emergency medical purposes over urban and rural areas in the event of a disaster or sudden illness, etc.
8. EMT (for doctors and patients, etc.): Emergency transport of doctors who have provided initial treatment and patients in the event of a disaster or sudden illness, etc.

2.2.2 Cargo Transport

1. Emergency transport of goods: Transporting required goods when disaster event occurs.
2. Inter-facilities: Transporting goods or products between facilities owned by a company/organization.
3. Cargo delivery (sea and mountainous areas): Transporting cargo along routes over the sea and within mountain areas (incl. remote medical care).
4. Cargo delivery (urban areas): Transporting cargo in urban areas.

In addition to the above, AAM is expected to include use cases in which companies independently introduce and use for their own purposes as well as, in the future, private ownership and use by individuals for their own personal use.

2.3 On-ground infrastructure

2.3.1 Vertiports

Definition/Overview
A “vertiport” is considered an "airport, etc." under the Civil Aeronautics Act, as a type of "heliport" dedicated to AAM. In the AAM operating environment, it is anticipated that there will be vertiports of various sizes with single or multiple Final Approach and Take-Off Areas (FATOs).

Vertiports may be dedicated to passenger transit, cargo loading, maintenance, or a blend of these functions. It is expected that they will be established more quickly than traditional aerodromes and airports due to the smaller scale of operations and smaller site area required.

Variations may exist in how vertiports will serve the local area. There may be a single vertiport within a local urban area. Alternatively, many vertiports within a local urban area may be operated by different organisations.

In the beginning, although AAM operations are expected to utilize existing rules such as the use of existing aerodromes/airports (referred to hereinafter to include heliports.) and permission for off-site take-off and landing. And new, dedicated vertiports will be needed to enable connectivity where existing aerodromes/airports do not already exist. Existing aerodromes/airports can be used for eVTOL operations if the necessary requirements are met. For instance, there is a likelihood that additional facilities such as electrical chargers, battery swapping equipment and fire extinguishing equipment for battery fires will be needed.

Facilities

For vertiports, the infrastructures appropriate to the size, performance, and operating conditions of the anticipated AAM aircraft will be required. In order to ensure safe operations at night and in bad weather conditions, vertiports may be necessary to establish instrument flight rules and to install air navigation facilities and other equipment associated with such rules. Infrastructure and equipment requirements for safety purposes will need to be standardized at vertiports.

Some vertiports may have dedicated spaces for AAM aircraft that are not in operation to park. The location where an AAM aircraft parks will be coordinated between the vertiport operator and the AAM aircraft operator. Movement between a FATO and an aircraft stand will take place while the AAM aircraft is on the ground (either moved using ground movement equipment or ground taxi under its own power) or in a low hover (if possible, at the vertiport).

Configuration

It is anticipated that vertiport capacity will affect the capacity of the whole AAM network, especially in the early stages when there are expected to be few vertiports available.

Some vertiports will have facilities for AAM aircraft to move from the FATO to a stand so that the FATO is available for other AAM aircraft. There will be a mix of vertiports with and without stands.

Since it is anticipated that the vertiports may be required to be used by AAM or other aircraft in off-nominal and emergency situations, preparedness for emergencies that might occur at the vertiport or another nearby vertiport should be considered.

Vertiport capacity will largely depend on the number and throughput of the FATO as well as the number of stands. This capacity will be impacted by the following.

- FATO occupancy time (arrivals)
- FATO occupancy time (departures)
- Departure's profile, arrival’s profile
- Effect of wake turbulence and separation
- Noise abatement or other specific airspace procedures required at the vertiport
- Turnaround time at stand (including charging time)

International Regulations and Standards

Currently, international and national unified design standards dedicated for vertiports do not exist. In Europe, EASA published Prototype Technical Specifications (PTS) for the design of VFR vertiports for the operation of manned aircraft with VTOL capability certified in the enhanced category in early 2022. The FAA issued an Engineering Brief, an interim design standards for vertiports in September 2022 ahead of a performance-based Advisory Circular around 2024.

ICAO is expected to produce an international standards (SARPs) for vertiports but this will likely take 3 to 5 years to complete. Similarly, standards for vertiport operations, which are anticipated for passenger transport VTOL flights, do not yet exist. However, standards development organisations, in particular EUROCAE, are in the process of developing guidance for vertiport operations for piloted VFR VTOL operations. EUROCAE has published an overarching guidance for vertiport operators and operations in 2022, and are working with industry stakeholders to develop further guidance and standards for the various specific aspects. These guidance documents could be used as a foundation for developing a vertiport certification regime.

Existing design and operational standards for aerodromes and heliports do not adequately account for the performance of eVTOL aircraft. The application of Obstacle Limitation Surfaces (OLS) requirements for eVTOL aircraft performance to vertiports is expected to promote the establishment of vertiports in urban areas and introduction and widespread use of AAM aircraft.

Regulations and standards will define the capability of vertiports for normal and off-nominal operating conditions. To enable the safe and timely introduction of vertiports in urban areas especially, and to support commercial AAM aircraft operations, the design and operational requirements (in partnership with industry where appropriate) need to be developed.

2.3.2 Non-public/public vertiports

A wide range of AAM aircraft types, configurations and performances are expected. The diversity of AAM aircraft is anticipated to increase in the long term with new market entrants, but on the other hand, it may reduce when there is industry consolidation. Vertiport design standards will need to be AAM aircraft agnostic and be able to accommodate the configurations and capabilities of any AAM aircraft.

Like existing heliports, there are public (available for unspecified operators) and non-public vertiports. For public use, the specifications must in principle be able to accommodate any AAM aircraft that is expected to be operated, and it is assumed that an entity independent from AAM aircraft operators will operate them. On the other hand, for non-public use vertiports, a few models of operation are envisioned such as an aircraft operator operates a vertiport directly, a vertiport operator enters into a contract with specific AAM aircraft operators only, and others.

AAM aircraft agnostic vertiports servicing many AAM aircraft operators will create a network effect of connections between RAM and UAM, as well as increase the utilization of the vertiports and AAM aircraft with the growth in scope and number of flights, which in turn is expected to reduce the cost of AAM aircraft operations and ticket prices for the passengers. To make this possible, it is expected that there will be different mission and take-off/landing profiles available at the vertiport with multiple operators of AAM aircraft. In addition, considering challenges such as airspace constraints and the lack of suitable vertiport installation sites in urban areas, there is a greater need for AAM aircraft agnostic vertiports.

2.3.3 Integration with existing aviation infrastructure

Locating vertiports at existing aviation infrastructure will maximise the use of existing airport facilities and provide seamless connectivity between AAM aircraft services and commercial air transport services. It can provide customers with a quick and comfortable means of transportation between the airport and city, and as a result, AAM can complement or replace surface transportation to and from airport. Secondary traffic from airports is expected to be an initial use case for AAM.

Airports are complex operating environments with a wide range of challenges and changing needs. When locating a vertiport at an airport, there are a number of factors to consider, including aerodrome approaches/departures of existing aircraft and runway capacity, safeguarding and other local requirements. The location of the vertiport should avoid areas that affect approaching or departing aircraft as possible in order to maintain safety and protect the throughput of existing runway operations. At airports with high traffic volumes and limited new airspace capacity, it is necessary to consider ways to minimize overall capacity reduction, such as operating AAM aircraft independently of other aircraft operations as much as possible, taking into account their performance characteristics.

The introduction of AAM operations close to the airport, in the controlled airspace, will require air traffic control to have a clear understanding of the processes and procedures being used at the vertiport to maintain safety and optimise traffic flow. It will be essential that the control agency always ensures that operations remain deconflicted in the event of baulked landings or when traffic needs to 'go around'.

The positioning of any vertiport must also take into consideration its impact on obstacle limitation surfaces of the airport to ensure safety and understand its impact on airport and aircraft operations and the neighbouring communities.

Integration of vertiports and AAM operations within an aerodrome/airport will depend on many factors, and will depend on the physical size of the airport, the apron area that the AAM aircraft will use, proximity to other aircraft, as well as existing traffic levels.

It is desirable that AAM operations are deconflicted with existing aircraft operations but remain within the airport area so that AAM passengers are close to terminal buildings. Passengers will need to connect with the air services, and the existing surface access infrastructure. Also, vertiports may be located within the airfield but in an area separate from existing operations, so that AAM operations are deconflicted with existing aircraft or vehicles moving on the ground. In addition, locating the vertiport in a separate area will allow passengers to avoid any security screening that would have been required to enter the secure areas of an airside (restricted zone).

The following areas will need to be considered when planning a vertiport on or close to an existing airport:

- If conflicts with existing aircraft are anticipated, emergency response methods and means of communication should be clarified so as not to affect the operation of existing aircraft.
- The vertiport desirably use the existing airport's rail, underground and road networks to avoid introducing new surface access links and provide accessibility for all.
- Interchangeability between AAM services and existing air and ground services are desired to be as frictionless and fast as possible for passengers.
- Consideration should be given to the characteristics of electric powered AAM aircraft, specifically the specifics of fires caused by AAM aircraft energy storage and propulsion systems (e.g., lithium-ion battery thermal runaway).
- The hazards when AAM aircraft operate within the airfield apron and adjacent to traditional aircraft should be considered.
- Safeguarding of the vertiport and impact on the Obstacle Limitation Surfaces will need to be guaranteed.
- The environmental impact and noise profile and performance of the AAM aircraft and components should be monitored and managed.
- Air traffic control operations where vertiports are co-located with airports must be specified.

2.3.4 Charging Infrastructure

Since multiple specifications are expected for charging facilities, especially for connectors, it is necessary to consider the AAM aircraft that are expected to be operated at each vertiport.

There are currently two known methods of charging of AAM aircraft: (1) battery replacement and (2) direct charging. Each method comes with advantages and disadvantages and the requirements on charging infrastructure are different.

Battery replacement may require space in the vertiport for battery charging facilities and storage. There is also an operational need to locate these facilities close to the aircraft stand for fast swapping to enable fast AAM aircraft turnaround.

Direct charging points need to be installed at each aircraft apron to facilitate fast charging during AAM aircraft turnaround. There may be a requirement to situate a power transformer or charging unit off site to supply these direct charging points. Appropriate ground servicing equipment will be needed to support the AAM aircraft.

At this time, the details of the charging system, etc. of AAM aircraft have not been clarified, but the parties involved will need to coordinate the division of responsibilities for the installation and operation of charging and power receiving facilities in the future.

2.4 Airspace, Traffic Management

2.4.1 Current Airspace Context

The current airspace conditions are shown in the figure below.

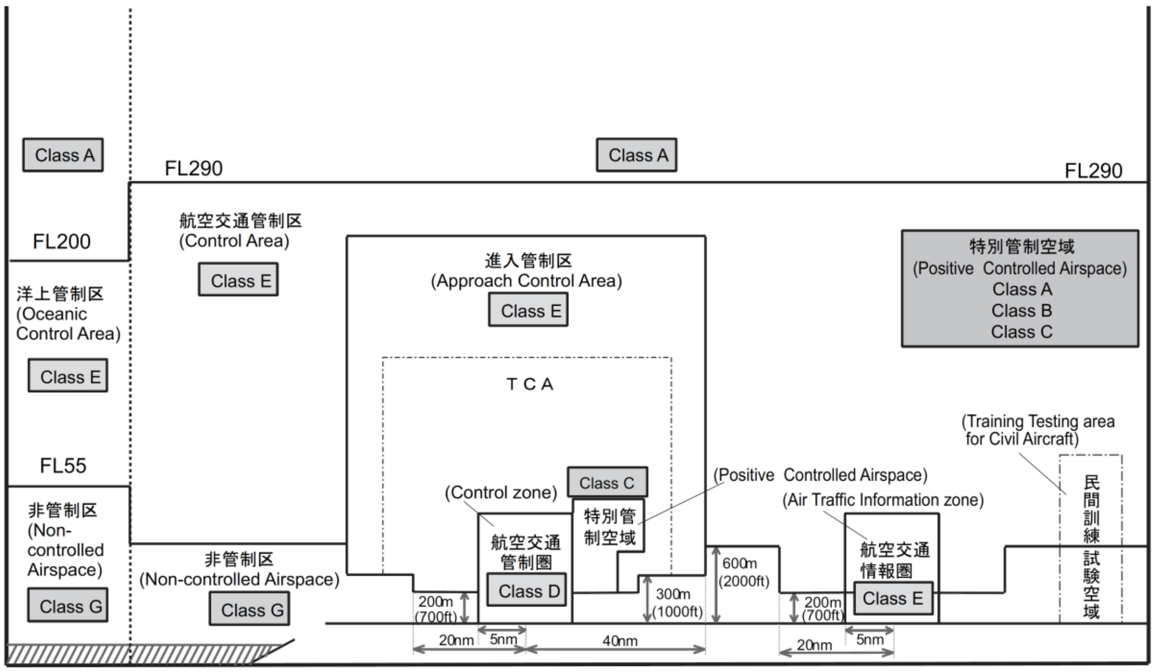


Figure 2-1 Airspace Conditions (extracted from AIP)

2.4.2 AAM use of Low-level airspace

This section describes how both UAM and RAM will operate in airspace.

UAM aircraft will operate in low-level airspace mainly inside the urban environment. Drones are basically required to fly less than 500 ft (150m) above ground level. UAM, on the other hand, are required under Article 81 of the Civil Aeronautics Act to fly at an altitude at or above the minimum safety altitude specified by ministerial ordinance, except when taking off or landing. Therefore, the airspace in which drones and UAM cruise is considered to be separated to a certain degree. However, there are cases where drones fly at or above 500 ft (150 m) with permission, and UAM flights for search and rescue to which Article 81-2 of the Civil Aeronautics Act applies and UAM flights based on permission under the proviso of Article 81 of the Civil Aeronautics Act may fly at altitudes below the minimum safety altitude. Also, UAM aircraft will operate in the same airspace as drones around aerodromes and vertiport locations. In such cases, it would be necessary to maintain safety intervals between the UAM aircraft and the drones.

Depending on the flight path and destination, UAM aircraft may need to transit through airspace that is both controlled and uncontrolled.

In the future, there will be more variety in the types of aircraft, operators and missions in the low-level airspace, including a mix of piloted and autonomous aircraft, etc. No single category of operators will have exclusive use of airspace, and it is envisioned that all operations will need to be integrated.

Considering that UAM operations will expand significantly due to urban traffic, etc., and the remote control or automated/autonomous operations are envisioned, etc., the current VFR with only visual safety measures will eventually reach its limits. Therefore, in order to respond to the increasing scale and upgrading operation configuration of UAM, a new concept of airspace and traffic management is needed to ensure safe and smooth air traffic by coordinating operations in certain airspace from the strategic phase. The airspace in which new traffic management services (see UATM services in the next section) will be provided based on the expected UAM traffic conditions is defined as "UATM Service Area (UASA)". UASA may include both controlled and uncontrolled airspace. The UASA is determined by ANSP on a flexible basis, based on the density and frequency of UAM operations and surrounding traffic conditions, and is not limited to the urban area.

Long-range RAM operations are expected to fly at higher altitudes than UAM operations. Due to the operational characteristics and scale of operations, it is expected that existing airspace and traffic management concepts are used for RAM operations for part or all of their flight.

Vertiport Airspace

Around a vertiport, airspace will need to be structured to enable aircraft to transition between departure/arrival and cruise phases of flight. Entry and exit points to/from vertiport airspace, arrival departure paths, and missed approach paths will be needed. The design of the obstacle limitation surfaces around vertiports will need to include consideration of obstacles and protection of airspace.

Similar to aerodromes and some heliports, busy vertiports may require slot and stand allocation to ensure the capacity of the airspace and landing infrastructure is maximised. Vertiport airspace will be flexibly activated and deactivated as needed.

UAM Routes & UAM Corridors [3][5]

UAM routes and UAM corridors provide means to structure airspace and mitigate the impacts of increased AAM flights volumes. UAM routes are established to increase the predictability of UAM aircraft locations, thereby improve situational awareness of other low-level airspace users. UAM corridors are established to allow for high-density UAM operations, especially when UAM operations are particularly high-dense and airspace capacity needs to be increased. The establishment of UAM routes and UAM corridors is expected to be based on the consideration of the frequency of UAM flights volumes. It should take into account not only the frequency of UAM flights volume but also the weather conditions in the surrounding area.

UAM routes are established to connect airports/vertiports. As a concept they are similar in nature to existing paths used by helicopter or VFR routes and provide routes connected to vertiport airspace entry and exit points, but it may be set as part of a route. In combination with position reporting points, UAM routes have benefits for the pilot and Air Traffic Control through improved awareness of AAM aircraft location. Route design can reduce on ground safety risk and noise impact. Setting UAM route does not necessarily require significant regulatory change compared to UAM corridors.

To enable access and equity, UAM routes can be used by aircraft other than UAM. However, depending on the location of routes, their use may require certain standards. A set of routes in an urban environment will form a network of routes with multiple points of interconnection between routes and to vertiports/airports. Key advantages of using UAM routes is the early adoption and the ability for them to be used with current other types of routes and airspace users.

The UAM corridor is a dedicated airspace which connects airports/vertiports. Aircraft use them complying with specific rules, procedures, and performance requirements. Like UAM routes, it may be set as part of a route. In the case that UAM corridors connecting two points increase, the shape may be changed based on airspace conditions. This type of airspace makes it mandatory to follow UATM services, and could be used where specific performance requirements are required to enable increased capacity of airspace. For example, UAM corridors may be advantageous for routes near airports which may have limited airspace volumes and require high utilisation. Where used with new (currently undefined) flight rules, UAM corridors has the potential to expand the weather conditions under which flights can be conducted.

UAM corridors, UAM routes and vertiport airspace may be used to support both strategic and tactical deconfliction of AAM aircraft through means such as public notification by aeronautical information. To operate in UAM corridors, operators must meet appropriate equipment requirements and performance requirements, and follow specific procedures. UAM corridors restrict access to airspace for airspace users who do not meet applicable requirements. The ability to create UAM corridor networks to support the location of where AAM aircraft want to operate may be challenging due to a need to enable fairness and equity across all airspace users. Introducing UAM corridors would require new regulation and procedures to ensure effective implementation and awareness of the airspace by all airspace users. The use of UAM corridors should be limited to situations where the benefits are required.

2.4.3 Air Traffic Management

Existing aircraft flight has been increasing in sophistication and refinement in response to the need for segregation of airspace and appropriate separation distances between aircraft due to the increase in number of aircraft, and the subsequent increase in the number of users and diversification of operations.

Initially, AAM aircraft are expected to operate within the requirements of the current ATM operating environment in accordance with existing procedures and/or concessions. As the AAM industry matures, various aircraft with varying levels of automation/autonomy (including piloted, partially automated and fully autonomous operations) are expected to operate within the low-level airspace. Increased density of operations, development of automation/autonomy, and the diversity of airspace users in the UASA are expected to require upgrading of the current ATM system.

New “Urban Air Traffic Management (UATM)” systems and services will be needed to support the operation of AAM aircraft in the UASA.

UATM services will support AAM aircraft operators in meeting AAM operational requirements that enable safe, efficient, and secure use of the UASA [3]. It may also provide value-added services to AAM aircraft operators. These services optimize operations of diverse airspace users in the UASA and provide authentication of access to data to support AAM operations. Also, UATM services will be provided with various supporting data including, but not limited to, terrain, obstacle, aerodrome availability, and weather. [3]

UATM services will support AAM operations and the goal is to maximize the performances of UASA. It requires balancing the individual items (e.g., flight efficiency as well as access and equity) while safety must, without exception, always meet acceptable levels as required under regulation. If traffic density is low in the initial AAM operations, they are expected to rely on current ATM services. UATM services will be implemented where benefits can be achieved from the standpoint of maximizing performance.

UATM’s set of services will include the followings.

- Information Exchange
- Airspace Management
- Conflict Management
- Flight Plan Confirmation/Authorization
- Conformance Monitoring

Not all services will be necessarily required during the initial phase of supporting AAM operations. These services will need to be introduced progressively and mature as the scale of AAM operations grows and technology improves. The UAM maturity level of these services may vary in each UASA depending on their utilization.
It is envisioned that the scope of aircraft and airspaces to which the UATM service will be provided will be expanded depending on the scale of operations, and that all aircraft in the UASA will eventually receive these services with respect to the aircraft to which it applies.

Information Exchange
To support the safe and efficient operation of AAM aircraft, the Information Exchange service will initially provide with a voice communication service by ANSP, and will be expanded in phases according to the maturity of AAM operations, progress in technological development, and the actual status of operations and congestion in the airspace. Specifically, it is envisioned that approved data will be exchanged among ANSPs and other concerned parties via an information sharing infrastructure such as System Wide Information Management (SWIM), paying attention to information management and security. This information will include flight data, restrictions, air route information, active special active airspace (SAA), etc. In the future,

timely and accurate data exchange among low-altitude airspace users including ANSPs, will ensure shared situational awareness for all low-altitude airspace users.

Airspace Management

Airspace Management will maximise the use of low-level airspace as environmental and operational needs shift. The service also aims to be responsive to traffic management needs during nominal and off-nominal scenarios. Consideration will be given to introducing dynamic airspace management as the scale of operations expands. Airspace and route/corridor availability for AAM operations will vary for a number of reasons. Furthermore, changes to airspace availability (e.g., Priority for rescue and relief operations in the event of an emergency or disaster) will be variously predictable and unpredictable.

Conflict Management and Flight Plan Confirmation/Authorization services will need to be based upon known airspace and route/corridor availability at the time of flight planning. Following changes in airspace and/or route/corridor availability, existing authorisations, including those already in flight, must be reviewed to determine how the changes affect the flight plans and whether the existing flight authorisations need to be cancelled or amended.

Conflict Management

Conflict Management will ensure that demand for AAM is met to the greatest extent practicable in the context of the limited resources in the airspace and vertiports. To maximise the capacity of vertiports, Conflict Management will be required to manage arrival and departure times (slots and stands).

If capacity changes at a vertiport, previously planned flights must be reviewed to ensure that vertiport capacity is not exceeded.

Flight Plan Confirmation/Authorisation

Flight Plan Confirmation/Authorisation will be in response to a flight plan for commencing operations of AAM aircraft. The current ATM service only confirms flight plans for VFR operations, but as the scale of operations increase, it will be required to prior coordination with authorize flight plans submitted by operators or pilots after reviewing it and making necessary adjustment. The flight planning including Conflict Management must align with the strategic objectives of the overarching UATM system.

Conformance Monitoring

Conformance Monitoring aims to provide timely information and present responses for non-conforming aircraft affecting the operation of UATM services and for other AAM aircraft affected by such non-conforming aircraft.

Conformance monitoring is to ensure that AAM aircraft within the UASA are flying in compliance with the confirmed/authorized flight plan, including monitoring and supporting such operations in the event of off-nominal operations described in APPENDIX 2. Accountability for conformance with the flight plan will lie with pilots or AAM aircraft operators.

Initially, the service will primarily provide for the coordination of changes to the flight plan over time.

In order to achieve a higher level of AAM operations, the parties concerned will continue to discuss the specific services required to avoid conflicts in real time, including spatial and temporal deviations from the planned flight path, altitude, and estimated time of passage. In

addition, the performance and reliability of the CNS, including the navigation performance required for each airspace and route, and the means of communication with noncompliant aircraft, will also be studied.
Conformance monitoring will not only function as a means to ensure the safety of both noncompliant aircraft and other AAM aircraft affected by noncompliance and to mitigate risks, but will also contribute to the future development of high-density operations and automated/autonomous operations through the understanding of AAM operational performance.

Integration of ATM, UTM, and UATM

Traffic management systems for AAM, drones and traditional aircraft will need to interact with one another, or be integrated, to support deconfliction, shared situation awareness and collaborative decision making. As traffic density increases further and greater levels of aircraft autonomy are implemented, this is likely to bring about the need for highly integrated and unified airspace management across all traffic management systems. A common three-dimensional coordinate system of latitude, longitude, and altitude could be an effective means of achieving this.

It will be important to define a framework for the integration and information management between ATM, UATM and UTM services. A common information exchange system will need to be used to share information between ATM, UATM and UTM systems.

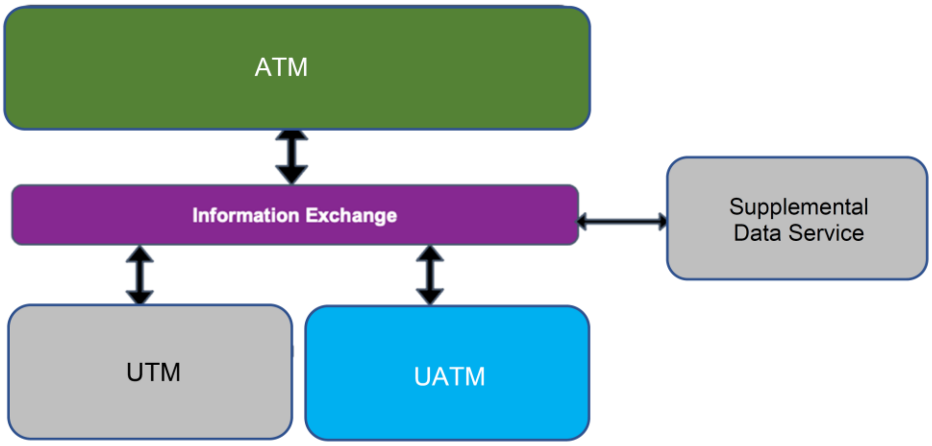


Figure 2-2 UATM, ATM and UTM Interfaces

2.5 Roles & Responsibilities

The roles and responsibilities of key stakeholders are listed below. Depending on the use case of the AAM, other stakeholders may have important roles. (e.g., local firefighting organizations)

2.5.1 AAM Aircraft Maker

AAM aircraft makers are responsible for designing and manufacturing safe AAM aircraft. They will have to obtain type certification and ensure the continued airworthiness of their respective AAM aircraft.

2.5.2 AAM Aircraft Operator

AAM Operations Management [3][4][5]
AAM aircraft operators manage their respective AAM aircraft operations. They are responsible for selecting the aircraft and pilot for incoming ride requests. In coordination with the pilot, the AAM aircraft operator submits a flight plan.

AAM aircraft operators conduct operations as scheduled service or on-demand service. Also, the AAM aircraft operator holds the operating certificate and is responsible for operational management. In addition, the AAM aircraft operator is responsible for meeting regulatory requirements and certification, planning flights, and sharing flight plan and current position information of its aircraft in the UASA. It is also responsible for pilot training and maintenance regime of the aircraft as well as passenger security screening and boarding procedure.

Pilot-in-Command (PIC) [4]
The PIC is a person who holds "final authority and responsibility for the operation and safety of the flight" of an AAM aircraft. This individual may be onboard or remotely operating the AAM aircraft.

A PIC who is not onboard while operating the aircraft is a remote PIC (RPIC). The PIC receives training and certification at a level deemed appropriate by JCAB for their role in the operation.

2.5.3 Vertiport Operator [5]

A vertiport operator, in consultation with regulators, defines what services their vertiport provides and to whom those services are provided. Vertiport operators are responsible for ground operations at the vertiport. They are also responsible for overseeing ground safety, security such as entry/exit control and charging or refuelling, although these responsibilities could sit with AAM aircraft operators or other third parties. The vertiport operator provides information regarding the operational status of their vertiport, including the availability of FATOs, stands (where applicable), personnel and charging facilities.

2.5.4 Maintenance and Ground Services Provider [4]

Maintenance and Ground services for AAM aircraft, including recharging, aircraft inspection/maintenance, aircraft servicing (food/beverage), deicing, passenger guidance and safety, security screening, and other applicable services will be similar to those at today's commercial airports and Fixed Base Operators (FBOs, Operator of flight support services).

These services will be provided by suitably qualified and trained personnel who will be employed by vertiport operators, AAM aircraft operators, or third parties contracted by either the vertiport operators or AAM aircraft operators, but the AAM aircraft operators are responsible for the aircraft maintenance regime and passenger security screening. Also, personnel who will be handling the re-charging of the eVTOL should receive the necessary training.

2.5.5 Japan Civil Aviation Bureau (JCAB)

The JCAB serves as both the regulator and the ANSP, although there is a clear distinction between the two roles.

Regulator

The regulator is responsible for certification of all safety-related elements including the aircraft, aircraft crew and vertiport. The regulator is the authority over aircraft operations in all airspace, and the regulatory and oversight authority for civil operations. The regulator maintains an operating environment that ensures airspace users have access to the resources needed to meet specific operational objectives and that shared use of the airspace can be achieved safely and equitably.

The regulator develops or modifies regulations to support AAM operations. The regulator may also provide guidelines to ensure that the regulator authority is maintained.

ANSP

The ANSP coordinates aircraft movement through controlled airspace, preventing collisions and ensuring efficient air traffic flow. Depending on the specific mandate, an ANSP provides one or more of the following services to airspace users:

- ATM services
- Aeronautical Information Management (AIM)
- Communication, Navigation and Surveillance (CNS)
- Meteorological (MET) services for air navigation
- Search and Rescue (SAR) services

In some States, the ANSP will accommodate AAM operations through the provision of ATM and/or other services. Also, the roles and responsibilities of the traffic management for the AAM environment (UATM) will be executed by the ANSP or delegated to an organisation or organisations. The decision to centralise or decentralise services will vary between countries and determined by each country's airspace conditions and legal framework. In Japan, UATM services are planned to be provided by ANSP. However, while AAM aircraft operations require the same level of safety as operations in a conventional ATM environment, it will continue to be investigated how to specifically ensure a high level of safety, given that in the future AAM aircraft with various speeds and flight characteristics are expected to operate at unprecedentedly high frequencies and densities. (Outside of UASAs, existing ATM services and other services will be provided.)

2.5.6 UAS Service Suppler (USS) [3][5]

USSs are entities that support drone operations under the UTM system. AAM operations are expected in the low-level airspace where drones operate. Some services that are provided by USSs will interact with UATM services as follows:

1. Enable UTM operations to use UATM services
2. Support AAM off-nominal operations as needed

Also, any systems used for UATM need to exchange information with a USS, which are key roles in UTM.

2.5.7 Supplemental Data Service Provider (SDSP) [3][4]

AAM aircraft operators and UATM services can use SDSPs to access supporting data including, but not limited to, terrain, obstacle, aerodrome availability, and specialized weather. SDSPs may be accessed via the UATM services or directly by AAM aircraft operators. Multiple service providers may provide similar information and be selected at the discretion of the user. The services supplied by an SDSP may be raw data, value added data, one or a suite of decision support tools.

2.5.8 Other Regulators [4][5]

Given the impact of AAM on noise in the urban environment, it will be important to ensure that the roles with respect to aircraft noise management are clearly defined.

Land planning will have important roles with respect to vertiports. Local governments have a greater role in AAM because AAM operations occur largely in cities near local communities and urban areas. Regulations related to urban planning, noise, infrastructure, etc. can impact selection of the locations of vertiports and the number and routes of AAM flights.

Regulators / Authorities which govern other related laws and regulations such as environmental assessment, electric power grid, telecommunications need to be considered.

3 Phases of Advanced Air Mobility Introduction

This chapter describes the phases of the incremental implementation of the AAM.

3.1 AAM Phases [5]

The introduction and growth of AAM operations will occur over a number of Phases:

- Phase 0 – Test flights and proof of concept flights prior to commercial operations
- Phase 1 – Commencement of commercial operations - low density (pilot on board, cargo transport with remotely piloted operations) : Around 2025
- Phase 2 － Scaled operations - medium to high density (pilot on board and/or remotely piloted) : Late 2020's or later
- Phase 3 – Establishment of AAM operations which include autonomy - high density (integrated with automated / autonomous operations) : 2030's and beyond

In this document, the phases are separated from qualitative perspectives, such as whether or not a pilot is on board, developments in automation/autonomy, and complexity of traffic management. Further accumulation of knowledge and experience, and verification, etc. are needed to define qualitative figures for the density of operations, etc. in each phase. [9]

Trials and demonstrations of more advanced technology will continue to occur through all phases. The aircraft, vertiports and airspace/traffic management in these phases are described below.

3.2 Phase 0

During Phase 0, trials and demonstrations will occur prior to commercial services. Test flights and proof of concept flights will require appropriate approval by JCAB following the safety standards of Civil Aeronautics Act. Operations will occur in a way to mitigate the associated safety risk. For example, operations may be conducted in segregated airspace away from populations on the ground. Trials and demonstrations will be conducted in accordance with the "Guidelines on the Application of the Civil Aeronautics Act to Test Flights, etc. of AAM."

3.2.1 Preparation for Phase 1

During Phase 0, some AAM aircraft will achieve type certification in accordance with the Japanese type certification process.

The design, planning and implementation of airspace, which are required for initial commercial operations, will commence in Phase 0. Analysis will be undertaken to understand the airspace capacity which can be enabled in Phase 1, prior to Phase 2.

Airspace and associated procedures developed in this phase to support Phase 1 will primarily be based upon existing airspace and ATM concept.

Use of existing airspace and ATM concepts in Phase 1 will ensure smooth initial implementation of AAM. For the introduction of more complex or new concepts, further sophistication should be sought in Phase 2 and beyond.

Vertiport design and operating requirements will need to be established with associated approval processes to enable construction of vertiports to commence. Vertiport planning and approval frameworks will need to consider social acceptance and community engagement requirements.

Preparation for AAM operations will also need to consider appropriate social acceptance and community engagement at locations overflown by AAM aircraft. Procedures and route structure planning should consider community impact as well as the impact on other airspace users.

The future scale of operations beyond initial introduction should be included in community and airspace user considerations for vertiport locations and airspace usage.

3.3 Phase 1

Phase 1 will see the initial introduction of commercial AAM operations in Japan. Preparation for Phase 2 will need to occur in Phase 1.

In Phase1, for passenger carrying AAM operations, initial operations are expected to occur in low density and be piloted under VFR, similar to existing aircraft operations.

Remotely piloted (no pilot on board) cargo AAM operations will require an appropriate safety standard.

In addition to a certified aircraft, AAM aircraft operators may need to have an approved Aircraft Operating Certificate and safety standards for the associated operating procedures.

Initially, it is anticipated that existing airports and other existing rules such as off-site take-off/landing permits will be utilized, but relatively small-scale vertiport developments are also envisioned.

A new or amended existing ATM framework will need to be implemented to operate AAM aircraft in surrounding vertiport airspace and at airports and vertiports. Airspace and associated procedures used during this phase will need to be primarily based upon existing airspace and existing ATM framework.

The low density of the Phase 1 will allow for the initial introduction of UATM services, which will operate based on existing ATM concepts but will not require significant regulatory changes or technological innovation. Basic UATM services may be used in Phase 1 to enable vertiport network management as vertiport resource availability may be a constraint on the overall AAM system performance. The services will primarily be used for situation awareness and balancing demand and capacity at vertiports. UATM services are likely to be used by AAM aircraft and vertiport operators.

UATM services in Phase 1 may include:

- Information Exchange (Providing information by voice in the vertiport airspace and the UAM route)
- Airspace Management (Implementation of vertiport airspace, UAM route, etc.)
- Conflict Management (Capacity management of congested ports)
- Confirmation of Flight Plan
- Conformance Monitoring (Obtaining location information using ADS-B, providing information by voice, etc.)

It is expected that advanced UATM services such as dynamic airspace management will not be used until the start of Phase 2, when an information exchange system among UATM stakeholders, including ANSP, becomes available and all airspace users in the UASA will use services provided by this system.

During Phase 1 as new vertiports and routes are established/designed, further consideration of the impact on community and other airspace users will be required.

It will be important, by the end of Phase 1, to conduct research, development and trial of more advanced concepts, such as UATM, to prepare for Phase 2 and beyond.

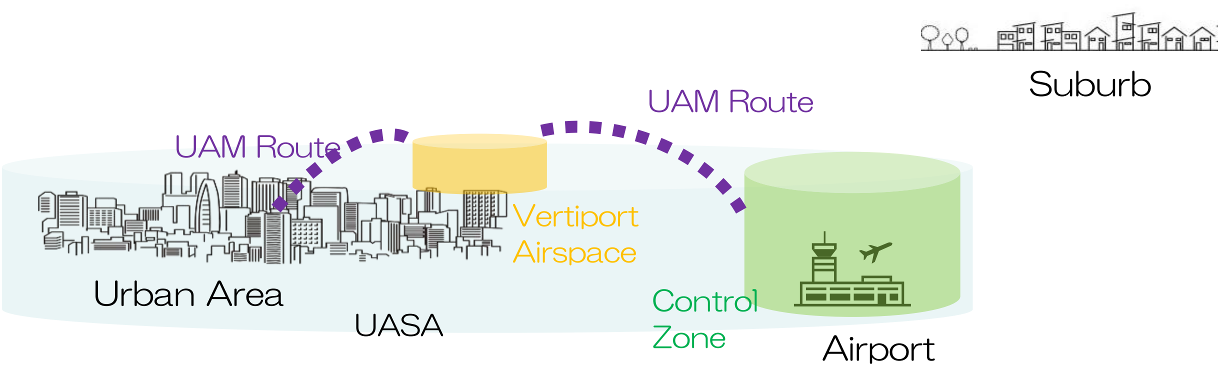


Figure 3-1 Phase 1

3.4 Phase 2

Phase 2 will see scaled Japanese AAM operations. In Phase 2, medium-to-high density, piloted operations are expected. In some urban environments, AAM operations will occur at a rate that is higher than traditional aircraft operations. AAM aircraft piloting may include remotely piloted oparetions of passenger carrying aircraft from the ground. Operations are expected in bad weather conditions.

Preparation for Phase 3 will need to occur in Phase 2, including significant research and development to enable the integration of autonomous operations.

A greater number, larger and more complex vertiports will be developed enabling higher capacity arrivals and departures. Design and operating requirements evolution maybe required to support more advanced vertiports, including in complex urban environments, e.g. on top of buildings.

Advanced traffic management systems and procedures will be required to support the scale and nature (e.g., remote piloting and IMC) of AAM operations. New airspace concepts and advanced UATM services will be implemented in Phase 2 where required. These new concepts and services may require new equipage and performance capabilities by participating aircraft. UAM routes or UAM corridors, as well as UASA may be used where appropriate.

UATM services in Phase 2 may include:

- Information Exchange (Information provision and exchange through data)
- Airspace Management (Implementation of UAM corridors and dynamic airspace management are included)
- Conflict Management (Advanced coordination including capacity management of airspace and flow management)
- Flight Plan Authorisation
- Conformance Monitoring (Real-time deconfliction will be also considered.)

In addition to AAM aircraft and vertiport operators, it is expected that other airspace users in the UASA will use UATM services in Phase 2 in a similar way to AAM aircraft.

An information exchange system between UATM stakeholders, including the ATM and traditional airspace users will be required.

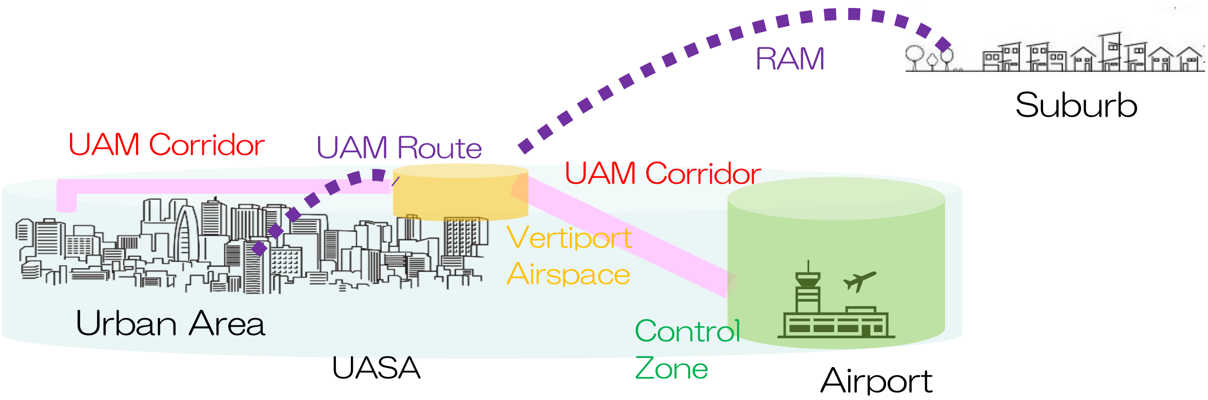


Figure 3-2 Phase 2

3.5 Phase 3

Phase 3 will see scaled Japanese AAM operations which include high-density operations. Operations in the UASA will include a mix of piloted and remotely piloted operations.

It is expected that, at some point, all airspace users in the UASA will use UATM services. UATM concepts may be expanded to other airspace outside of the UASA and integrated with ATM and UTM.

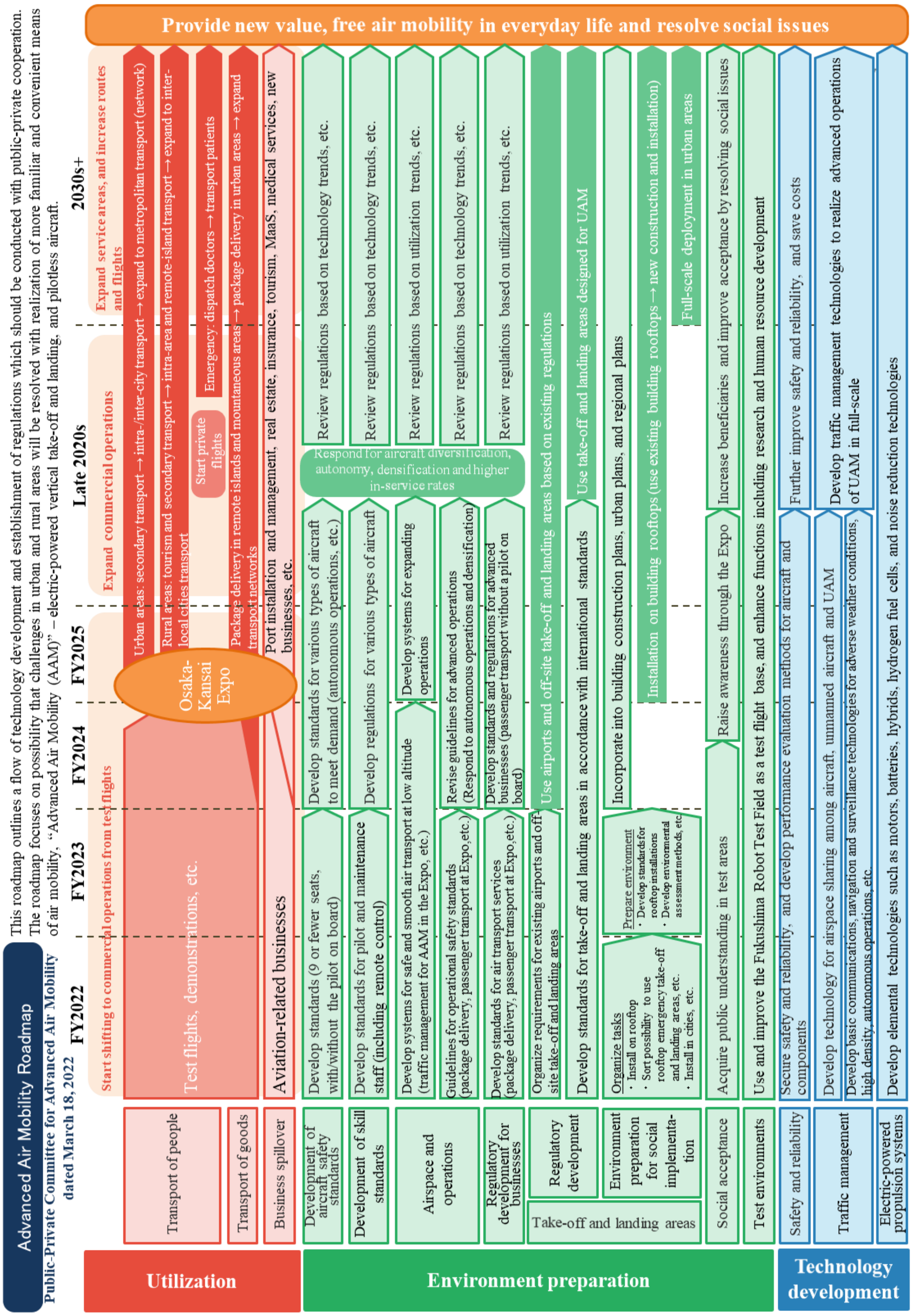
In addition, operations may become more sophisticated as autonomous operations commence.

4 Conclusions

Following discussions at the Official's Meeting of the Public-Private Council for the Air Mobility Revolution, we have compiled the "Concept of Operations (ConOps) for Advanced Air Mobility," which outlines the overall ecosystem, including the main elements of the AAM (airframe, ground infrastructure and traffic management), as well as the phases of phased introduction.

However, the content described in this document is based on current knowledge and projections, and it is important to constantly evolve the content based on future technological advances, overseas trends, and feedback from stakeholders. Therefore, it is envisioned that discussions will continue at the Public-Private Council for the Air Mobility Revolution, and that updated versions will be issued.

APPENDIX 1 Roadmap for the Advanced Air Mobility



APPENDIX 2 Typical AAM Passenger and Aircraft Journey

This section describes the steps that (1) the passenger and (2) the AAM aircraft will likely experience on a typical AAM flight. The purpose of these journeys is to highlight how stakeholders will interact, describe the roles in an operational context, and define the resources needed in the AAM infrastructure.

The steps of passenger and AAM aircraft reflect operations in a mature AAM environment with medium to high-density operations with a pilot on board (i.e., not autonomous operations). The journeys described are examples. Other additional or different functions and elements may be applicable in other scenarios.

(1) Example of AAM Passenger User Journey

- PREFLIGHT
  - **Book an AAM flight.** Passenger uses an app to book seats on an AAM flight and enter estimated weight of passengers and bags.
    - INTERACTIONS. AAM aircraft operator, Booking platform provider
    - TOOLS. App on mobile device, Desktop booking or in-person booking

  - **Travel to vertiport and check in.** Passenger takes transit or car to vertiport. On the way, they use an app from either the booking platform or AAM aircraft operator to check in for their flight.
    - INTERACTIONS. Ground transportation, Vertiport operator, AAM aircraft operator/Booking platform provider
    - TOOLS. App on mobile device or check-in Kiosk

  - **Weigh all bags and passengers.** Passenger uses a scale to weigh themselves and their bags at the vertiport to verify and update the weight estimated during check in. This information is sent to the AAM aircraft operator to ensure the AAM aircraft is correctly weighed and balanced. This process can be done prior to arrival of vertiport.
    - INTERACTIONS. AAM aircraft operator, Vertiport operator
    - TOOLS. Scale for weighing bags and passengers

  - **Receive safety briefing, undergo security screening and wait for flight.** The passenger views a short safety briefing on their mobile device, undergoes security screening, and waits for the boarding process to begin. A boarding call will be made and there will be a final verification of the passenger to ensure that the passenger boards the correct flight.
    - INTERACTIONS. AAM aircraft operator, Vertiport operator
    - TOOLS. App on mobile device, Waiting area/lounge

- BOARDING AND DEPARTURE
  - **Give bags to ground crew.** Passenger is assisted by ground crew in boarding process. Bags are given to the ground crew for loading.
    - INTERACTIONS. Ground crew

- TOOLS. AAM aircraft

- **Board AAM aircraft and follow safety instructions.** Passenger boards the AAM aircraft and puts on seat belts. Flight then takes off.
  - INTERACTIONS. Ground crew, Pilot
  - TOOLS. AAM aircraft

- CRUISE
  - **Passenger relaxes during the flight.**
    - INTERACTIONS. --
    - TOOLS. --

- APPROACH AND LANDING
  - **Disembark flight.** AAM aircraft lands on a vertiport and ground taxis or is towed to a stand. Passenger disembarks aircraft at the stand and goes to passenger terminal.
    - INTERACTIONS. Ground crew
    - TOOLS. AAM aircraft

  - **Collect bags and exit vertiport.** Ground crew unloads bags. Passengers pick up bags at designated area and exit vertiport.
    - INTERACTIONS. AAM aircraft operator, Ground crew, Vertiport operator
    - TOOLS. --

(2) Example of AAM Aircraft journey

- PREFLIGHT
  - **Plan flight and coordinate the use of vertiports.** AAM aircraft operator plans flight and share with UATM. AAM aircraft operator gains flight plan authorization, reserves vertiport slots, and gathers information about weather, aeronautical information, and other operational factors.
    - INTERACTIONS. ANSP, AAM aircraft operator, Vertiport operator
    - TOOLS. UATM service

  - **Pre-flight inspect AAM and transmit data about aircraft status.** Ground crews inspect aircraft for flight readiness. AAM aircraft transmits data about its system health to AAM aircraft operator.
    - INTERACTIONS. Ground crew, AAM aircraft operator
    - TOOLS. Cloud platform

  - **Move from hangar to vertiport.** If the AAM aircraft cannot be stored at the vertiport overnight, AAM aircraft needs to be moved from hangar to vertiport / stand for the first flight of the day.
    - INTERACTIONS. Pilot, ANSP, Vertiport operator
    - TOOLS. AAM aircraft, UATM service

- **Register flight plan information to the AAM aircraft.** AAM aircraft operator sends authorized flight plan to the pilot. Pilot accepts the flight authorization and registers the flight plan information to the avionics system on board.
    - INTERACTIONS. Pilot, AAM aircraft operator, ANSP
    - TOOLS. UATM service, AAM aircraft avionics

- BOARDING AND DEPARTURE
  - **Passengers board.** Ground crew ensures the aircraft is balanced and within weight limits. Passengers have checked in and begin to board. Ground crew loads bags into aircraft.
    - INTERACTIONS. Ground crew, Passengers
    - TOOLS. UATM service, Booking platform

  - **Turn on motors and depart.** Passengers complete boarding and ground crew closes doors. Pilot confirms readiness to depart, receives flight clearance, turns on motors to taxi (or be towed) and then departs vertiport.
    - INTERACTIONS. Pilot, ANSP, AAM aircraft operator, Ground crew
    - TOOLS. UATM service, Vertiport operator

- CRUISE
  - **Transmit position and system health data of aircraft.** AAM aircraft continuously transmits its position and system health data to ANSP and AAM aircraft operator throughout the flight.
    - INTERACTIONS. Pilot, ANSP, AAM aircraft operator
    - TOOLS. AAM aircraft, UATM service,

  - **Fly in accordance with flight plan and survey surroundings.** AAM aircraft fly in accordance with its flight plan and continuously surveys surroundings for aircraft status and potential conflicts.
    - INTERACTIONS. Other AAM aircraft
    - TOOLS. AAM aircraft

- APPROACH AND LANDING
  - **Descend, land and taxi to stand.** Pilot descends to vertiport, lands with confirmation by UATM service, and ground taxis (or be towed) to the stand.
    - INTERACTIONS. ANSP, Vertiport operator, Pilot
    - TOOLS. AAM aircraft

  - **Turn off motors.** At the stand, the pilot turns off the motors (or prior to towing from TLOF). When the rotors or towing stops, the doors open to let passengers disembark. Ground crew unloads baggage from aircraft.
    - INTERACTIONS. Pilot, Ground crew, Vertiport operator
    - TOOLS. AAM aircraft

- POST-FLIGHT / BETWEEN OPERATIONS
  - **Send flight closure notice.** Pilot sends a flight closure notice to UATM service, which is shared with AAM aircraft operator.

- INTERACTIONS. Pilot, ANSP, AAM aircraft operator
- TOOLS. UATM service, Cloud platform

o **Charge / Swap batteries, inspect aircraft and prepare for next flight.** If needed, ground crews recharge or swap AAM aircraft batteries. They clean the cabin, inspect the aircraft, and ensure readiness for the next operation. Ground crews share updates on aircraft status with pilot, and AAM aircraft operator.

- INTERACTIONS. Ground crew, Pilot, AAM aircraft operator, ANSP
- TOOLS. Battery charger, Cloud platform, UATM service

- END OF DAY

o **Move to hangar.** After the last flight, the pilot or ground crew move the AAM aircraft to a hangar for overnight storage if not stored at vertiport.

- INTERACTIONS. Pilot, Ground crew
- TOOLS. AAM aircraft

o **Turn off motors and receive maintenance.** At the hangar, the pilot turns off the aircraft. Ground crews then conduct any maintenance activities and fully recharge the battery in preparation for the next day. This activity could also occur at the vertiport.

- INTERACTIONS. Pilot, Ground Crew
- TOOLS. Battery charger, Cloud platform, UATM service

o **Transmit system health data.** After maintenance is complete, the AAM aircraft automatically sends the AAM aircraft operator an update about its system status and health. This process may also be continuously used during operations.

- INTERACTIONS. AAM aircraft operator, ANSP
- TOOLS. AAM aircraft, Cloud platform

(3) Off-nominal Flight [5]

An AAM aircraft may need to change aerodrome or vertiport destination due to various onboard reasons such as technical system failure, sudden illness or disorientation of the pilot. An off-nominal situation may also arise from external issues such as vertiport unavailability or bad weather.
If an AAM aircraft is enroute to its destination and there is doubt about landing at the landing site, it will be necessary to change the landing site and reroute the aircraft to another alternative airport, etc.
One or possibly several alternative airports, etc. and suitable take-off and landing sites other than the destination should be predefined prior to departure to allow for unforeseen circumstances.

Temporary flight restrictions may also be imposed due to sudden establishment of restricted airspace, etc. AAM aircraft may need to change route to the intended destination when airspace access issues arise.

APPENDIX 3 Acronyms

The following acronyms are used in this document.

AAM	: Advanced Air Mobility
AIM	: Aeronautical Information Management
AIP	; Aeronautical Information Publication
ANSP	: Air Navigation Service Provider
ATM	: Air Traffic Management
ConOps	: Concept of Operations
CNS	: Communication, navigation and surveillance
EASA	: European Aviation Safety Agency
EUROCAE	: European Organisation for Civil Aviation Equipment
eVTOL	: Electric Vertical Take-off and Landing
FAA	: Federal Aviation Administration
FATO	: Final Approach and Take-Off Area
FBO	: Fixed Base Operator
ICAO	: International Civil Aviation Organization
IMC	: Instrument Meteorological Conditions
JCAB	: Japan Civil Aviation Bureau
MET	: Meteorological
NASA	: National Aeronautics and Space Administration
PIC	: Pilot in Command
PTS	: Prototype Technical Specifications
RAM	: Regional Air Mobility
RPIC	: Remote PIC
SAA	: Special Activity Airspace
SAR	: Search and Rescue
SARPs	: Standards and Recommended Practices
SDSP	: Supplemental Data Service Provider
TLOF	: Touchdown and Lift-off Area
UAM	: Urban Air Mobility

UATM	: Urban Air Traffic Management
UAS	: Unmanned Aircraft Systems
UASA	: UATM Service Area
USS	: UAS Service Supplier
UTM	: UAS Traffic Management
VFR	: Visual Flight Rules
VTOL	: Vertical Take-off and Landing

APPENDIX 4 Glossary

In this document, the following explanations are applied.

Advanced Air Mobility (AAM)
An accessible and sustainable next generation means of air transportation, made possible by aeronautical technologies such as electrification and automation, as well as vertical take-off and landing and other modes of operation.

Drone
Any device which can be used for flight operations and which is structurally unsuitable for a person on board, and which can be flown by remote control or autopilot (meaning automatic control by a program). (Excluding devises less than 100g)

Vertiport (Ref : Chapter 2.3.1)
An "airport, etc." under the Civil Aeronautics Act, and its type is a "heliport" dedicated to AAM.

Phase 0 (Ref : Chapter 3.1)
Test flights and proof of concept flights phase of AAM operations prior to commercial operations.

Phase 1 (Ref : Chapter 3.1)
Initial introduction of commercial AAM operations in Japan – low density, piloted operations, cargo transport with remote piloted operations.

Phase 2 (Ref : Chapter 3.1)
Scaled Japanese AAM operations – medium to high density, piloted operations (on board and/or remote).

Phase 3 (Ref : Chapter 3.1)
Establishment of AAM operations which include autonomy - high density, integrated with automated / autonomous operations.

eVTOL (electric Vertical Take-off and Landing)
Aircraft that take-off and land vertically using electric power.

FATO (Ref : Chapter 2.3.1)
The area of land or water over which the final phase of the approach to a hover or landing is completed and from which the take-off manoeuvre begins.

RAM (Regional Air Mobility) (Ref : Chapter 1.1, 2.4.2)
RAM is used in contrast to UAM. RAM refers to the longer distances flown by longer range AAM aircraft. Their cruise phase of flight is likely to occur at a higher altitude than UAM operations. Due to the operational characteristics and scale of operations, it is expected that RAM aircraft operations will be able to utilise existing airspace and traffic management concepts for part or all of their flight. RAM aircraft that operate in the UASA or in a similar way to UAM aircraft will be subject to similar considerations as UAM aircraft.

UAM (Urban Air Mobility) (Ref : Chapter 1.1, 2.4.2)
UAM indicates a certain range of operating modes of AAM. UAM operations are likely to occur on shorter distances at a lower altitude than RAM. Low-level airspace includes airspace both inside and outside of the urban environment.

UAM Corridor (Ref : Chapter 2.4.2)
Dedicated airspace corridors in which aircraft must comply with specific rules, procedures, and performance requirements, which connects airports/vertiports. It is an area of airspace of defined dimensions and set when UAM operations are particularly dense and airspace capacity needs to be increased.

UAM Route (Ref : Chapter 2.4.2)
UAM routes are set to connect airports/vertiports and can organize operation paths. Their implementation does not necessarily require significant regulatory change compared to UAM corridors. To enable access and equity, UAM routes can be used by other airspace users.

UATM (Urban Air Traffic Management) (Ref : Chapter 2.4.3)
Over time, new Urban Air Traffic Management (UATM) systems and services will be needed to support the integrated operation of AAM aircraft in the UASA. UATM will support AAM operations and maximise the performance of AAM and the UASA.

UASA (UATM Service Area) (Ref : Chapter 2.4.2)
Airspace where new traffic management services (UATM services) will be provided based on UAM traffic conditions. It may include both controlled and uncontrolled airspace. The UASA is determined by aviation authorities on a flexible basis, based on the density and frequency of UAM operations and surrounding traffic conditions, and is not limited to the urban area.

UTM (UAS Traffic Management) (Ref : Chapter 2.4.3)
UAS Traffic Management (UTM) is envisioned as a subset of ATM that is aimed at the safe, economical and efficient management of UAS operations through the provision of facilities and a seamless set of services in collaboration with all parties and involving airborne and ground-based functions.

APPENDIX 5 Reference Document

1. Japan Civil Aeronautics Act and its Enforcement Regulations and related notices

2. Roadmap and other materials of the Public-Private Comittee for Advanced Air Mobility

3. Urban Air Mobility (UAM) Concept of Operations v1.0, FAA, 2020
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   https://ntrs.nasa.gov/api/citations/20205011091/downloads/UAM%20Vision%20Concept%20of%20Operations%20UML-4%20v1.0.pdf

5. Urban Air Traffic Management Concept of Operations VERSION 1, Airservices Australia and EmbraerX, 2020
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7. Study on the societal acceptance of Urban Air Mobility in Europe, EASA, 2021
   https://www.easa.europa.eu/sites/default/files/dfu/uam-full-report.pdf

8. CAP 2272 Key Considerations for Airspace Integration within an Urban Air Mobility Landscape. UK CAA 19 October 2021.
   https://publicapps.caa.co.uk/docs/33/CAP2272%20%20with%20dates%20Key%20Considerations%20for%20Airspace%20Integration%20within%20an%20Urban%20Air%20Mobility%20Landscape%20(1).pdf

9. Material for results briefing for "Project for Energy-Saving Society with Robots and Drones/Leading Research and Study on AAM", Theme 3) Survey on elemental technologies for the social implementation of Japan's Advanced Air Mobility, Research Commissioned Project of New Energy and Industrial Technology Development Organization, 2021
   https://www.nedo.go.jp/content/100944265.pdf