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

Summary

(English version)

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

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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.**
- This document is expected to constantly evolve based on technological advances, overseas trends, and feedback from stakeholders.

*1 AAM does not include drones.

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, **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.
- 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.

Aircraft

Initial Stage	Future
• eVTOLs powered by rechargeable batteries , hybrid(e.g. gasoline-electric hybrid). • A pilot on board operate manually or automatically. Remotely piloted mainly for cargo transport • Operate under Visual Flight Rules (VFR)	• Hydrogen fuel cell-powered aircraft may also provide AAM operations • Automated flight operations or autonomous operations • Operate In more severe weather

Aircraft Concept Types

- 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.

※ 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.

Use Cases

Passenger Carrying	
Airport shuttle	Transporting passengers from/to airport and their onward destination.
Intra-urban	Transporting passengers within urban areas.
Routes to suburban areas	Transporting passenger from urban centres from/to suburban/remote areas.
Entertainment	Excursion flights around recreational facilities and tourist destinations.
Access to tourist areas	Transporting tourists, etc. from/to recreational facilities and tourist destinations.
Routes connecting remote islands or mountainous areas	Transporting passengers between remote islands and the mainland, between islands and between mountainous and urban areas.
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.
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.
Cargo Transport	
Emergency transport of goods	Transporting required goods when disaster event occurs.
Inter-facilities	Transporting goods or products between facilities owned by a company/organization.
Cargo delivery (sea and mountainous areas)	Transporting cargo along routes over the sea and within mountain areas (incl. remote medical care).
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.

【Expected Benefits】

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).

On-ground infrastructure (Vertiports)

【Definition/Overview】

- A **“vertiport”** is considered **an “airport, etc.” under the Civil Aeronautics Act, as a type of a “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).
- 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/Configuration】

- 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. Some vertiports may have dedicated spaces for AAM aircraft that are not in operation to park.
- 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.

【Non-public/public】

- 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.

【Charging Infrastructure】

- 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 ：It may require space in the vertiport for battery charging facilities and storage.
  - Direct charging：charging points need to be installed at each aircraft apron to facilitate fast charging during AAM aircraft turnaround.

Airspace, Traffic Management

- Since UAM are required to fly at an altitude at or above the minimum safety altitude specified by Regulation for Enforcement of the Civil Aeronautics Act, 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 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 planning stage. 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 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.
- 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.

UAM Routes：They are established to connect airports/vertiports and to increase the predictability of UAM aircraft locations, thereby improve situation awareness of other low-level airspace stakeholders. 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.

UAM Corridors：Dedicated airspaces in which aircraft must comply with specific rules, procedures, and performance requirements, which connect airports/vertiports. They are areas of airspace of defined dimensions and set when UAM operations are particularly dense and airspace capacity needs to be increased.

Airspace, Traffic Management (continued)

- 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.
- 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.

Overview of UATM Services

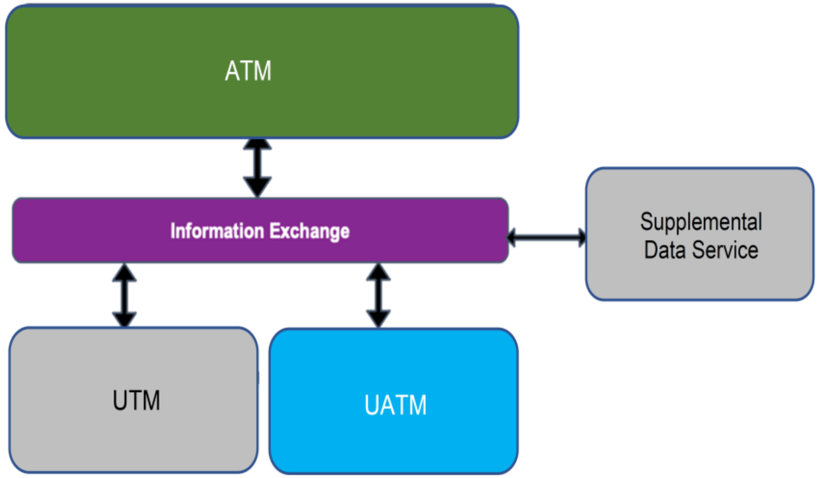
Information Exchange：Exchange timely and accurate data among low-altitude airspace stakeholders including ANSPs, to support the safe and efficient operation of AAM aircraft.

Airspace Management：Maximise the use of low-level airspace as needs shift. Implementation of UATM and/or route/corridor. Consideration will be given to introducing dynamic airspace management as the scale of operations expands.

Conflict Management：Ensure that demand for AAM is met to the greatest extent practicable in the context of the limited resources in the airspace and vertiports. Manage arrival and departure times and slots.

Flight Plan Confirmation/Authorization：As the scale of operations increase, authorize flight plans submitted by operators or pilots after reviewing it and making necessary adjustment.

Conformance Monitoring：Ensure that AAM aircraft within the UASA are flying in compliance with the confirmed/authorized flight plan. Provide timely information and present responses for nonconforming aircraft affecting the operation of UATM services and for other AAM aircraft affected by such non-conforming aircraft.



UATM, ATM and UTM Interfaces

Roles & Responsibilities

AAM Aircraft Maker	Design and manufacture safe AAM aircraft. Obtain type certification and ensure the continued airworthiness.
AAM Aircraft Operator	Manage their respective AAM aircraft operations. Pilot-in-Command (PIC) holds “final authority and responsibility for the operation and safety of the flight” of an AAM aircraft.
Vertiport Operator	Responsible for ground operations at the vertiport. 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. Provides information regarding the operational status of their vertiport.
Maintenance and Ground Services Provider	Similar to those at today’s commercial airports and Fixed Base Operators (FBOs, Operator of flight support services) including charging, aircraft inspection/maintenance, aircraft servicing (food/beverage), deicing, passenger guidance and safety, security screening.
Japan Civil Aviation Bureau (JCAB)	Serves as both the regulator and the ANSP, although there is a clear distinction between the two roles. The regulator is responsible for certification of all safety-related elements. UATM services are planned to be provided by ANSP. However, it will continue to be investigated how to specifically ensure a high level of safety, given that in the future AAM aircraft are expected to operate at unprecedentedly high frequencies and densities。
UAS Service Suppler (USS)	Support drone operations under the UTM (UAS Traffic Management) system。
Supplemental Data Service Provider (SDSP)	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.
Other Regulators	Govern other related laws and regulations such as noise, land planning, environmental assessment, electric power grid and telecommunications.

Phases of Advanced Air Mobility Introduction

Phase	Maturity Level	Timeframe
Phase 0	**Test flights and proof of concept flights prior to commercial operations**	
Phase 1	**Commencement of commercial operations** - **Low density operations** - **Pilot on board , cargo transport with remotely piloted operations**	Around 2025
Phase 2	**Scaled operations** - **Medium to high density operations** - **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

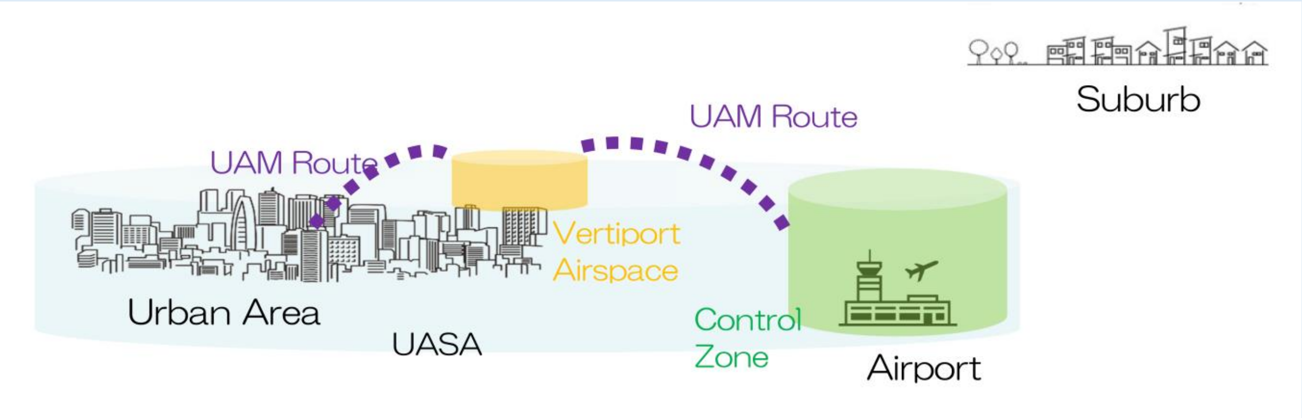
Phase 0 / Phase 1

Phase 0 :

- Trials and proof of concept flights 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.

Phase 1 :

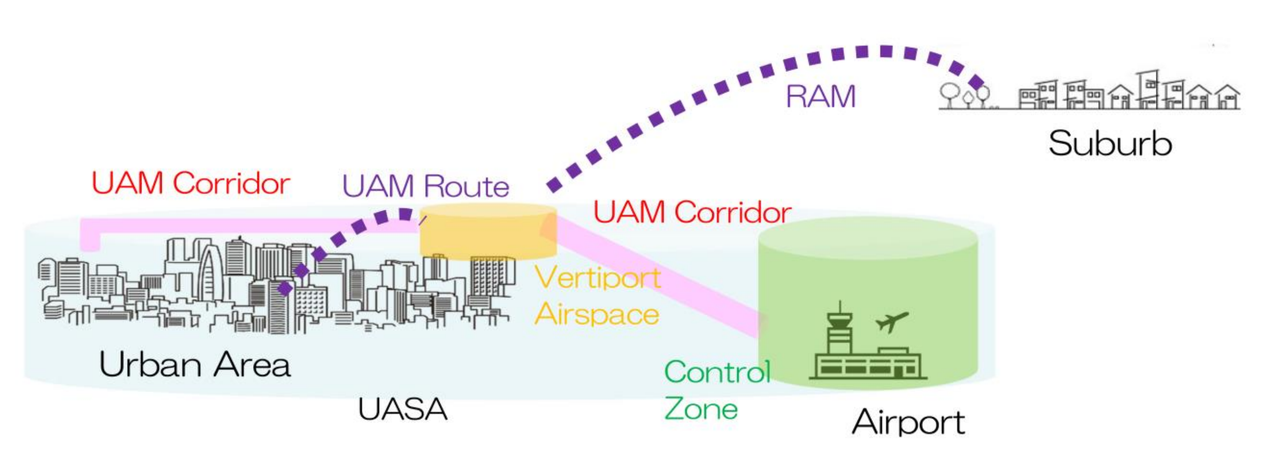
- The initial introduction of commercial AAM operations in Japan will occur. In Phase1, for passenger carrying AAM operations, initial operations are expected to occur in low density and be piloted under VFR, similar to existing aircraft operations.
- Initially, it is anticipated that existing airports and other existing rules such as off-site takeoff/landing permits will be utilized, but relatively small-scale vertiport developments are also envisioned.
- 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.
- 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.)



Phase 2 / Phase 3

Phase 2 :

- Japanese AAM operations will be scaled up. Medium-to-high density, piloted operations (including remotely piloted) are expected.
- Larger and more complex vertiports will be developed including in complex urban environments, e.g. on top of buildings.
- New airspace concepts and advanced UATM services will be implemented where required to support the scale and nature (e.g., remote piloting and IMC) of AAM operations.
- 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.)



Phase 3 :

- Japanese AAM operations will be scaled up including high-density operations. Operations in the UASA will include a mix of piloted and remotely piloted operations. Operations may become more sophisticated as autonomous operations commence.
- 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.