The 140th Transport Policy Colloquium -Washington Report Ⅷ-

Action for the Implementation of Urban Air Mobility in the United States

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What is UAM (Urban Air Mobility) –①

- Definition in the U.S. Federal Aviation Administration (FAA)

➢ A safe and efficient air transportation system that will use highly automated aircrafts that will operate and <u>transport passengers and cargo</u> at lower altitudes within <u>urban and suburban areas.</u>

➢ UAM will be composed of an ecosystem that considers the evolution and safety of an aircraft, the framework of operation, access to airspace, infrastructure development, and community engagement.

What is UAM (Urban Air Mobility) -②

- Relationship with so-called drones (small unmanned aircrafts)

	urban areas			Outside urban areas
	Passenger Transport	**Transportation of cargo**	Other (aerial photograph y, etc.)	
Small unmanned aircrafts (So-called drones)		✓	✓	✓
Larger aircrafts	✓	✓	✓	✓

UAM

The yellow area is the subject of today's explanation.

- ➢ Drones (small unmanned aircrafts): remotely piloted or autopiloted
- ➢ UAM which transports passengers: remotely piloted, autopiloted, or operated by an onboard pilot

1. the situation surrounding "flying cars" (UAM)

Why is UAM getting so much attention?

- Global concentration of population in urban areas

➢ United States: 75% (1990) → 82% (2018) → 89% (2050 forecast)

➢ Japan: 77% (1990) → 92% (2018) → 95% (2050 forecast)

Data are from the United Nations' World Urbanization Population Prospects 2018.

- This has led to increased traffic congestion in urban areas (data from the U.S.)

➢ Ratio of time required during peak hours to off-peak hours

1.10 (1982) → 1.23 (2017)

➢ Annual cost of traffic congestion for the country as a whole

15 billion dollars (1982) → 179 billion dollars (2017)

Data is from the Texas A&M Transportation Institute's 2019 Urban Mobility Report.

Expansion of possible use cases

- The definition of UAM is "transportation of passengers and cargo" in "urban and suburban areas", but the following use cases are also envisioned.

➢ Expansion of usage areas (not only urban areas and suburban areas, but also rural areas and inter-city areas)

➢ Use for public purposes (e.g., emergency response by police, fire fighting, and emergency medical services)

➢ Personal and recreational use

- The term "Advanced Aerial Mobility (AAM)" is also used as a higher-level concept of UAM that incorporates use cases that are not limited to operation in urban environments (i.e., UAM is part of AAM).

Situation in Japan

- In August 2018, the Public-Private Council for the Air Mobility Revolution (secretariat: Ministry of Economy, Trade and Industry, Ministry of Land, Infrastructure, Transport and Tourism) was established.
- In December 2018, the Council formulated a "Roadmap for the Air Mobility Revolution" and set the following goals

➢ Start operations in the mid-2020s (target: 2023)

➢ Expansion of practical applications in the 2030s

- In the "Follow-up to the Growth Strategy" in July 2020, the following decisions was made

➢ Begin studying the rulemaking such as standards for aircrafts, operations, and pilots during FY2020, and revise the roadmap during FY2021.

➢ To utilize flying cars as a means of transportation at the Osaka-Kansai World Exposition in 2025, we will promote the development of automatic and autonomous flight technology and technology for managing the operation of many aircrafts.

UAM aircraft system -①

- In urban areas, large scale infrastructure such as runways cannot be built, and noise and emissions must be minimized.

- For this reason, basically, the UAM aircraft is eVTOL (electric Vertical Take Off & Landing), which has an electric propulsion system and is capable of vertical take off and landing.

UAM aircraft system -②

- According to the mechanism of the propulsion system for takeoff and horizontal flight, the UAM under development are divided into three main types as follows

➢ Vectored thrust type

The propulsion system for takeoff is tilted for horizontal flight (similar to the Osprey military aircraft).

➢ Attached type (Lift & Cruise)

Separate propulsion systems for takeoff and level flight

➢ Multi-rotor type

A larger version of a drone with many rotor blades.

Example of a vectored thrust type aircraft (Joby S4)

©Joby Aviation

Photos and aircraft specifications are from the Joby Aviation website.
https://www.jobyaviation.com/

Development Company
Joby Aviation
(California, USA)

Aircraft specifications
5-seater (1 pilot + 4 passengers)
Max speed 200 miles per hour
Cruising range 150 miles

Relationships with other companies
TOYOTA (about $400 million) and Intel invested in the project.
Partnering with Uber

Example of an attached type aircraft (Beta Technologies ALIA)

©Beta Technologies

Photos and aircraft specifications are from Beta Technologies' website. https://www.beta.team/aircraft/

Development Company
Beta Technologies (Vermont, USA)

Aircraft specifications
6-seater (1 pilot + 5 passengers)
Cruising range 250 Nautical mile

Relationships with other companies
Partnered with United Therapeutics, a biotechnology company

Example of a multi-rotor type aircraft (Volocopter VoloCity)

©Volocopter

Images and aircraft specifications are from Volocopter's website
https://press.volocopter.com/index.php/media-images/products/
https://www.volocopter.com/en/product/

Development Company
Volocopter
(GERMANY)

Aircraft specifications
2-seater
Max speed 68 miles per hour
Cruising range 22 miles

Relationships with other companies
Partnering with Grab, a Singapore-based ride-sharing company, and Japan Airlines

Advantages and disadvantages of each type of aircraft system

- Each type has the following advantages and disadvantages
- They all have their advantages and disadvantages, but for short distances, such as within a single city, the multi-rotor type has the advantage, while for long distances, such as inter-cities, the vectored thrust type and the attached type have the advantage.

	advantage	weak point
Vectored thrust type (similar to Osprey)	No mechanism that wastes weight.	Mechanisms and controls for thrust vectoring are complex.
Attached type (Separate propulsion systems for takeoff and level flight)	Simple mechanism and control	The propulsion system for takeoff is a waste of weight in level flight.
Multi-rotor type (A larger version of a drone with many rotor blades)	No mechanism that wastes weight.	Limited speed and range due to lack of fixed wing

1. the situation surrounding "flying cars" (UAM)

2. merits and challenges of "flying cars" (UAM)

2-1 merits of a "flying car" (UAM)

2-2 challenges for the realization of a "flying car" (UAM)

3. efforts to address challenges such as safety, security, and social acceptability

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Realization of a transportation network that is independent of infrastructure for routes

- In land transportation, routes depend on infrastructure, making it difficult to expand additional routes in developed urban areas.
- UAM allows for a transportation network where routes are not dependent on infrastructure, making it relatively easy to add or expand routes even in developed urban areas.
- In addition, UAM will be able to carry out transportation of high social priority, such as emergency medical service and disaster relief, on a larger scale than the current helicopter without disruption on the ground.

Reduction of noise by electrification of propulsion system

- Since UAM has electric propulsion system, noise will be reduced if existing helicopter operations are replaced with UAM operations.
- In general, electrification of the propulsion system will significantly reduce noise.

(Reference) An example of noise reduction by electrification of a two-seater propeller aircraft :

Made by Pipistrel (Slovenia)	→	Made by Pipistrel (Slovenia)
Virus SW 121 (reciprocating engine)		Virus SW 128 (electric)
Takeoff noise level: 70 dB(A)		Takeoff noise level: 60 dB(A)

※A reduction of 10 dB(A) is equivalent to achieving the same noise level even when the distance between the aircraft and the point of measurement is reduced by 1/3 (60 db(A) at a distance of 150 m is about 70 dB(A) at a distance of 50 m).

Takeoff noise level is based on EASA noise certification data sheet TCDSN EASA.A.573

2-1 merits of a "flying car" (UAM)

Other merits

- Reduction of CO2 emissions by electrification of the aircraft

➢ No CO2 emissions during operation due to electric propulsion instead of fossil fuel propulsion

（As a side note, CO2 emissions for the entire life cycle depend on the composition of the power source.）

- Reduce operating costs through electrification and automation of aircraft

➢ Maintenance costs are expected to be reduced by electrification of the aircraft.

➢ In addition, automated aircraft will reduce the costs associated with pilots.

2-1 merits of a "flying car" (UAM)

Various challenges to the realization of UAM

- safety
- security
- Environment
- Social acceptance
- Future growth and flexibility of operations

2-2 Challenges for the realization of a "flying car (UAM)

Safety challenges

- UAM, which will be used to transport a wide range of general passengers, needs to be carefully examined to determine whether designs based on conventional safety standards for small aircraft and helicopters are sufficient.

- In addition, the electrification of an aircraft reduces the number of problems related to the propulsion system, but increases the factor of new problems such as batteries.

- While automated aircrafts reduce the human error factor, they also present challenges in dealing with unforeseen events.

  (In judging abnormalities and disconnecting the relevant systems, there is a possibility of omission of judgment or disconnections based on misjudgments.

Security challenges

- Current air traffic control relies heavily on voice communication between pilots and controllers.

- Due to the automation of the aircraft, consideration must be given to attacks on digital communication links, data on digital communication and location systems.

Environmental challenges

- Although the use of electric propulsion systems is expected to reduce noise, noise and its psychological impact will continue to be a major issue.

- Meeting existing noise standards for small helicopters is not sufficient for actual operations in a wide range of areas.

  (Reference) Existing noise standards for small helicopters (for aircraft with a maximum take-off weight of 1,417 kg or less - roughly 4 to 5 passengers or less)
  Flyover noise level at 150m altitude: 82 SELdB or less

- No concrete moves have been made toward the establishment of new noise standards, and the situation is dependent on the voluntary efforts of the aircraft development companies.

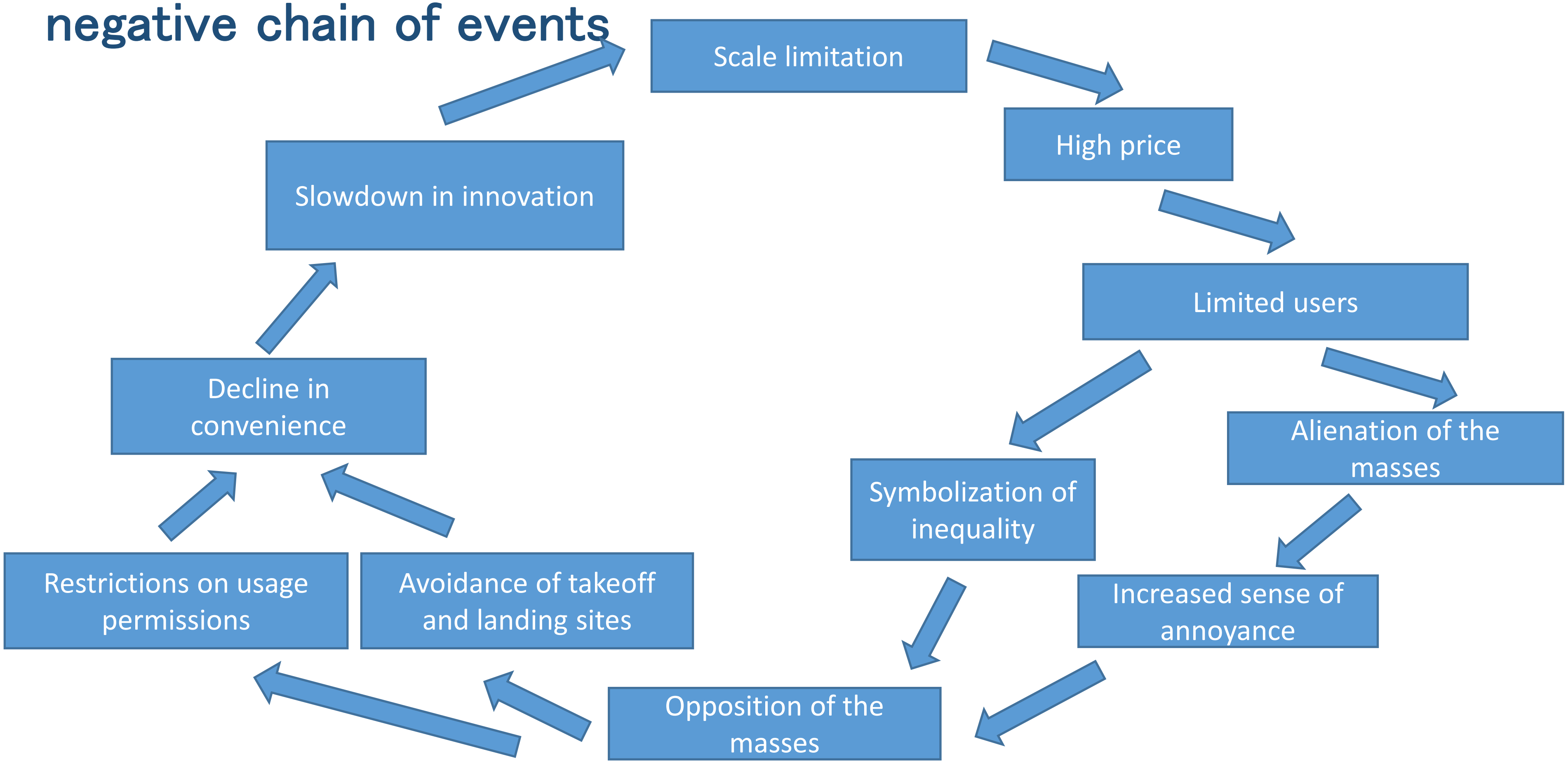
Issues of social acceptance

- The realization of UAM requires not only the resolution of safety issues, but also the recognition that the benefits of new technologies outweigh the negative impacts on the environment and quality of life (including privacy concerns).

- With the passage of time, convenience and other merits may improve, and the issue of social acceptance may be overcome, but social acceptance may be the biggest challenge for expansion of scale

Negative chain of events regarding social acceptance

- <u>Expansion of scale may not be achieved</u> due to the following negative chain of events



2-2 challenges for the realization of a "flying car (UAM)

Based on the research report from the National Academies of Sciences, Engineering, and Medicine, Advancing Aerial Mobility: A National Blueprint (2020).

Future increase in operations and flexibility challenges

- The increase in operations around airports and en route is being addressed in many countries by extending existing technologies for air traffic management and precision flight paths, but is approaching its limits.

- Difficult for air traffic controllers to handle a significant increase in aircraft density in the airspace due to UAM operations

- Therefore, it is necessary to gradually automate the current role of air traffic controllers

- Flexibility is also necessary to safely integrate its operations if unknown use cases emerge in the future.

2-2 challenges for the realization of a "flying car (UAM)

Simulation for Haneda Airport

- At Haneda Airport, access by cabs or hire cars on weekdays (to and from the airport combined) accounts for 3.5% of all passengers, or about 5,200 people.

  Data is based on the Civil Aviation Bureau's "Fiscal Year 2009 Survey of Current Airline Passengers - Summary Results.

- If we assume that half of these accesses are replaced by UAM (2 passengers), the number of takeoffs and landings will increase by about 1,300 even if there are no deadheads at all.
- This is equivalent to the current number of takeoffs and landings per day at Haneda Airport, and will more than double the density of aircraft in the surrounding airspace.
- At JFK Airport in New York, more than 7,000 people per day use cabs from the airport alone.

  Data is from The Port Authority of NY &NJ's "2019 Airport Traffic Report".

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Aircraft Safety Certification Scheme in the United States

- FAA intends to conduct a review of the UAM based on the safety standards applicable to small aircrafts (Federal Aviation Regulations Part 23).

- This safety standards underwent a major revision in August 2017, changing it to a performance-based one based on the number of passenger seats and maximum speed

- However, this is not specific to UAM safety certification, and twists and turns in the review process are expected in order to ensure that UAM is safer than conventional small aircrafts.

Safety certification scheme for aircraft in Europe –①

- Vertical Take Off & Landing (VTOL) aircrafts, including UAM, are positioned as a different type of an aircraft from an existing fixed-wing and rotary-wing aircraft, and their Special Conditions were established by the European Aviation Safety Agency (EASA) in July 2019.

- The structure of the Special Condition conforms to the standard applicable to small aircrafts (CS-23). However, it is divided into two categories: "Enhanced" for flights over densely populated areas and commercial passenger transport, and "Basic" for other uses.

Safety certification scheme for aircraft in Europe –②

- Contents of Special Condition for VTOL
  - General
  - Flight
  - Structure
  - Design and assembly
  - Installation of lift/thrust device
  - Systems and equipment
  - Interface with crew and other information
  - Certification guidance of Safety Analysis
- This does not include technical requirements for the propulsion system itself or certification guidance of other than safety analysis (described later).

3. efforts to address challenges such as safety, security, and social acceptability

Safety certification scheme for aircraft in Europe –③

- The difference between the "Enhanced" and "Basic" categories

➢Aircraft in the "Enhanced" category

In case of failure, the aircraft must be able to continue to fly safely and land at the original destination or a suitable alternate location.

➢Aircraft in the "Basic" category

In case of failure, the aircraft must be able to perform emergency landings such as glide and autorotation.

Safety certification scheme for aircraft in Europe –④

- In the guidance for the certification of safety analysis, "Enhanced" category aircraft are subject to the same stringent failure condition probability requirements as large passenger aircrafts, regardless of the number of passenger seats.

		Severity of the failure condition (right is more serious)			
		Minor	Major	Hazardous	Catastrophic
"Enhanced." Category		Less than 1 per 1,000 flight hours	Less than 1 in 100,000 flight hours	Less than 1 in 10 million flight hours	Less than 1 in 1 billion flight hours
"Basic." Category	Number of passenger seats 7 to 9	Less than 1 per 1,000 flight hours	Less than 1 in 100,000 flight hours	Less than 1 in 10 million flight hours	Less than 1 in 1 billion flight hours
	Number of passenger seats 2 to 6	Less than 1 per 1,000 flight hours	Less than 1 in 100,000 flight hours	Less than 1 in 10 million flight hours	Less than 1 in 100 million flight hours
	Number of passenger seats 0 to 1	Less than 1 per 1,000 flight hours	Less than 1 in 100,000 flight hours	Less than 1 in 1 million flight hours	Less than 1 in 10 million flight hours

Prepared based on EASA AMC VTOL.2510 Equipment, system, and installation

3. efforts to address challenges such as safety, security, and social acceptability

Safety certification scheme for aircraft in Europe –⑤

- The following two contents not included in the Special Condition for VTOL developed in July 2019 have already been published by EASA in their respective drafts

➢ In January 2020, the draft Special Condition for electric and hybrid propulsion systems was published.

➢ In May 2020, the draft certification guidance of other than safety analysis was published.

3. efforts to address challenges such as safety, security, and social acceptability

Consideration by international standardization bodies –①

- For specific methods of proving compliance to technical requirements, the use of the following processes is expanding

Participation of aviation authorities in studies by international standardization bodies → Coordination in international standardization bodies → Adopted by aviation authorities as an example of an acceptable method

- As for UAM, ASTM International (USA) and EUROCAE (Europe) are currently leading this study.

Consideration by international standardization bodies –②

- ASTM International (U.S.A.) established the following two Advisory Committees (ACs) for active consideration

➢ Certification requirements for automated systems (AC377)

➢ How to show compliance of eVTOL (AC433)

- Based on the review by the Advisory Committee, the following committees in each field are working on the preparation of specific technical standards.

➢ F38: Unmanned Aircraft Systems (related to unmanned aircraft operations)

➢ F39: Aircraft systems (related to electric propulsion systems)

➢ F44: General aviation aircraft (technical standards for flight characteristics, structure, etc.)

Consideration by international standardization bodies –③

- EUROCAE (Europe) established a working group (WG-112) to study specific methods of proving compliance to the Special Condition for VTOLs established by EASA.

- Under the above working group, specific technical standards are being developed in each subgroup, including the following

➢ Electrical system
➢ Lift and thrust
➢ Safety
➢ Flight characteristics
➢ Avionics (electronic equipment)

Addressing security challenges

- NASA's System-Wide Safety (SWS) Project within the Airspace Operations and Safety Program (AOSP) is conducting research on cybersecurity risks associated with unmanned aerial vehicles.

- Consider measures to address the following aspects

➢ Redundancy of digital communication links

➢ Encryption of data over digital communications

➢ Preventing unauthorized data from entering into autonomous decision making and machine learning

3. efforts to address challenges such as safety, security, and social acceptability

Addressing the challenge of social acceptability –①

- The FAA launched its program for unmanned aircraft, the Integration Pilot Program (IPP), in 2017 (ending in October 2020).

➢ Objective :

Assisting in the development of future regulations by improving communication with state and local jurisdictions and addressing security and privacy risks

➢ Implementation system :

Operators and manufacturers of unmanned aircrafts, in collaboration with state and local government agencies

Addressing the challenge of social acceptability –②

- The integrated pilot program includes the following public interest operations
  - Border surveillance (IPP in California)
  - Emergency delivery of AEDs and other medical equipment (IPP in Nevada)

↓

- Expectations that this kind of public service operation will trigger an increase in the social acceptance of the entire next-generation aviation system

- The integrated pilot program is now moving to a successor program called BEYOND.

3. efforts to address challenges such as safety, security, and social acceptability

Addressing the issue of social acceptability –③

- In addition to individual community outreach by UAM development companies for permission to conduct test flights, the Community Air Mobility Initiative (CAMI), a U.S. non-profit organization, was established in 2019.

- CAMI, with support from aircraft development companies and other organizations, conducts activities to educate and enlighten the community and policy makers on the realization of UAM.

Addressing challenges related to operations

- The FAA, in collaboration with NASA and industry, developed Version 1.0 of the UAM Concept of Operations (ConOps), and published it in June 2020.
- Proposing a Crawl–Walk–Run approach as follows

➢ First, introduce a new type of aircraft that is allowed to fly under current regulations and operating environment (similar to helicopters).

↓

➢ Next, support the expansion of UAM operations with development of regulations and the UAM Corridor (next page).

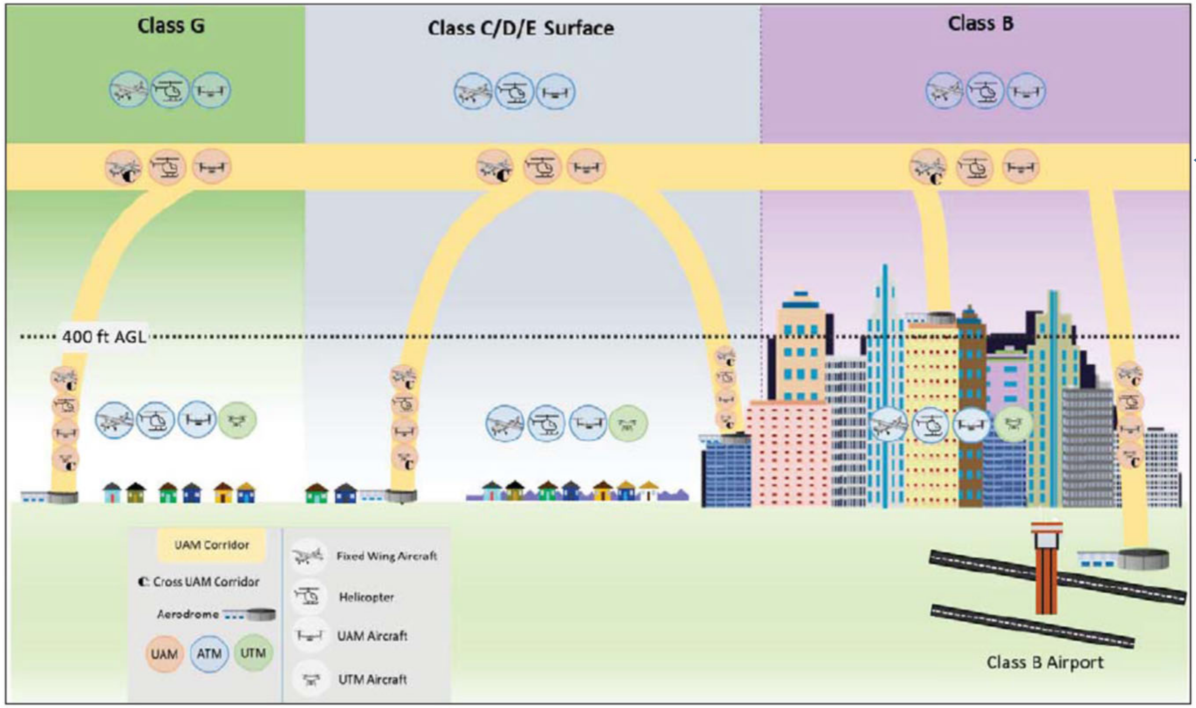
↓

➢ Finally, new regulations and infrastructure will allow for highly automated traffic management and further expansion of operations with remotely piloted/autopiloted aircrafts.

3. efforts to address challenges such as safety, security, and social acceptability

Overview of the UAM Corridor –①

- A UAM Corridor is a "virtual corridor" within which all aircrafts are subject to specific operating rules.
- Consists of the part in the sky above and the part connecting this to the UAM take-off and landing site.



The light yellow area is the UAM Corridor.

3. efforts to address challenges such as safety, security, and social acceptability

Diagram of the relationship between the UAM Corridor and existing airspace classes
Image from FAA UAM Concept of Operations (ConOps) version 1.0

Overview of the UAM Corridor –②

- Conventional fixed-wing aircrafts will pass through this "corridor," while helicopters and UAMs are expected to fly inside the corridor.
- Regardless of the existing classification of airspace classes, the rules of operation within the "corridor" will be the same, and it is assumed that separation between aircrafts will be maintained without the involvement of air traffic control.
- The volume of the "corridor" will be expanded to meet the demand of the operation.

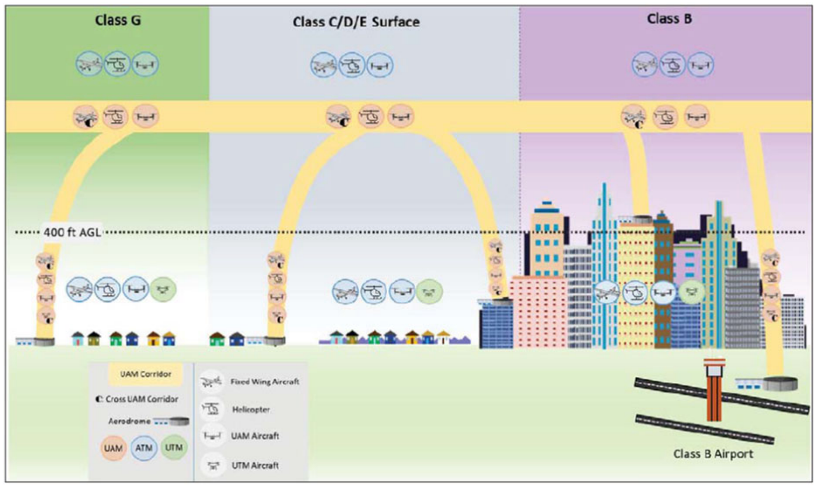


Diagram of the relationship between the UAM Corridor and existing airspace classes
Image from FAA UAM Concept of Operations (ConOps) version 1.0

3. efforts to address challenges such as safety, security, and social acceptability

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eVTOL development projects

- Hundreds of development projects are listed in the eVTOL Aircraft Directory that the Vertical Flight Society compiles on its Electric VTOL News website.

- The number of development projects listed by type of aircraft system (including those that have been cancelled) is as follows

➢ Vectored thrust type: 132

➢ Attached type: 53

➢ Multi-rotor type: 103

eVTOL Aircraft Directory: https://evtol.news/aircraft
Based on data as of December 3, 2020.

- Although the number of attached type is somewhat low, it is not extremely skewed, and development of each type of aircraft is underway.

Example of a vectored thrust type aircraft (Joby S4) [reprinted]

©Joby Aviation

Photos and aircraft specifications are from the Joby Aviation website.
https://www.jobyaviation.com/

Development Company
Joby Aviation
(California, USA)

Aircraft specifications
5-seater (1 pilot + 4 passengers)
Max speed 200 miles per hour
Cruising range 150 miles

Relationships with other companies
TOYOTA (about $400 million) and Intel invested in the project.
Partnering with Uber

1. the situation surrounding "flying cars" (UAM)

Example of a vectored thrust type aircraft (Lilium Jet)

©Lilium

Photos and aircraft specifications
are from Lilium's website.
https://lilium.com/

Development Company
Lilium
(GERMANY)

Aircraft specifications
Five-seater (1 pilot + 4 passengers)
Max speed 186 miles per hour
Cruising range about 180 miles

Relationships with other companies
Funded by Tencent, a major IT company in China

Example of an attached type aircraft (Wisk Cora)

Image courtesy of Wisk

Photos and aircraft specifications are from the Wisk website.
https://wisk.aero/cora/

Development Company

Wisk Aero
(California, USA)

Aircraft specifications

2-seater (autopilot + 2 passengers)
Max speed 100 miles per hour
Cruising range 25 miles

Relationships with other companies

The original developers, Kitty Hawk and Boeing, formed a joint company in 2019.

4. status of development in venture companies, etc.

Example of an attached type aircraft (Beta Technologies ALIA) [Reprinted]

©Beta Technologies

Photos and aircraft specifications are from Beta Technologies' website.
https://www.beta.team/aircraft/

<u>Development Company</u>
Beta Technologies
(Vermont, USA)

<u>Aircraft specifications</u>
6-seater (1 pilot + 5 passengers)
Cruising range 250 Nautical mile

<u>Relationships with other companies</u>
Partnered with United Therapeutics, a biotechnology company

Example of a multi-rotor type aircraft (Volocopter VoloCity) [reprinted]

©Volocopter

Images and aircraft specifications are from Volocopter's website
https://press.volocopter.com/index.php/media-images/products/
https://www.volocopter.com/en/product/

Development Company
Volocopter
(GERMANY)

Aircraft specifications
2-seater
Max speed 68 miles per hour
Cruising range 22 miles

Relationships with other companies
Partnering with Grab, a Singapore-based ride-sharing company, and Japan Airlines

Example of a multi-rotor type aircraft (EHang 216)

©EHang

Photos and aircraft specifications are from EHang's website.
https://www.ehang.com/article/
https://www.ehang.com/ehangaav/

<u>Development Company</u>
EHang
(China)

<u>Aircraft specifications</u>
2-seater (autopilot + 2 passengers)
Max speed 81 miles per hour
Cruising range 22 miles

<u>Relationships with other companies</u>
Partnership with Vodafone, a telecommunications company

4. status of development in venture companies, etc.

Initiatives at Boeing

- Acquired Aurora Flight Sciences (Virginia, USA) in 2017 (before co–founding Wisk) and made it a subsidiary.

- The company developed a PAV, an attached type UAM, for experimental purposes and conducted test flights.

Photo is from Aurora Flight Sciences’ website
https://www.aurora.aero/pav-evtol-passenger-air-vehicle/

Initiatives at Airbus

- Active in in-house development among major aircraft manufacturers
- Development project for Vahana, a vectored thrust type UAM, started in 2015 in California, USA (Acubed), with over 130 test flights
- The Vahana development project was completed in 2019 and the project team moved on to the CityAirbus development project.

Initiatives at Airbus

- CityAirbus is a multi-rotor type UAM, different from Vahana

Aircraft specifications
4-seater (autopilot + 4 passengers)
Max speed 75 miles per hour
Cruising range about 19 miles

Airframe specifications are from Airbus' website.
https://www.airbus.com/innovation/zero-emission/urban-air-mobility/cityairbus.html

4. status of development in venture companies, etc.

Type of aircraft system and range

- The following table shows the relationship between the type of aircraft system and the range of the aircraft.

	cruising range		
	~25 miles	25 to 100 miles	100 miles
vectored thrust type			Joby S4 Lilium Jet
attached type	Wisk Cora		ALIA
multi-rotor type	VoloCity EHang 216 CityAirbus		

- At present, the range of the multi-rotor type is limited to about 25 miles (40 km).

Conducting test flights outside the country where the aircraft was developed

- The development projects described before have been extensively tested and demonstrated in countries other than the countries where they were developed, as summarized below
  - Wisk Cora (USA): New Zealand
  - Volocopter VoloCity (Germany): Dubai, Finland, Singapore
  - EHang 216 (China): Korea, USA, Qatar, Austria, etc.

- Although safe flight is a prerequisite, there are many advantages, including the number of test flights, securing a variety of test environments, appealing to the public, and establishing a leading position in the actual operation.

4. status of development in venture companies, etc.

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5-1 trends toward early realization

5-2 toward achieving wide dissemination (conclusion)

Trends toward early realization

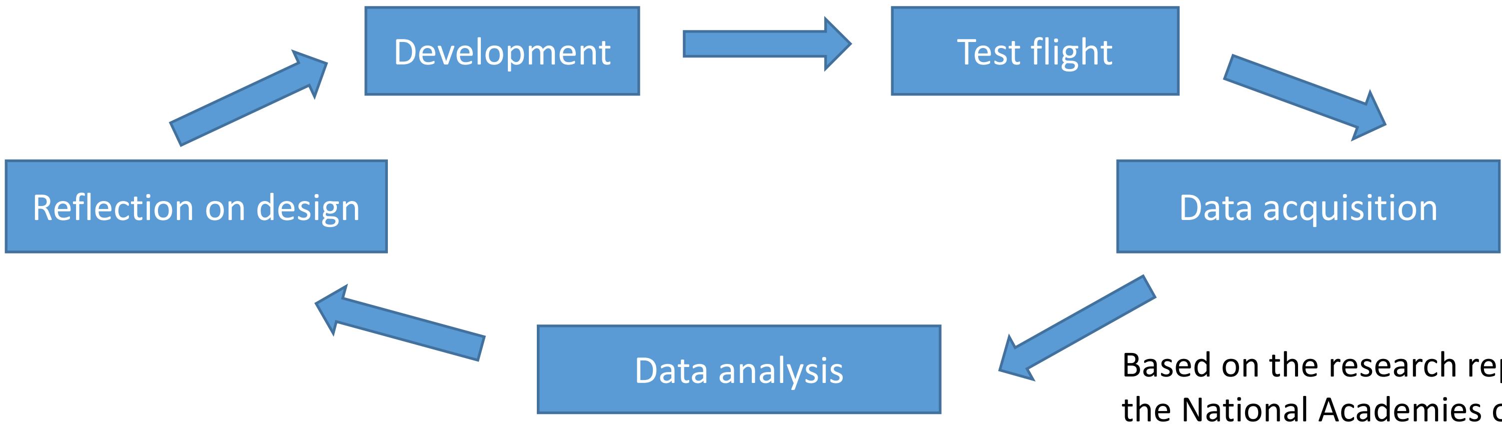
- The following efforts are underway in the U.S. to realize UAM as soon as possible

➢ Securing a location for test flights

➢ Government, military and industry projects

Importance of test flights

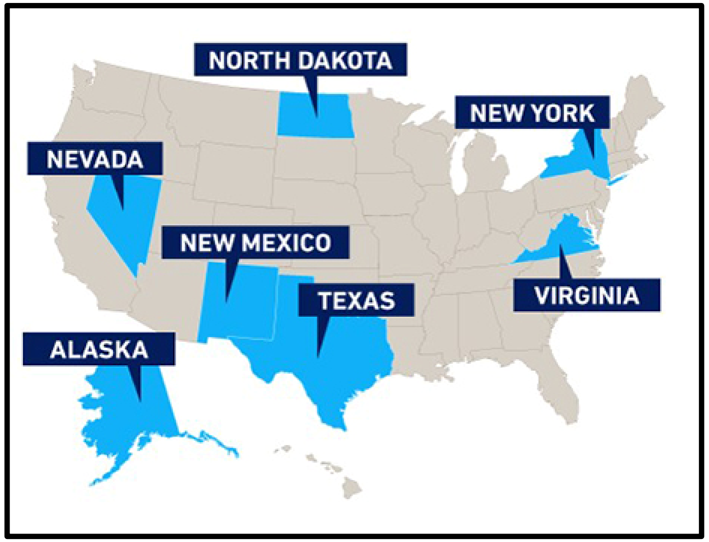
- Due to the advanced system of electric propulsion, mechanism and control for thrust vectoring, more flight time is required for development than for conventional helicopters.
- In addition, a number of test flights will be required to demonstrate operations, including new use cases and relationships with ground infrastructure.
- In addition, the implementation of test flights integrated with the aircraft and flight operations development process is expected to accelerate the development as the following cycles.



Based on the research report from the National Academies of Sciences, Engineering, and Medicine, Advancing Aerial Mobility: A National Blueprint (2020).

Establishment of a flight test site under the initiative of the FAA

- Establishment of six unmanned aircraft flight test sites under the FAA Modernization and Reform Act of 2012
- Subsequently, a seventh unmanned aircraft flight test site was added under the FAA Extension, Safety and Security Act of 2016
- The operating entity of the flight test site provides infrastructure for test flights and support for obtaining special flight permits, and these sites are also used for UAM test flights.



Location of the FAA-led flight test site

Image from FAA website https://www.faa.gov/uas/programs_partnerships/test_sites/

NASA-led project

- NASA is in the process of soliciting and selecting participants for the AAM National Campaign to promote the realization of Advanced Aerial Mobility (AAM) including UAM.

- NC-1, the first phase of the AAM National Campaign, is based on a scenario of commercial transportation of passenger and cargo in a non-densely populated, low complexity environment.

- Special emphasis is placed on working closely with the FAA from this point forward to ensure that the results of the AAM National Campaign are reflected in future policy decisions.

NASA-led project

- The following companies and others are participating in the AAM National Campaign
  - Test flight (aircraft manufacturer)

    Joby Aviation, Inc.
  - Traffic management simulation

    AirMap, AirXOS, ANRA Technologies, ARINC, Avision, Ellis and Associates, GeoRq, Metron Aviation, Inc., OneSky Systems, Uber Technologies, University of Noth Texas
  - Information exchange

    Bell Textron, Boeing, NFT, Prodentity, Zeva
- In addition to these companies, Wisk Aero and Alaka'i Technologies will also participate in the information exchange, announced in November 2020.

Air Force–led project

- The U.S. Air Force has launched a project called "Agility Prime" to promote the development of UAM aircrafts.

- In this project, the UAM aircrafts were divided into three categories for development competition

➢ 3 to 8 –seater, max speed over 100 mph, range over 100 miles

➢ 1 to 2 –seater, max speed over 45 mph, range over 15 miles

➢ Cargo 500 pounds or more, max speed over 100 mph, range over 200 miles

- The first military flight permit was granted to Joby Aviation in December 2020, and a similar permit is expected to be granted to Beta Technologies within the next few months.

5-1 trends toward early realization

Private projects

- Uber, a ride-sharing company in the U.S. and elsewhere, established the Uber Elevate division and began activities in 2017 with the goal of launching Uber Air, a UAM-based ride-sharing service, in 2023

- Los Angeles and Dallas in the U.S. and Melbourne in Australia were selected as the three locations for the launch of the service.

- Later in December 2020, Uber announced the sale of its Uber Elevate division to Joby Aviation and an additional $75 million investment in that company.
- The two companies have also agreed to integrate their services into each other's apps in the future, aiming for seamless integration of ground and air travel.

5-1 trends toward early realization

Concerns about achieving wide dissemination (summary)

- In the U.S., in addition to industry and government, a military project is underway to support the early realization of UAM.
- However, NASA's project and Uber's project have different directions.

➢ NASA: Oriented to a phased approach from non-densely populated areas

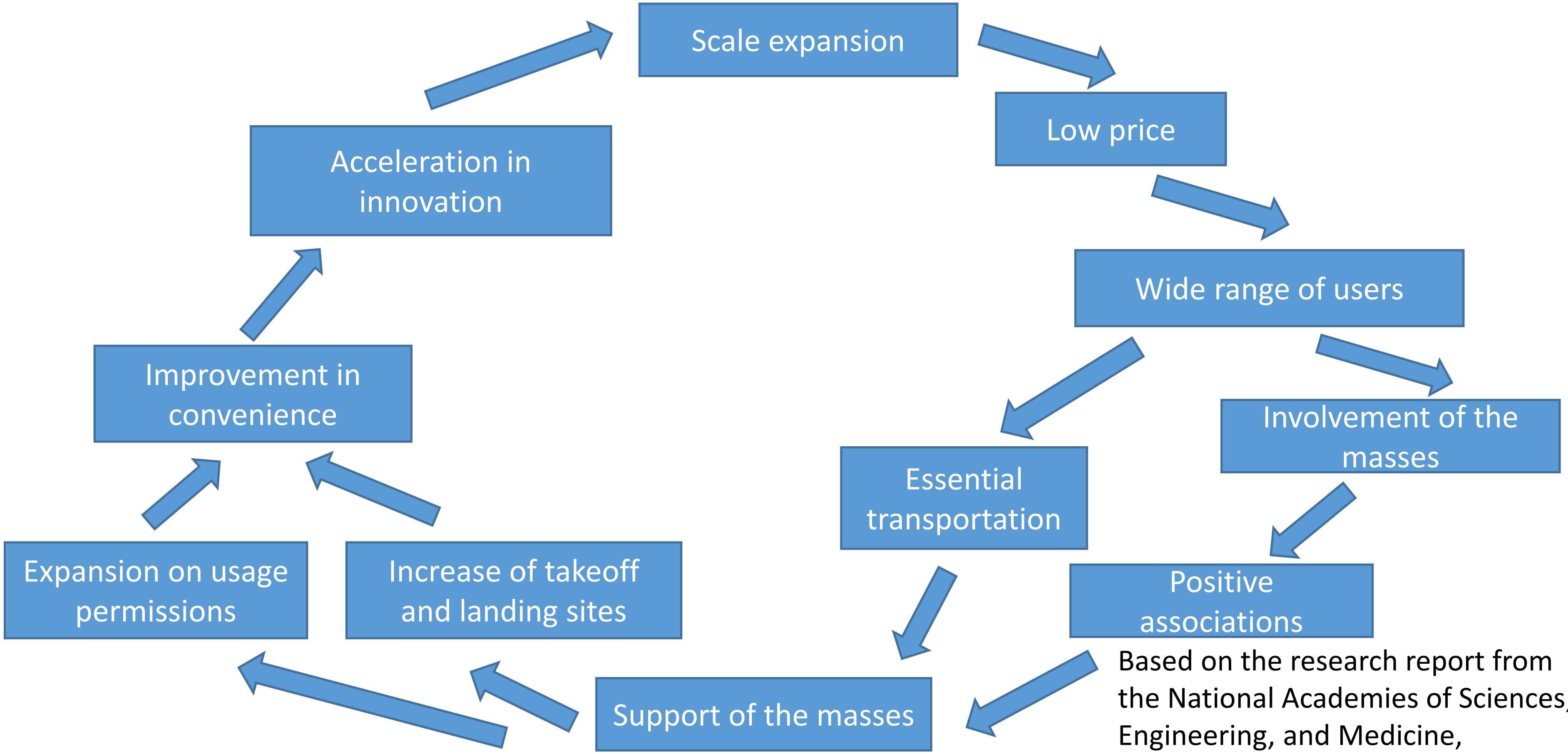
➢ Uber: Plans to start in urban areas where there are many potential customers

- It has also been pointed out that there is a lack of a master plan that defines the country's vision for the future and the implementation plan to achieve it.
- This may lead to early pilot implementation in some areas, but may delay full-scale dissemination in a wider area.

5-2 toward achieving wide dissemination (conclusion)

Positive chain of events for wide dissemination of UAM

- Rather than introducing the UAM ahead of others, it is more important <u>how we can ensure safety and social acceptance and achieve the</u> following <u>positive chain of events as early as possible.</u>



Based on the research report from the National Academies of Sciences, Engineering, and Medicine, Advancing Aerial Mobility: A National Blueprint (2020).

5-2 toward achieving wide dissemination (conclusion)

Conclusion: Toward achieving wide dissemination

- In order to achieve wide dissemination at an early stage, the following efforts are considered necessary

➢ Harmonization of directions among stakeholders through the development of a master plan

➢ Steady accumulation of results from non-densely populated areas

➢ Additional efforts to improve social acceptance, including guidelines on noise

5-2 toward achieving wide dissemination (conclusion)

Thank you very much for your attention.