Advanced Air Mobility Concept of Operations

FOR INCHEON METROPOLITAN CITY

Institute for Aerospace Industry-Academia Collaboration

Incheon Metropolitan City

MITRE

Advanced Air Mobility

WHAT IS AAM?

AAM aims to introduce aerial transportation to local and regional transport networks.

AAM uses advanced aircraft with special design features including greater use of automation, electric propulsion, and vertical takeoff and landing.

AAM uses new air access points known as vertiports to connect communities and provide new and efficient mobility options for people in underserved or remote areas.

WHAT ARE AAM USES?

AAM serves a variety of transportation markets from air taxi trips to emergency medical transport to cargo delivery. Urban-focused use cases for AAM are commonly referred to as Urban Air Mobility (UAM). Since Incheon aims to support both urban and regional markets, this document addresses the broader AAM concept.

WHAT DOES AAM OFFER?

AAM envisions a future where aerial transportation becomes an accessible, sustainable, and integral component of urban life, transforming cities into more connected, vibrant, and resilient communities.

By integrating AAM solutions with traditional modes of transportation, such as car, ferry, and rail systems, AAM offers residents and businesses unprecedented connectivity, efficiency, and sustainability.

WHY NOW?

While helicopters have been a limited use option for aerial mobility for decades, AAM introduces technological advancements in aircraft systems, combined with increased demand for more efficient transportation, to drive the prospect for a scalable, sustainable market for aerial transportation.

Around the world, governments and technology companies are racing to develop, certify, and deploy AAM for routine public transport. Incheon aims to be a leader in this race.

Global UAM Regional Summit (GURS) Memorandum of Understanding (MOU) Signing Ceremony

FOREWORD BY INCHEON MAYOR

Thirty years ago, foreign movies popularized the idea of taxis flying between dense, urban buildings. At the time, I thought that such a thing might be possible in the very distant future. Although these science fiction movies were set 250 years in the future, Incheon City has prepared a detailed plan for the operation of Advanced Air Mobility (AAM) in this decade.

Advanced Air Mobility is becoming a practical choice to address the challenges of urbanization and the climate crisis. This is no longer a dream or a prediction—it is becoming reality. Korea is expected to have over 85% of its population living in urban areas by 2050. Economic and social challenges will continue to increase due to issues such as housing, transportation, and environmental concerns. Advanced Air Mobility is an eco-friendly transportation method that will utilize airspace over urban areas to revolutionize urban living.

The *Advanced Air Mobility Concept of Operations for Incheon Metropolitan City* (the first publication of its kind by a local government in Korea) presents a vision and approach to proactively establish an AAM ecosystem that considers urban development, environmental issues, and infrastructure changes in the setting of the large city of Incheon. It describes necessary changes and initial plans to accelerate this innovative opportunity through cooperative projects that promise to improve the lives of 3 million Incheon citizens on the mainland and on the islands.

The era of AAM is just around the corner. New laws for AAM have passed the National Assembly. Incheon City, as a global and world-class city, will lead the charge to realize the benefits of AAM and strengthen the competitiveness and happiness of Incheon's citizens.

Thank you very much,

Incheon Metropolitan City Mayor
Jeong-bok Yoo
유정복

DECEMBER 2023

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PART ONE

OVERVIEW, VALUE, AND USES OF AAM

Introduction

> Incheon is poised to achieve success in advanced air mobility (AAM) with this concept of operations (CONOPS) as the blueprint for the path forward.

The Republic of Korea and the Incheon Metropolitan City region seek to be world-leaders in the introduction of advanced air mobility (AAM) and to define a new future for aviation. Incheon City—in collaboration with its citizens, consortium partners, the national government and international partners—will follow a set of priorities and deliberate actions to achieve its goal.

AAM presents a unique transportation opportunity that leads to a significant shift in travel habits and brings about structural changes in the transportation landscape. For most city residents, air travel has been confined to airports located on the outskirts, disconnected from everyday life. In contrast, AAM seamlessly integrates into the urban landscape, providing residents with more direct access to an aviation transportation network and revolutionizing the way people navigate their cities.

Numerous stakeholders, including national governments, aircraft manufacturers, and operators, have published AAM CONOPS that focus on integrating AAM at a national level. In contrast, this CONOPS emphasizes the urban environment. As a result, it offers a way forward not only for Incheon Metropolitan City and its surrounding region but also serves as a guide for cities worldwide having similar geographies, hosting major airports, and supporting regional maritime locations. This blueprint can serve as a guide for other cities that are planning and implementing AAM operations and systems.

> FOR MOST CITY RESIDENTS, AIR TRAVEL HAS BEEN CONFINED TO AIRPORTS LOCATED ON THE OUTSKIRTS, DISCONNECTED FROM EVERYDAY LIFE.

Previously, city officials were not required to take on extensive responsibilities for major airport operations. With the rise of AAM, their roles are expected to become more substantial. These enhanced duties will encompass active participation in aviation-related land use planning, delivering improved city services, modernizing electric utilities, and jointly overseeing and managing AAM surface operations and infrastructure in collaboration with the national government.

KEY OBJECTIVES AND PRIORITIES

Incheon has identified two objectives for this new form of transportation. These are:

- **Enable residents of the Incheon islands to visit mainland Incheon and return home within one day.**
- **Enable Incheon residents to travel anywhere around the broader Incheon and Seoul region within 30 minutes.**

Incheon has defined three priorities that are profoundly important in guiding city initiatives and investments in the development and deployment of advanced air mobility.

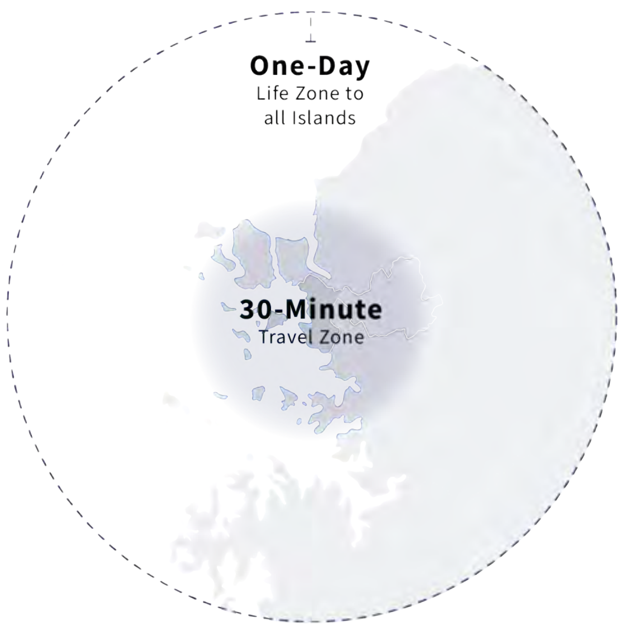
- **Ensuring the safety** and well-being of Incheon City citizens.
- **Involving the community** to gain its trust and acceptance of AAM.
- **Improving quality of life** through greater access to efficient, environmentally sustainable mobility.

COLLABORATIONS

Incheon City recognizes the importance of collaborating to enable AAM. As a result, it is partnering with several private companies to build an AAM demonstration platform. Incheon is also engaging with public institutions such as Incheon International Airport Corporation and Korea Land and Housing Corporation to lay the foundation for AAM. Incheon City is participating as a member of UTK (UAM Team Korea), a UAM public-private consultative body launched by the Ministry of Land, Infrastructure and Transportation (MOLIT). Finally, Incheon City has created the Global UAM Regional Summit (GURS), an AAM international cooperation system involving various cities, airports, and research institutes.

In 2012, Songdo International City in Incheon City was chosen as the host city for the Green Climate Fund (GCF) Secretariat. The GCF, initiated under the United Nations Climate Change Conference, is the world's largest climate fund established by developed countries to assist developing nations in achieving low-emission, climate-resilient pathways. Incheon's involvement in AAM and its contributions to the GCF will enable others to learn and address global climate challenges related to urban transportation in an environmentally friendly way.

THIRTY MINUTE TRAVEL ZONE IN URBAN AREAS AND ONE DAY LIFE ZONE FOR THE ENTIRE REGION.



Benefits of the integration of AAM in the region will be significant. It is expected that AAM deployment will result in transportation improvements, workforce development, job creation, improved regional access, improved emergency services, increased environmental sustainability, technology advancements and economic growth among other benefits.

INCHEON GUIDING PRINCIPLES

Incheon will prioritize a set of three guiding principles when designing the AAM ecosystem. These principles are the north star for the Incheon region. When making decisions about what infrastructure to use, or what policies to set, decision makers can return to these guiding principles.

Safety—Safety is the foremost guiding principle for AAM operations in Incheon. It encompasses the implementation of rigorous safety standards, procedures, and technologies to ensure the protection of passengers, crew, and the public. Safety considerations will be embedded in all aspects of AAM operations from vehicle design and maintenance, personnel training, corporate culture, airspace management, and emergency procedures. An important aspect of safe operations is security. Robust physical and cyber security measures will protect AAM aircraft, infrastructure, and data transfers. Security considerations such as risk assessment, authentication protocols, data encryption, and access management will be embedded through all aspects of the AAM ecosystem. Significant effort will be required to ensure the policies and regulations support and enforce a strong safety culture in AAM operations.

Community Acceptance—The principle of community acceptance recognizes the significance of engaging and involving local communities in the development and implementation of AAM operations. It emphasizes the importance of understanding and addressing the needs, concerns, and aspirations of the communities where AAM will operate. Incheon aims to foster positive relationships, trust, and collaboration between AAM stakeholders and the communities they serve. To achieve a successful outcome, a deliberate set of activities will be undertaken in advance of operations to inform the public on AAM opportunities and associated changes. Opportunities will be provided to receive feedback from communities such that maximum value to the transportation system is derived with minimum impact to communities.

Improved Mobility—The keyword for AAM is mobility. By utilizing vertical flight capabilities, AAM aircraft can access urban areas, remote locations, and congested environments with greater ease than other modalities. It is expected that the cost of access to air travel will be reduced therefore increasing access to more of Incheon's residents. Vertiport placement in Incheon will focus on locations that provide an additional mobility option, opening new and more efficient transport opportunities to the citizens of Incheon.

Incheon City formed the K-UAM Confex, one of the largest urban air mobility (UAM) conferences in the world. The city has also been an active partner in the K-UAM Grand Challenge, a series of UAM technology demonstrations organized by the national government. Moreover, Incheon City is organizing research activities, developing simulation tools, and performing risk analysis to guarantee the safe and effective incorporation of AAM technology and infrastructure into the city's environment.

Benefits of AAM for Incheon

Incheon and its surrounding environment provide an ideal location for the exploration, development, and sustained growth of an AAM industry.

INCHEON AS A LEADER IN AAM

Incheon city is part of an extensive metropolitan area that connects with Seoul, the capital city, and includes numerous islands and a major international airport. The city is a technologically advanced city, open to innovation, supported by local research and academic institutions, and possessing a highly skilled workforce ready to drive progress and change. Furthermore, Incheon City and the national government are strong advocates for exploring inventive transport solutions, capitalizing on the country's talented labor pool and advanced technological sectors.

TRANSPORTATION IN TODAY'S INCHEON METROPOLITAN REGION

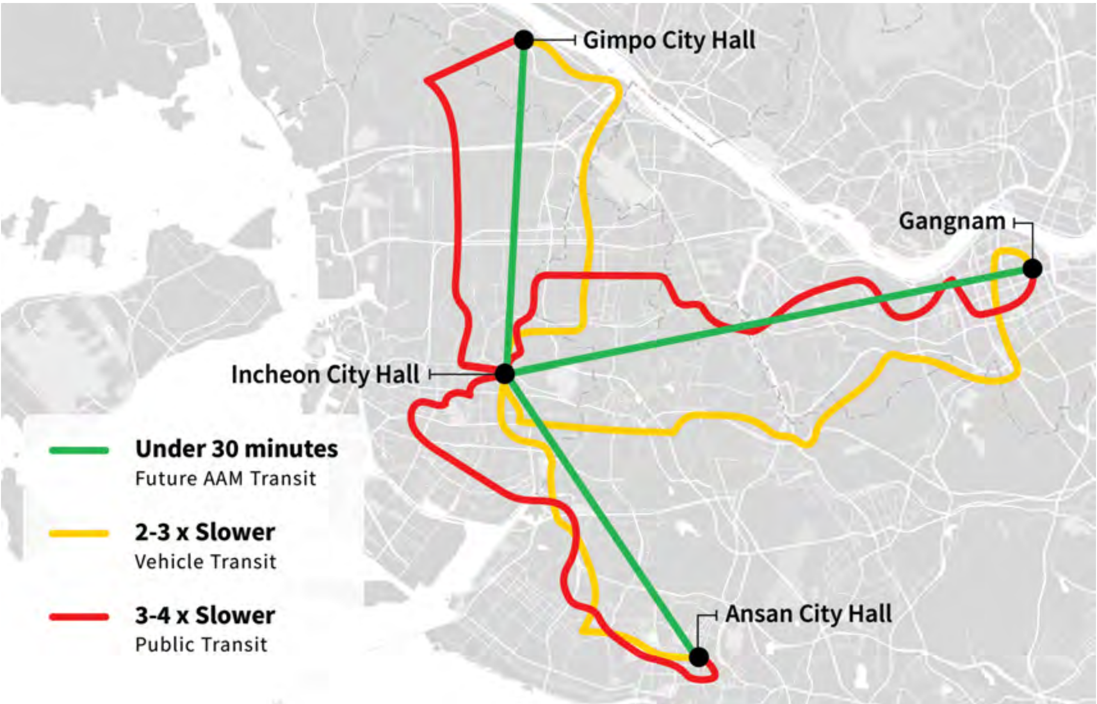
The Incheon metropolitan area has an extensive and modern network of roads, bus services, subways, trains, and ferries. Despite this, surface travel in some areas and at certain times of day remains a challenge. Travel times in the Incheon metropolitan area can vary significantly depending on traffic conditions, routes, and time of day. For instance, it takes about 30 minutes without traffic to drive 30 km between Cheongna in Incheon City and Sangam in Seoul; however, during peak hours travel time can increase to 90 minutes. The lack of competitiveness of public transportation to the outside of Incheon has led to an increase in the use of private cars, which causes traffic congestion.

Long travel times are not exclusive to the city. Incheon Port, the second-largest port in Korea, connects the city to local islands and international destinations. Travel times to nearby islands can vary depending on the distance and type of ferry service chosen.

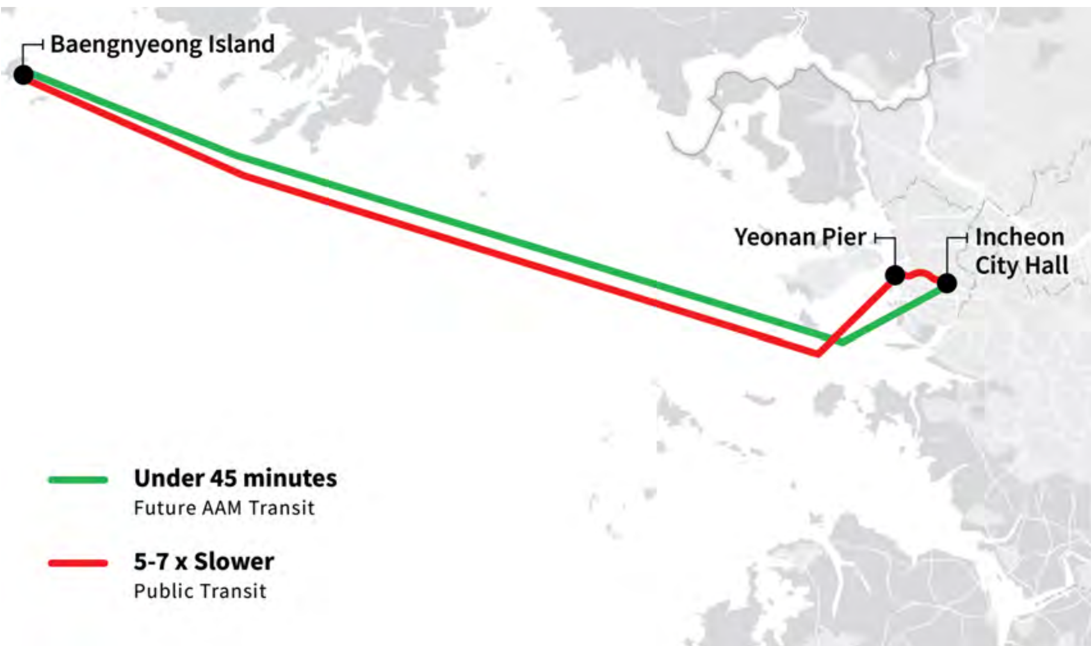
For example, travel to Baengnyeong-do Island, 176 km to the northwest, takes about 4 hours by ferry. There are only 1 to 2 ferry operations per day, and these can be canceled due to weather or other reasons. A routine visit to the mainland may take up to three days. Lack of rapid service to many of these remote islands is not only an inconvenience but also delays potential medical care, cargo delivery, and other services requiring rapid responses. An objective of Incheon City is to ensure a "one day life zone" whereby round trips to destinations anywhere in the metropolitan area can be achieved in one day.

AN OBJECTIVE OF INCHEON CITY IS TO ENSURE A "ONE DAY LIFE ZONE" WHEREBY ROUNDTRIPS TO DESTINATIONS ANYWHERE IN THE METROPOLITAN AREA CAN BE ACHIEVED IN ONE DAY.

Nearly all air travel into and out of Incheon involves long-distance flights. The use of helicopters and established helipads in Incheon are reserved for use by police and military services. Passenger transport by small, general aviation aircraft is non-existent in this region, apart from some helicopter operations for tourism. AAM will offer Incheon citizens an opportunity to access aviation services to save time on congested, circuitous, and slow routes experienced by surface and sea transportation today, though its volume of operation is expected to be a small percentage of all transportation.



Comparison of trip times between city locations around Incheon.



Comparison of trip time between Baengnyeong Island and Incheon City Hall. The AAM path is not shown as a direct route so as to avoid conflict with Incheon airport operations.

THE AAM OPPORTUNITY

AAM will improve the overall well-being and quality of life for Incheon urban residents and rural communities through improved urban and remote island transportation options, environmental sustainability, and transportation convenience and accessibility. Specific benefits will include:

Transportation Improvements	**Increased connectivity:** AAM will connect remote or underserved areas while improving overall transportation networks. **Convenience and speed:** AAM will provide a convenient means of transportation that will bypass delays associated with surface vehicles. **Transportation diversification:** AAM will offer an alternative mode of transportation where inefficient or congested connections exist today and may act as a backup for other modes of transportation. **Safety:** As people move from cars to AAM aircraft, incidents of car and pedestrian accidents may be reduced.
Workforce Development	**Job creation:** The development, manufacturing, and maintenance of AAM aircraft and systems will create new jobs in the aerospace, utilities, engineering, electrical infrastructure, air traffic management, operations management, vertiport management and other advanced technology sectors. **Specialized skills:** AAM can foster the growth of specialized skills in areas such as automation, air traffic management, communications, cybersecurity, and maintenance for eVTOL aircraft, vertiports, and supporting systems and services. **Localized workforce:** Whereas airports are located on the periphery of cities, AAM can draw its workers from the local community, thereby adding economic benefits to that community and reducing the need for long commuting times.
Regional Access	**Improved accessibility:** By providing faster and more efficient transportation options, AAM can expand access to supplies, services, and job opportunities for people living in remote or underserved areas, especially in the island communities. AAM can enable a one day life zone concept for Incheon where no resident will have to travel more than one day for any particular trip in the region. **Emergency services:** AAM can better support emergency and urgent services by providing faster response times for medical services, supplies, police, and humanitarian assistance.
Environmental Sustainability	**Carbon reduction:** Many AAM aircraft are electric powered, which significantly reduces greenhouse gas emissions when compared to legacy aircraft and carbon fuel-based surface transport. **Low noise:** AAM operating at low altitudes have noise emissions at levels comparable to cars and will be nearly silent at cruise altitudes. **Infrastructure offsets:** Though AAM operations will require infrastructure, this new construction may reduce the need for more costly and disruptive surface infrastructure such as road, rail, and bridge development or expansion to meet growing transportation demand.
Technology Advancement	**Technology development:** Introduction of AAM involves cutting edge technologies in automation, communications, controls, vertiports, electrification, security, and other areas that can spin off and strengthen high technology sectors in the region. **Smart city connectivity:** AAM will connect seamlessly with Incheon's smart city communication networks to enhance safe and effective urban management of this new transport sector. **Innovation:** Rapid growth and evolution of technologies associated with the AAM ecosystem will spark ingenuity and innovation benefiting performance, productivity, and efficiency in other sectors of the economy.
Economic Growth	**Business opportunities:** The expansion of AAM can stimulate economic growth through job creation, increased productivity, improved transportation, enhanced tourism, and new business opportunities including those for local businesses. **Increased investment:** AAM development and expansion can attract investment in infrastructure, technology, and related industries that are not always directly related to AAM. **Travel efficiencies:** AAM will offer greater potential travel time and cost reductions as networks expand and operations scale. **Global trade:** Improved transportation networks brought about by AAM will enhance international trade and image as a high technology country as well as support economic growth on a macro scale.

Integrating AAM into Incheon's Transportation Network

Several prominent firms, including Morgan Stanley, NEXA Advisors, and Deloitte, have projected AAM market valuations to range between $155 billion USD and $1.5 trillion USD in the next 15-20 years. Although these estimations vary significantly, they highlight the uncertainty and yet underscore the immense market potential of this emerging technology. With a population of about 3 million people and a robust transportation network, Incheon provides ample opportunities to integrate AAM operations. Incheon's current transportation network consists of personal vehicles, city buses, metro lines, airports, and a ferry system to connect the islands. Together these modes of transportation result in millions of daily connections to enable the city's robust economy.

AAM is expected to compliment Incheon's transportation network. Cars and taxis provide flexible access to any destination along a road network. Bus and subway systems provide efficient station-to-station connections for travelers. AAM blends the flexibility and distance benefits of cars/taxis with the station-to-station model of buses and subways. While buses and metros are limited to linear connections along their routes, AAM vertiports (i.e., stations) can connect to any other station which enhances the flexibility of this mode. Many AAM users will still need to use first-mile and last-mile legs provided by the other modes of transportation. Therefore, AAM infrastructure will need to be thoughtfully coupled with other transportation methods to maximize its utility. This integration of AAM will result in a more versatile and interconnected transportation system for Incheon's residents.

Incheon average daily passenger transportation statistics (Estimates from most recent available data between 2019-2022. Personal vehicle data is an estimate based on similar size international cities.)

Transportation Method	Number of Daily Passengers
Personal Vehicle	900,000
Bus	688,000
Taxi	822,000
Subway	1,064,000
Ambulance Trips	551
Airport	662,000
Ferry	2,500
Total Passengers Transported	4,139,051

Possible AAM operations growth as aircraft and vertiports are incorporated into the transportation system. Projected passengers derived from a MITRE AAM simulation platform.

Operational Horizon	AAM Network Characteristics	AAM Daily Passengers	% of Incheon Transportation Passengers
Early Operations	3 Vertiports, 12 eVTOL	292	0.007
	8 Vertiports, 24 eVTOL	993	0.024
	15 Vertiports, 60 eVTOL	2,608	0.063
Mature Operations	25 Vertiports, 150 eVTOL	8,651	0.209
	35 Vertiports, 420 eVTOL	36,671	0.886

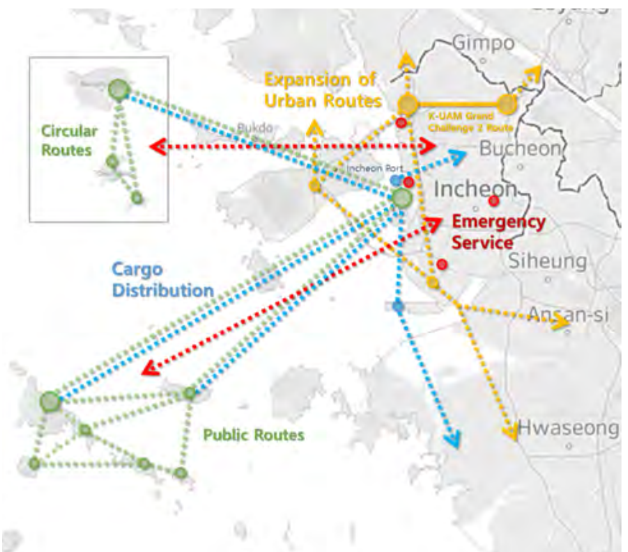
Notional future route network and vertiports in Incheon

The fraction of the transportation market that AAM operations can serve will depend on the size of the AAM network, which is largely dependent on how many aircraft and vertiports are available. Market modeling tools can estimate the number of passengers an AAM operational network can serve based on assumptions for the time required between operations and the turnaround time at vertiports. In initial operations, AAM will primarily be used for high value use cases that represent a fraction of Incheon's over 4 million daily transportation connections. Even at high capacity, AAM is anticipated to carry significantly fewer passengers than traditional ground transportation methods. Nonetheless, the connections provided by AAM will offer immense value to its users. In many cases, AAM may support connections that would not have otherwise happened with the current transportation network. AAM will provide a fast and reliable form of transportation that complements the Incheon transportation network. This vision of integrating a new aviation system into the existing transportation network presents an opportunity to significantly transform the lifestyle of Incheon residents. By saving 1-2 hours on specific journeys, passengers can enjoy more time at their destinations, allowing for activities such as visiting friends, attending an extra work meeting, or exploring new dining options. AAM will also allow residents to travel greater distances in a given time than current forms of transportation. This opens opportunities to visit new locations, make new work connections, or explore previously inaccessible leisure activities. All of this adds up to a more connected region with new economic patterns and an enhanced quality of life for Incheon residents.

Image source: Incheon Port Authority (IPA)

Incheon Use Cases

A variety of use cases for AAM demonstrate significant benefits to the Incheon region. For a use case to be valuable, it must provide a public good or a marketable service that will improve quality of life for residents of Incheon



Conceptual AAM Operation Routes of Incheon Metropolitan City

ISLAND CONNECTIONS

Over 100 islands flank the Incheon coastal region. Today, these islands are connected with a ferry system based at the Incheon Port. AAM can enable much faster connections between the Incheon mainland and the vast array of islands. AAM air taxis can also shuttle passengers and cargo between islands, some of which may not have an existing ferry connection today. These island connections may also result in further economic development due to improved access.

- Island residents commuting to a work event in downtown Incheon
- Patient flying to Inha University Hospital for a medical procedure and returning home to their island within the same day
- Elderly couple flying to a nearby island to visit friends or family
- Mainland residents flying to Baengnyeong island for a vacation or a day of adventure

Notional vertiport locations and flight connections that would support the island connection use cases

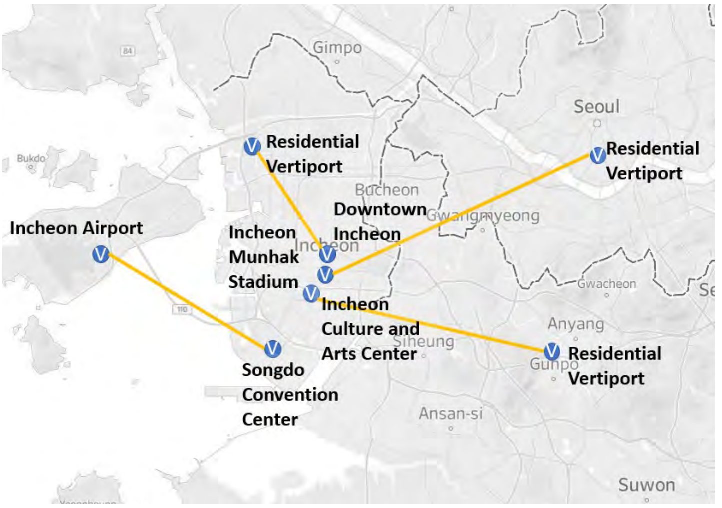
AAM operations to Incheon's archipelago is a priority as it provides an underserved community with a new and efficient transportation option and will facilitate tourism and emergency response improving the overall quality of life for residents. Moreover, operations in this maritime environment present minimal risk relative to air traffic or surface hazards.

URBAN AIR TAXI

Urban air taxi services are a leading use case for AAM in the Incheon region and will offer efficient and fast transportation. This service will connect key locations such as airports, business districts, hospitals, universities, and tourist attractions.

- Concert-goers flying to watch a performance at Incheon Culture and Arts Center
- Residents commuting to work in the morning and from work in the evening
- Fans flying to attend a sporting event at Incheon Munhak Stadium
- Passengers flying to Incheon International Airport to connect to an airline flight
- Citizens flying to Incheon Convention Center for a conference gathering

AAM will complement existing urban ground transportation systems such as subway, bus, train, and automobile. Operations will be integrated into the current ground transportation network such that arrivals and departures are



Notional vertiport locations and flight connections that would support the air taxi use cases

convenient to users. Operators may schedule flights at published times or operate at the request of travelers. Passengers request a flight, travel to the nearest vertiport, board the aircraft, and arrive at their destination quickly and efficiently. AAM will not replace existing transport modes but will provide travelers with an additional choice for urban transportation.

CARGO DISTRIBUTION

The market for drone delivery of small packages continues to expand. With the development of eVTOL aircraft, AAM operators will expand this concept on a larger scale by providing cargo distribution and logistics services. AAM aircraft can transport time-sensitive or high-value cargo, such as medical supplies, perishable goods, or urgent deliveries, to and from various locations within the region.

- Merchants sending goods from distribution warehouses to storefronts to supplement existing trucking services
- Shipping department transporting timely cargo from Incheon Port to distribution warehouses
- Business sending goods from manufacturing facilities to Gunpo Complex Logistics Terminal
- Resupply service sending perishable items to remote areas and islands in the Incheon region

AAM operations will not replace cargo distribution systems of today but will provide

Notional vertiport locations and flight connections that would support the cargo distribution use cases

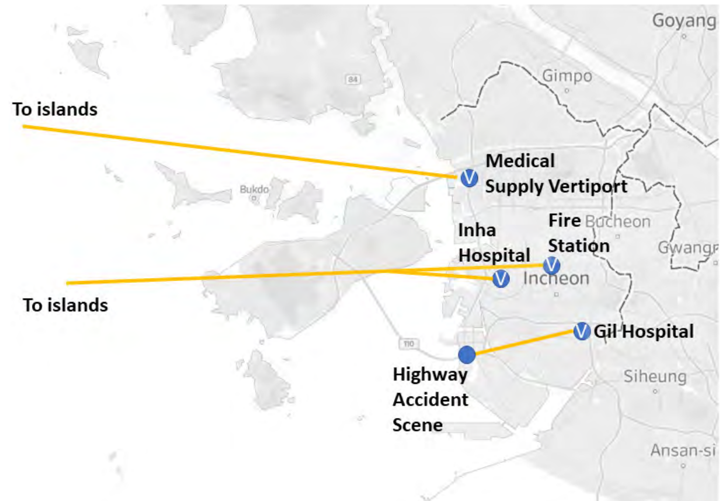
an additional transport method to enhance supply chain logistics. AAM aircraft will be able to take goods to places that are not easily accessible by trucks or trains today. AAM operations may support increased throughput of goods and enhance the timely delivery of critical products at a higher speed and lower cost to help spur economic development.

EMERGENCY SERVICES

AAM operators have the opportunity to improve healthcare outcomes by providing emergency services to the Incheon population. In many situations, AAM aircraft can transport people in need of emergency care to a hospital faster than conventional ambulances.

- An injured motorist flown from an accident scene to a nearby trauma center
- First responder transported from a dispatch station to an emergency scene
- Delivering urgent medical supplies (e.g., organ transplant) from the mainland to an island to meet a specific emergency healthcare need
- Firefighters traveling to island areas for fire suppression activities

AAM aircraft developed for emergency service applications may need special design considerations much like today's ambulances are equipped. Access to airspace may also



Notional vertiport locations and flight connections that would support emergency services use cases

be prioritized for this type of aircraft to assist with more rapid deployment. AAM aircraft providing emergency services may also be able to land and depart from highways, grassy areas, or existing helipads without the support of services typically found at a vertiport or vertistop.

REGIONAL MOBILITY

Most AAM missions in the Incheon region will be designed to support operations in the immediate metropolitan area. However, some aircraft will be developed to enable longer range missions. Regional air mobility is defined here as AAM operations to locations greater than 100 km away. These AAM operations will transport passengers and cargo to neighboring regions in Republic of Korea. As battery technology improves and flight ranges increase, there may be future opportunities to provide regional connections to neighboring countries.

- Business traveler going from downtown Incheon to Sejong City for a business meetings
- Fishing merchants sending seafood from coastal towns along the East Sea (e.g., snow crab from Yeongdeok, squid from Ulleungdo)
- Incheon residents flying from Incheon to a golf resort on the eastern coast of Korea

Notional vertiport locations and flight connections that would support regional transportation use cases

The utilization of AAM aircraft for regional mobility will expedite the delivery of critical services and goods, such as essential medical supplies. In certain cases, regional AAM operations will replace journeys that might be too circuitous or involve multiple connections across various transportation modes, making them impractical.

PART TWO

AAM SYSTEM DESCRIPTION

Aircraft, Vertiports, and Ecosystem

AAM aircraft, vertiports, and the supporting ecosystem are the fundamental components that facilitate this novel transportation concept. While they bear resemblances to conventional aircraft, heliports, and operational networks, AAM system elements possess distinct designs, features, and capabilities that distinguishes them from traditional aviation assets.

AAM AIRCRAFT

Advanced Air Mobility aircraft, known for their unique designs and highly automated systems, hold the potential to revolutionize passenger and cargo transportation by providing eco-friendly, efficient, and cost-effective services. A wide variety of designs are being proposed including retrofits of traditional aircraft and all manner of novel aircraft systems. Some aircraft are designed for shorter intracity flights, while others are designed for longer intercity flights and access to rural areas. In general, AAM aircraft are powered by electric or hybrid fuel sources (e.g., hydrogen, electric and combustion), produce minimal noise, and offer vertical take-off and landing (VTOL) or short takeoff and landing (STOL) capabilities.

EVTOL AND HELICOPTERS DIFFERENCES

AAM aircraft differ from helicopters in several key aspects. These aircraft often rely on highly automated, distributed electric propulsion systems that control multiple smaller rotors, as opposed to the single or twin rotors manually controlled in helicopters. Some utilize coupling of propulsion and controls, and many rely heavily on carbon base structures with associated weight reductions. It is expected that part counts for EVTOL aircraft will be significantly lower than for traditional helicopters with an associated reduction in costs for maintenance and overhaul. These ultimately impact the cost per flight hour.

Another significant difference is noise level. AAM aircraft are generally designed to be quieter than helicopters. Given the propulsion system choices, AAM aircraft are expected to operate more efficiently and be low- or non-carbon emitting. AAM aircraft also typically employ advanced automation control systems making them easier to operate than helicopters. Some AAM designs go further and seek to remove the pilot from the cockpit and operate without an onboard pilot in a highly automated mode.

The advantages of helicopters over AAM aircraft today are their greater range, endurance, and carrying capacity; higher levels of power; established infrastructure and supply chain; public acceptance in most areas; highly trained work force for military and civilian applications; and the fact that several aircraft are certified for operations with a mature industrial base. Over time as AAM vehicles mature, it is expected that some of these advantages will erode.

AIRCRAFT AUTOMATION LEVELS

Automated systems aboard AAM aircraft employ different techniques to inform, enhance, or limit the inputs of a pilot. These techniques can affect the roles, responsibilities, and even the authority of the pilot to act during certain aircraft states, conditions, contingencies, or environments.

The terms "automation" and "autonomy" can often be confused. In this document, automation refers to predefined actions or functions commanded by a human pilot and performed by the AAM aircraft. These predefined actions are limited in scope and may be subject to manual intervention. An automated AAM aircraft will therefore follow programmed orders but cannot make its own decisions. In contrast, autonomy makes decisions to achieve an objective, with no expectation or need for human intervention. A fully autonomous AAM aircraft decides all functions of flight including control inputs and flight path.

Automation levels of AAM aircraft allow for simplified pilot controls enabling safe single pilot operations. More advanced aircraft will not require an onboard pilot. Remote operation and remote monitoring of automated aircraft will eventually be joined by autonomous aircraft. Remote operators will manage a single flight or supervise multiple aircraft.

It is expected that pilots will be onboard during initial operations but will transition to remotely piloted operations as the technology is proven as safe and reliable. As most AAM aircraft have limited number of seats, this later instantiation will reduce the cost of operations and make AAM flight increasingly more affordable.

EVTOL CONFIGURATIONS

AAM aircraft are being configured to carry passengers or cargo and can be categorized as follows:

Multirotor: Multirotor aircraft use distributed rotors to produce thrust and lift and couple controls and propulsion to maneuver. These aircraft have limited or no fixed lifting surfaces and are most suited to short-distance flights.

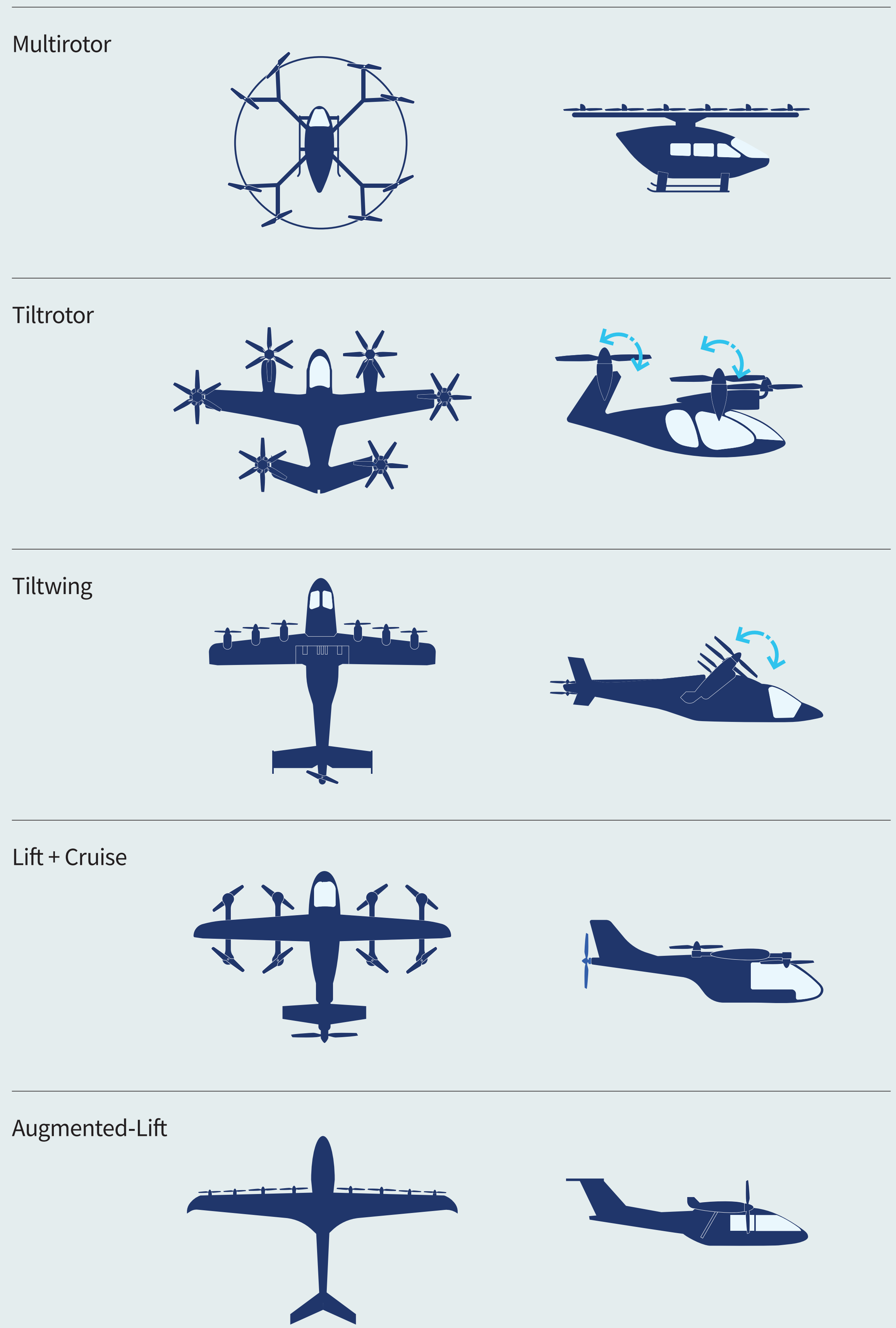
Tiltrotor: Tiltrotor aircraft have rotors that can tilt between horizontal and vertical positions, allowing them to take off and land vertically like a helicopter and fly with speed and efficiency that is closer to that of a fixed-wing airplane.

Tiltwing: Like tiltrotor designs, tiltwing aircraft have wings and engines that can rotate between vertical and horizontal positions. This allows the aircraft to take off and land vertically, or with short takeoff distances then transition to forward flight like a conventional airplane.

Lift+Cruise: Lift+cruise aircraft use separate systems for vertical lift and forward propulsion. They typically feature multiple rotors or propellers for vertical take-off and landing, and separate engines or motors for forward flight.

Augmented-Lift: Augmented-lift aircraft, also referred to as blown-lift aircraft, use high volumes of air produced by the propeller to blow air over the entire span of a wing allowing for takeoff and landing over very short distances (e.g., within 100 m). These aircraft can use minimal runway lengths that can be built in urban locations.

EVTOL CONFIGURATIONS CATEGORIES



VERTIPORTS

Vertiports are specialized airports for AAM aircraft. They vary in size, services offered, facilities, capacity, and location; most are designed to support VTOL aircraft with future variants allowing for Short Takeoff and Landing (STOL) aircraft. Vertiports may be publicly or privately owned and serve passenger transport, cargo, or both. Because many will be in urban areas, their operations require new procedures and advanced technologies to support the aircraft and to coordinate with air traffic, third party service suppliers, and city officials.

Vertiport concepts can be grouped into two main categories:

Full-service vertiports: Full-service vertiports are facilities that can accommodate multiple AAM aircraft at once. They offer passenger ticketing and security services, and structures for a passenger terminal; parking areas; takeoff, landing, and taxi areas; charging stations; and aviation support systems (e.g., communications, weather sensors, and lighting). Some larger vertiports—alternately named "vertihubs"—will also include aircraft maintenance and repair facilities, storage areas, and access points to other transportation modes. Full-service vertiports will be scalable and adaptable to accommodate growing demand. Some may be collocated with and share many of the surface areas, structures, and services used by conventional aircraft at airports. However, most full-service vertiports are also likely to be integrated into existing rail, bus, and ferry transportation hubs.

Vertistops: Vertistops are small-scale facilities, often with one landing pad and limited parking, designed for quickly loading and unloading passengers and cargo. Few if any passenger services are available. Vertistops may or may not have charging stations or other support systems. Their small size allows them to be located closer to high-demand urban destinations and ground-based transportation where a full-service vertiport construction would not be practical or possible. Vertiports are also suitable for island operations. There is a high possibility that vertistop-sized vertiports will be installed in small island areas.

For the remainder of this document, these variants will be described collectively as "vertiports," unless otherwise specified.

Full-service vertiport

Shared Airport and Heliport Facilities

Vertiports may be collocated with and share many of the surface areas, structures, and services used by conventional aircraft (most commonly helicopters) and possibly cargo carrying remotely piloted aircraft. These shared facilities may have systems, procedures, and markings unique to the operational needs of AAM aircraft. Early testing and development of AAM operations may take advantage of existing aerodrome infrastructure.

Vertiport Locations

Vertiport locations within Incheon City and the region will be based on community concurrence, an assessment of public good, government approval, and supporting business demand for AAM operations. Ideally, vertiports will be located where transport demand and community value are greatest, city infrastructure and services are readily available, and the surrounding airspace is well-suited to integrate their operations safely and efficiently. These facilities may be located on existing rooftops or at ground level. Some vertiports may be integrated into existing buildings or as a new construction project, such as over a highway or railyard. Yet others may have modular designs that can be transported to different locations as needed, such as to serve temporary events or humanitarian operations.

Vertiport Standards and Development

Standards and requirements for vertiports are maturing as innovative designs continue to progress. Several companies—some well-established in airport construction and others new to the field—are building and testing vertiport concepts worldwide. Government regulators have also begun to consider the regulatory environment, requirements, and standards under which vertiports are built and operated. The US, Europe, and Australia have developed draft guidelines for the design of these structures.

Multimodal access to vertistop

Vertiport Operations

Vertiport operations may require advanced technology and regulatory changes to support AAM operations at scale, and to coordinate with other AAM and Air Traffic Management (ATM) system actors. For their part, Incheon City officials will be able to receive notifications in case of needed support (e.g., police), and will likewise communicate to AAM operators or designated service providers any planned or urgent conditions that may impact the operation of vertiports (e.g., local fire activity).

AAM ECOSYSTEM

Successful AAM deployment will require coordination within a complex and evolving ecosystem of technology, infrastructure, policy, training, and regulation. This includes an incremental approach to maturing from initial AAM flight demonstration to sustainable operations. Ultimately, this will lead to a transformation of mobility options in Incheon and the surrounding region. Conventional flights operate to and from a few main airports around a metropolitan area. Airports are typically sited away from downtown population areas to reduce ground risks, mitigate noise concerns, and ensure large areas for runways. For example, Incheon airport is the world-class international airport for the Incheon and Seoul region and is located on an island 23 km (12 NM) west of downtown Incheon. In contrast, AAM operations will land at one of numerous vertiport sites that, in some cases, are tightly integrated with population centers. This philosophical change to the nature of flight operations introduces complex integration challenges. These challenges require holistic thinking about the flight operations, surface integration, and interconnected technologies and regulations that tie the operation together. It will no longer be sufficient to think of aviation as segregated from city operations. With AAM, aviation operations and city operations will be closely coupled. Because AAM operations require a complex network of interconnected systems, the term ecosystem will be used to describe the AAM environment.

Multi-modal Transportation

Incheon AAM Ecosystem Elements

Incheon's roadmap to AAM includes six distinct elements of the holistic AAM ecosystem: Airspace Integration, Infrastructure, Technology, Operations, Regulations, and Urban Integration. Successful deployment of AAM in the Incheon region will require close coordination in all six areas of activity in tandem.

Airspace Integration	Preparation of airspace design, air traffic procedures, and air traffic management systems for integration of AAM operations.
Infrastructure	Standards and planning for infrastructure needed to support the construction and operation of veriports and supporting systems.
Technology	Maturing and approval of aircraft systems and ground-based technologies that support increasingly automated AAM operation.
Operations	Development of approval and oversight processes for operations, personnel, and service providers.
Regulations	Development of regulations and policies to support safe, efficient, sustainable, and equitable growth of UAM operations.
Urban Integration	City preparation and land use planning for integration of AAM operation with multimodal transportation system.

Description of the six AAM ecosystem elements

PART THREE

PREPARATION AND ESTABLISHMENT OF AAM

Background image source: IFEZ

Incheon City Roles

Urban areas like Incheon and Seoul are highly constrained and complex. Incorporating new aviation infrastructure and operations into the existing framework demands meticulous planning and preparation.

As Incheon City officials work towards cultivating a thriving AAM ecosystem, they have been and will continue to consider all transportation requirements of the city and the surrounding region while also addressing the concerns of impacted communities and stakeholders. Incheon City aims to concentrate its resources on three key functions to facilitate AAM: transportation planning, managing and overseeing operations, and fostering collaboration. These aims are aspirational and represent intended efforts rather than a commitment to perform the stated actions exactly as described.

TRANSPORTATION PLANNING

Incheon has developed the Incheon Metropolitan City Urban Transportation Comprehensive Plan (2017-2036) that aims to shift the city and region from personal vehicles toward increased shared and integrated transport. It focuses not only on efficiency but also on equity and sustainability and promotes universally accessible mobility rather than limited mobility. Several of the plan's goals align well with the integration of an AAM transportation ecosystem, including:

- Developing a connected transportation system in preparation for the expansion of national transportation facilities and the advancement of industrial complexes.
- Realizing a healthy and clean low-carbon transportation city.
- Creating a comfortable and barrier-free transportation environment for all citizens.
- Improving the mobility, safety, and convenience of the transportation system by utilizing cutting-edge information and communication technology.
- Establishing a transportation infrastructure that leads to future changes.

To accomplish its AAM objectives, Incheon City is carrying out economic, transportation, and environmental research to thoroughly understand the advantages and consequences of AAM infrastructure on the city and its surrounding area. This includes examining the effects on travel time, travel expenses, access to transportation, safety, and social conditions. This information will support planning efforts leading to potential changes in several areas.

Zoning and Land Use: Specific areas in the Incheon region may be designated in land use planning and zoning for vertiport development. This will involve updating building codes and specifying noise and safety protection zones around vertiports or sensitive areas within the city. Progress is dependent on data from AAM aircraft manufacturers concerning noise emissions, energy consumption, takeoff and landing performance, and safety requirements associated with infrastructure and supporting systems.

Regulation and Policy: Existing Incheon City and regional regulations and policies will be assessed to determine if changes or new rules are needed to address unique noise, traffic management, parking, and safety conditions arising from vertiport structures and their operation.

Transportation Integration: Vertiport infrastructure will tie into existing rail, bus, airport and sea transportation networks where feasible. Integration into the city environment will also be a factor in parking and convenient public access to pedestrian and bicycle connections.

Electric Utilities: Power demands of AAM aircraft may require the city to upgrade electric distribution lines and assess energy supply management to effectively support battery storage and recharging stations.

Finance: In building public use vertiports and associated city infrastructure, Incheon will seek financing from local, regional, and national taxes supporting transportation modernization initiatives, and will also rely on public-private partnerships in collaboration with AAM and vertiport industries. Other funding mechanisms being explored include user fees paid by the vertiport operators, AAM operators, and passengers. To attract private funding, Incheon may offer tax incentives, particularly in underserved locations where profitability may be limited and private investment difficult to obtain.

Smart City Data: Incheon is one of the world's leading smart cities. This includes the use of advanced information and communication technologies to inform transportation planning and to optimize the efficiency and sustainability of its transportation infrastructure and operations. AAM infrastructure and operations will integrate into its smart city network. Information will be used to manage and oversee systems, operational performance, and safety of individual vertiports and the vertiport network.

Approvals and Oversight: City building inspector guidance and training will be updated to ensure inspectors are prepared and qualified to approve vertiport construction and system installations. Once approved, the city will continue to oversee the continued maintenance and operation of the infrastructure to ensure conformance with city requirements. Additional inspections and oversight will be conducted by the Ministry of Land, Infrastructure, and Transport (MOLIT) for compliance with national aviation regulation regarding the installation, functioning, data reporting, and maintenance of aviation safety components.

Security: Cyber and physical security of AAM infrastructure and operational systems will be vital as breaches may disrupt operations or cause harm. Incheon and MOLIT will work to ensure security protocols are in place and appropriate standards and requirements followed when approving and overseeing AAM infrastructure and its operations.

Emergency Response: Preparing for emergencies at vertiports will involve development of response plans for incidents such as battery fires, accidents, and medical emergencies where rapid access by city first responders is critical. Scenarios will be developed and city and vertiport personnel trained in emergency procedures and the safe use of equipment. To facilitate awareness and response times to vertiports, communication systems will be established with local fire departments, hospitals, and police.

Incheon's UAM Demonstration Platform Workstation

MANAGING AND OVERSEEING OPERATIONS

Incheon City currently assumes varying degrees of operational management and oversight for current transportation modes. For instance, the city is the primary operator of metro train operations; the city sets schedules and fares, maintains infrastructure, and handles daily operations. For taxis, however, Incheon City mainly oversees aspects like determining pickup locations, certifying drivers, and setting fare regulations. While the city's exact level of operational management for AAM operations is still undetermined, Incheon City anticipates playing a role that guarantees a cohesive transportation system that benefits all citizens. This role will require expanded investments, sustained attention, and additional resources.

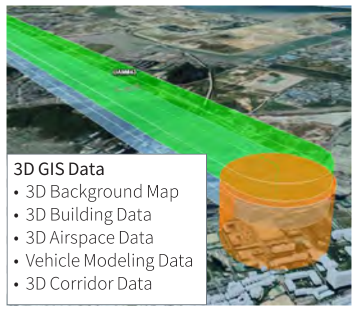
Throughout its evolution, the city will evaluate and define objectives for underserved areas, such as nearby island communities, and may provide subsidies in cases where private entities may not find development and operations profitable. It will also decide where vertiports may be shared for public use (e.g., emergency aviation services) or permitted to operate privately. Additionally, the city will oversee vertiport operators and perform safety and security risk management in accordance with city regulations.

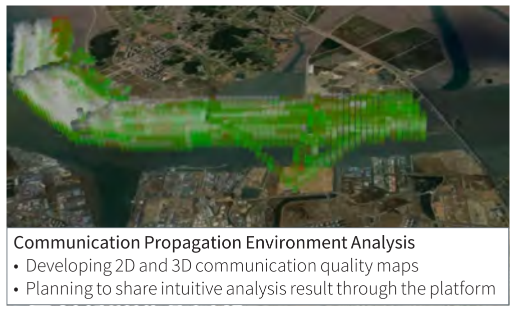
Incheon City will also work with businesses associated with or directly supporting AAM and vertiport operations, such as maintenance, repair, and storage facilities. This ensures that businesses receive the necessary government support to successfully develop in locations most advantageous to business interests and community needs. It also fosters workforce development.

In a social capacity, Incheon City will continuously monitor developments to make certain its citizens are supported with AAM services and facilities that are usable (practical for use as a transportation alternative) and equitable (reasonably accessible and cost effective).

Incheon City UAM Demonstration Platform Projects

Year	Sub-Projects
2021	Airspace Analysis and Route Design
	Establishment of 3D Digital Infrastructure
	A Basic Study on the Aircraft Simulation & Analysis Technology
	Platform UI Design and Scenario Development
	Development of Integrated System & Demonstration Workstation Construction
2022	UAM Demonstration Platform Design & Functional Development
	Creating a Regulatory Sandbox
	Development of an Aircraft Performance Analysis Tool
	Analysis of Noise Damage
	Analysis of Vertiport Turbulence
	Airspace & Route Design
	Development of Vertiport Video Surveillance System
	Investigation and Analysis of Communication Transmission Environment
	Establishment of UAM Integrated Monitoring Center
	Establishment of UAM Indoor Test Room
2023	Enhancement of Sophisticated UAM Demonstration Platform Functions
	Enhancement of Sophisticated Vertiport Video Surveillance System Functions
	Strategic Planning for Establishing the Incheon UAM System


3D GIS Data
- 3D Background Map
- 3D Building Data
- 3D Airspace Data
- Vehicle Modeling Data
- 3D Corridor Data


Communication Propagation Environment Analysis
- Developing 2D and 3D communication quality maps
- Planning to share intuitive analysis result through the platform

Real-time Video Surveillance System


Incheon City is undertaking a project to develop a UAM virtual digital twin and validation platform, which aims to create a UAM validation foundation from a regional standpoint. This project involves various tasks, such as risk assessment, analysis of communication propagation, weather conditions, and the establishment of a validation workstation.

FOSTERING COLLABORATION

Incheon City officials, in collaboration with government ministries, are conducting needs assessments and formulating guidelines and regulations pertaining to AAM. They are consulting with Seoul and regional planning departments, politicians, and policymakers to devise plans and policies concerning ground infrastructure. Incheon City has also launched public awareness campaigns to educate residents about the advantages of AAM technologies and garner public support and acceptance for these new modes of transportation while simultaneously gathering community feedback.

In partnership with MOLIT, Incheon City officials are evaluating the regulation of vertiports to ensure their design, construction, and operation minimize risks to the public, passengers, crew, and other personnel. Furthermore, the city is engaging with AAM industry members, academic institutions, and research organizations like IAIAC and MITRE to develop the most effective, safe, efficient, and equitable solutions for AAM and urban infrastructure.

Community Engagement

Building trust within the community is essential to gain social acceptance of AAM infrastructure projects and prospective services. This begins with early engagement and collaboration. To this end, Incheon City officials have begun and will continue outreach events to its citizens, community leaders, and local businesses to explain AAM high-level objectives, evolutionary steps, potential cost and benefits, and details of near-term plans and longer-term visions.

Incheon City is also working with AAM aircraft manufacturers and vertiport developers, along with representatives from MOLIT, to conduct public demonstrations, exhibitions, visualizations, and forums to showcase AAM aircraft and vertiports. Having these community engagements early in the visioning and planning process gives Incheon, its citizens, and its leaders an opportunity to share their concerns, ideas, and perspectives.

Incheon City is working closely with Incheon International Airport Corporation, the Korea Land & Housing Corporation, and MOLIT to lay the foundation for the AAM industry.

An essential part of communications will be assurances by Incheon City officials, MOLIT, and industry that AAM operations will be safe and socially acceptable, will improve mobility and efficiency, and will be environmentally sustainable. Further, they will address community issues and questions such as costs and potential disruptions from construction, aircraft noise and visual intrusion. Whenever possible, results of relevant studies (e.g., cost and benefit, economic feasibility), evaluations, and tests will be shared with the public and other stakeholders.

To evaluate the evolution of community response, Incheon City will conduct periodic surveys to assess changing attitudes and trends. Survey results will be shared, and online and in-person opportunities will be made available for the community to ask questions and share their thoughts or concerns.

MOLIT

Incheon City is collaborating with MOLIT who is responsible for overseeing all modes of transportation in the Republic of Korea including aviation, road, rail, and maritime. As such, the agency has a role in approving the design, development, placement, and operation of AAM-related infrastructure such as vertiports. Related MOLIT responsibilities involving consultation and alignment with Incheon City include:

Policy and Regulation: For vertiports, sets the policies and regulates the design, construction, and operation of AAM vertiports and operational systems. This may include endorsement of industry standards. Regulations around the safe storage and movement of aircraft and equipment will be set by Incheon City and MOLIT.

Transportation Planning: Assists in developing transportation plans that encourage multimodal transportation networks and hubs to be linked with vertiports, including equitable access to these facilities.

Land Management: Oversees land development and preservation. As such, it oversees land use policies including planning and zoning. MOLIT will coordinate closely with Incheon City officials in assessing locations for vertiports and in the application of standards concerning those facilities.

Airspace Compatibility: Ensure the surrounding airspace is compatible with AAM vertiport operations and, in collaboration with Incheon City and communities, develop noise abatement procedures and design traffic routes to minimize the effects of noise and visual disturbances on those communities.

Planning and Construction: Plans and constructs public facilities including those needed to build, operate, and maintain public vertiports and supporting infrastructure. In this capacity, MOLIT will work closely with Incheon City officials and vertiport firms to address vertiport infrastructure requirements and construction schedules.

Approvals: As the approval agency for all aviation operations, personnel, and systems, MOLIT will issue vertiport operational certifications and approve all critical ground systems used for the safe conduct of AAM aircraft, such as weather sensors and navigational aids. MOLIT also oversees safety-critical personnel involved in vertiport operations.

Inter-government Coordination: Will coordinate with relevant government agencies requiring input or decisions on specific matters, such as communications spectrum usage. This may also involve discussions with international governments and ICAO to facilitate harmonization of standards or requirements.

Safety Management: Will require vertiport applicants to have a safety management system, or SMS, to ensure risks are identified, mitigated, and tracked. An effective SMS will address an organization's, policies, practices, and safety culture for facilities and supporting systems. The level of detail in the SMS will be commensurate with the size, complexity, services, and systems provided by the vertiports.

BUSINESS ECOSYSTEM

Incheon City will play a vital role in nurturing and supporting the growth of a thriving AAM business ecosystem. This involves creating an environment that encourages innovation, investment, and collaboration between various stakeholders in the industry. These stakeholders may be manufacturing part or systems for AAM operations or developing digital services to enable AAM. The city can achieve this by providing incentives, such as tax breaks and subsidies, to AAM businesses and startups. Additionally, the city can support the AAM ecosystem by facilitating partnerships between businesses, research institutions, and government agencies. This can lead to the development of new technologies and solutions, ultimately driving growth of the AAM industry. The city can also help in creating a skilled workforce by promoting education and training programs related to AAM technologies and operations.

Incheon City is a member of UAM Team Korea, a consultative body launched by MOLIT to facilitate the commercialization of Korean AAM, and promote the plan for public-private joint demonstration projects.

KEY STAKEHOLDERS

Key stakeholders in industry, academia, and research organizations are seeking solutions to make AAM infrastructure safe, interoperable, adaptable, efficient, equitable, and economically viable. Incheon City is working with these stakeholders to find a balance that serves the needs of its citizens while accommodating the development and operation of AAM aircraft and vertiports.

Airspace Users: As with residential and business communities, Incheon City is including airspace users in information sessions, surveys, and forums relevant to their aviation interests. Incheon City and MOLIT will apprise the region's airspace users (e.g., airlines, drone operators, helicopter operators, airspace service providers, and the military) of plans and developments to understand and assess how AAM vertiport locations, technologies, and operational procedures may benefit or impact their operations.

Infrastructure Developers and Operators: The AAM infrastructure industry is at the forefront of making investments, conducting experiments, collecting data, and ultimately designing and building vertiports and supporting systems. To construct a permanent and scalable ground environment, AAM infrastructure developers (public and private) and operators must be assured of a reasonable return on investment. This requires assurances that the plans, policies, and regulations under consideration will not unnecessarily constrain designs, extend schedules, or inflate costs.

For their part, industry stakeholders will work collaboratively with Incheon City and MOLIT to share plans, develop prototypes, conduct experiments, solve technical issues, and provide data to help inform their planning, community outreach, financing, and governance of the industry. This partnership will ensure that the necessary technology and infrastructure are in place to support the integration of AAM aircraft into the city's transportation network.

KEY STAKEHOLDERS IN INDUSTRY, ACADEMIA, AND RESEARCH ORGANIZATIONS ARE SEEKING SOLUTIONS TO MAKE AAM INFRASTRUCTURE SAFE, INTEROPERABLE, ADAPTABLE, EFFICIENT, EQUITABLE, AND ECONOMICALLY VIABLE.

Infrastructure Stakeholders
- Airports
- Vertiports
- IT Infrastructure
- Real Estate Development
- Electrical Infrastructure

Operational Stakeholders
- Airports
- Helicopter Operators
- AAM and Vertiports
- MRO and Training
- Transport and Medical

Technology Stakeholders
- Aircraft OEM
- CNSI System Providers
- IT System Providers
- OEM Supplies
- Electrical Providers

Airspace Integration Stakeholders
- Meteorological Services
- Airport Operations
- Air Traffic Control
- Other Services

Urban Integration Stakeholders
- National and Local Government
- Airport and Vertiport Authorities
- Public Service Authorities (Police, Fire, EMS)
- Investors and Business Owners
- Local Transit Authorities

Regulatory Stakeholders
- Ministry of Land, Infrastructure, and Transport (MOLIT)
- Standard Bodies
- Local Government

Key Stakeholders

Global UAM Regional Summit MOU Signing Ceremony

GURS Joining Ceremony: City of Odense

As a member of UAM Team Korea (UTK), a public-private joint policy consultative partnership for urban air transportation, Incheon City is closely cooperating with the K-UAM Grand Challenge, a demonstration project conducted by the Ministry of Land, Infrastructure and Transport (MOLIT) to promote the commercialization of Korean AAM.

Incheon City plays a vital role in promoting community engagement, fostering cooperation between industries and governments, setting standards, developing policies, determining land use modifications, and obtaining resources to guarantee the successful incorporation of AAM. Considerable efforts have already been made to lay the foundation and cultivate leadership among global cities.

Academia and Research Organizations: Academic and research organizations are playing a pivotal role in propelling Incheon and the AAM industry forward in Korea. The IAIAC is lending its support to Incheon in the strategic planning of AAM vertiport locations and routes and is actively participating in forums dedicated to setting AAM-related standards. Meanwhile, MITRE is offering its expertise in aviation strategy technology and airspace matters to guide the initiative.

Moreover, there is a collaborative effort between the Korea Aerospace Research Institute (KARI) and the US National Aeronautics and Space Administration (NASA). Incheon City continues to harness research from national and international organizations, aiming to keep abreast of the latest advancements, and to design a sustainable path that is tailored to the transportation needs of its residents. This approach ensures that the city's transport system adapts to the evolving needs of its citizens.

International Collaboration: Incheon City is actively engaging in collaborations for AAM integration through participation in international collaboration and partnerships.

To achieve tangible and practical results for the construction of AAM future cities and to foster global collaboration, Incheon City established the Global UAM Regional Summit, which includes various international cities, airports, and research institutions. In 2022, the city became a cooperating member of the World Economic Forum's AAM Cities and Regions.

Incheon closely monitors the outcomes from the recently formed International Civil Aviation Organization (ICAO) AAM Study Group, aiming to apply any viable advancements from these discussions to facilitate international alignment of policies, procedures, and standards related to AAM. The extent of international involvement continues to evolve, as Incheon remains open to collaborating with other countries in their approach to integrating AAM operations into urban and airspace environments.

Aviation Infrastructure

AAM operations will require infrastructure to support both traditional aviation needs and AAM specific needs in communications, navigation, surveillance, and information systems as well as vertiports and its supporting digital and physical infrastructure.

Integrating AAM-supporting infrastructure into the urban environment necessitates meticulous planning and coordination among various stakeholders with diverse goals. Incheon City is addressing this challenge by formulating strategies and collaborating with the Ministry of Land, Infrastructure, and Transportation (MOLIT), the Incheon and regional community, and other stakeholders, aiming to achieve widespread acceptance of this novel technology and its accompanying infrastructure requirements.

Incheon International Airport

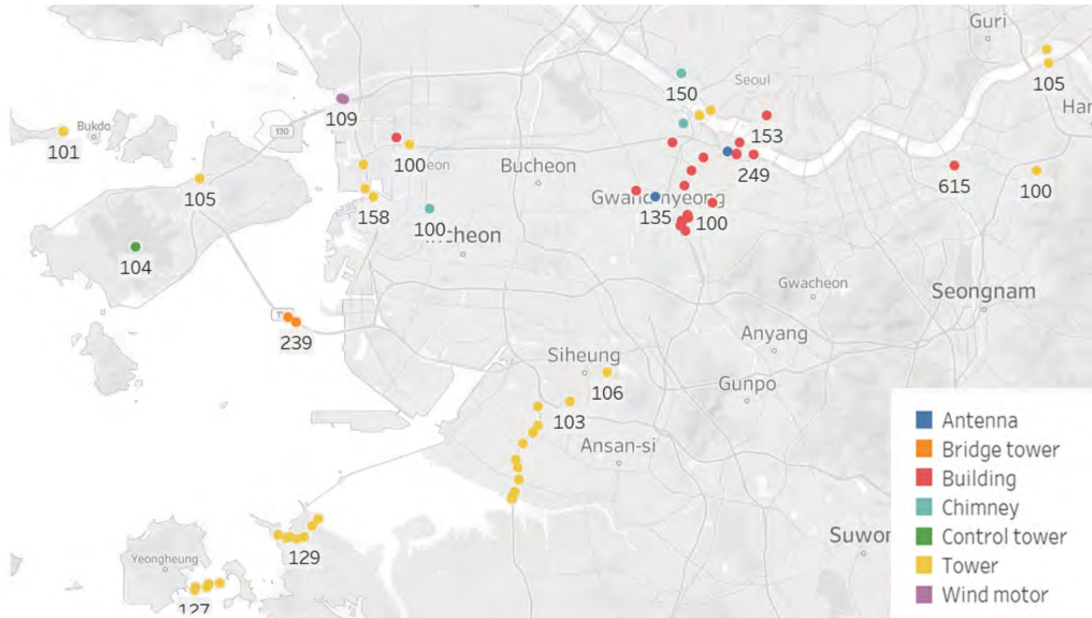
COMMUNICATION SYSTEMS

Radio communication systems are widely used in aviation for voice communication between pilots and air traffic controllers. In initial AAM operations in Incheon, pilots are expected to utilize conventional voice radio systems to communicate with air traffic controllers, receive instructions, and report their positions and intentions. As AAM operations advance towards increased operational tempo and integrated procedures, an increased use of digital communication technologies is expected. The exact technologies to support this future vision are still under research and development and may include some technology not commonly used for aviation purposes such as cellular networks, wi-fi, and dedicated short-range communications (DSRC). The K-UAM Grand Challenge activities in 2024-2025 will explore and help establish requirements for future communication technologies.

In addition to air-to-ground communications, AAM operations are expected to have increased need for air-to-air communications to enable cooperative maneuvers, collision avoidance, and efficient routing decisions. As AAM operations advance towards higher automation levels and experience increased traffic densities, it is anticipated that next-generation communication networks, such as 5G and 6G technologies, will be employed. The table below summarizes some of the core communication functions expected for AAM operations and some candidate systems to enable the function.

Communications systems needed for AAM

Functional Element	Function Description	Performance Needs	Systems
Vehicle-to-Vehicle Communication	Enables direct air-to-air communication between AAM aircraft.	Real-time, low-latency, reliable	DSRC, Celluar Networks
Vehicle-to-Infrastructure (V2I) Communication	Facilitates communication between AAM aircraft and ground infrastructure such as AATMSP and AAM Operators.	Secure, low-latency, bidirectional	DSRC, Celluar Networks
Ground Control Station (GCS) Communication	Enables communication with AAM aircraft through remote pilot systems installed within the GCS.	Reliable, low-latency, bidirectional	Data Link Communication Systems, Satcom, Cellular Networks
Pilot to Air Traffic Control (ATC) Communication	Facilitates communication between AAM pilots and air traffic control authorities.	Real-time, clear, secure	VHF/UHF Radios, Satcom, Cellular Networks, Data Link Communication Systems
Ground System Communications	Enables exchange of information between AATMSP, Air Traffic Control, Vertiport operators, and other stakeholders connected to landline communication systems.	Secure, reliable, multicast	Ethernet



Charted obstacles around Incheon that are greater than 100 m above ground level
(This chart is based on 2023 data, and there may have been changes since its creation.)

NAVIGATION SYSTEMS

Navigation is essential to many aspects of aviation, as it is necessary for routing, trajectory management, instrument procedures, and is a dependency for surveillance and separation management. In early operations, pilots are expected to use existing aviation navigation systems such as global satellite-based positioning and navigation capabilities. AAM vehicles will use Global Navigation Satellite System (GNSS) and AAM vehicles may use Ground-Based Augmentation System (GBAS) receivers to provide more precise location information along predefined routes and for vertiport approach and departure paths.

The Aeronautical Information Publication (AIP) includes a database of air navigation obstacles in the Incheon region. Most of these obstacles are towers that have a height of 100–300 m above the ground (Note: The AIP contains data only for obstacles exceeding 100 m in height; however, safety concerns may necessitate data on obstacles below 100 m). Most AAM operations are expected to cruise above these obstacles; however, approach and departure procedures around vertiports will need to consider these hazards. Third-party data services are expected to provide obstacle database information to AAM operators to ensure they have the latest information that can be used to safely navigate around obstacles.

IN EARLY OPERATIONS, PILOTS ARE EXPECTED TO USE EXISTING AVIATION NAVIGATION SYSTEMS SUCH AS GLOBAL SATELLITE-BASED POSITIONING AND NAVIGATION CAPABILITIES.

SURVEILLANCE SYSTEMS

Surveillance systems play a crucial role in monitoring and maintaining situational awareness in AAM operations. Initial AAM operations in Incheon are expected to be tracked using existing ATC surveillance systems. These include radar systems and Automatic Dependent Surveillance—Broadcast (ADS-B). Most of the airspace around Incheon is covered by radar and ADS-B service. AAM flights to the Incheon islands may have spotty radar and ADS-B coverage particularly in locations where ATC services are not provided. Additionally, AAM flights into and out of vertiports at low altitudes may be below radar and ADS-B coverage floors. ATC surveillance systems may need to be supplemented with new ADS-B stations depending on specific vertiport locations and operating plans.

As AAM technologies advance and move towards remote pilot or fully autonomous systems, additional surveillance systems will be required. In some cases, new sensors may be placed onboard an aircraft. Examples include LiDAR, radar, or camera-based vision systems. These systems will support an enhanced picture of the AAM aircraft surroundings, particularly in locations with poor radar or ADS-B coverage. AATMSPs may also provide surveillance services that utilize new ground-based surveillance systems to provide AAM operators with a common operating picture.

INFORMATION SYSTEMS

Information exchange will be a fundamental component to enabling AAM operations in Incheon. The K-UAM CONOPS v1.0 describes the envisioned architecture for exchanging data and information to support future AAM operations. At the center of this architecture is a set of AAM Air Traffic Management Service Providers (AATMSP) whose role is to exchange information among stakeholders and provide services to AAM operators. The AATMSP is the main hub to interact with the operational stakeholders including AAM operators, air traffic control, vertiport operators, and third-party service providers. For example, an AATMSP may be given authority to schedule, coordinate, and monitor flights within an AAM corridor.

Development of information exchange networks must accomplish a variety of critical responsibilities to ensure safe operations.

- ▷ Collection, retention, and expiration management of data.
- ▷ Secure transmission between stakeholders factoring in privacy management, ownership rights, access permission, and encryption protocols.
- ▷ Data governance standards, harvesting limitations, and operational oversight of information systems.

Information System Stakeholders

Entity	Roles in Information Management
AATMSP	Exchange information among stakeholders. Create and monitor AAM flight plans and schedules. Share information with ATC. Send approved flight plan to AAM operator.
AAM Operator	Manage AAM flight operation in coordination with AAM pilot. Ensure operational safety and manage schedules. Share flight status updates and plans with AATMSP.
Vertiport Operators	Manage safe AAM operations at vertiports. Manage vertiport facilities and security. Share vertiport capacity limits with AATMSP for scheduling purposes.
Air Traffic Control	Manage safe and efficient flight operations in the airspace, such as sharing air traffic restrictions with AATMSP.
Third Party Service Providers	Generate and provide supplemental and dynamic data such as obstacle locations, localized microweather, and noise sensitive locations or times.
Other Stakeholders	Access information (e.g., sharing schedule information with connecting ground transport operators to ensure efficient multi-modal connection) by stakeholders such as passengers and city officials.

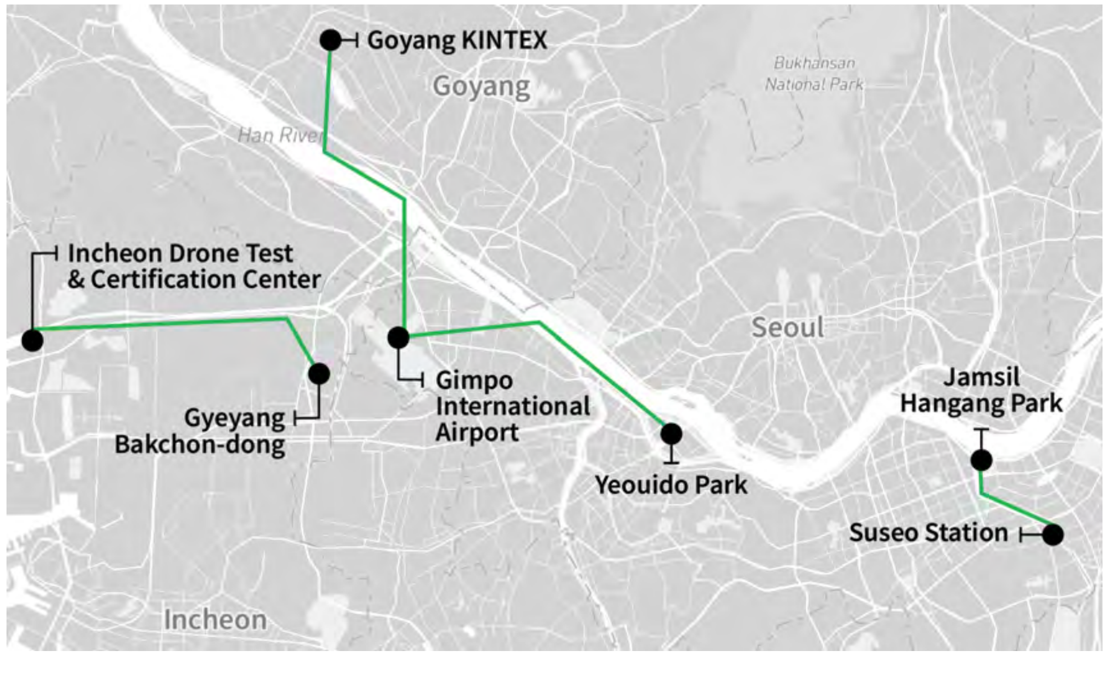
VERTIPORT INFRASTRUCTURE

Vertiports are the primary infrastructure enabling AAM operations. Vertiport development may require city modifications and upgrades to utilities, safety systems, roads, parking, and signage. Additionally, installation of ground systems such as highly localized weather sensors, precision navigation devices, and cellular and land-based communication networks will be needed to support AAM aircraft and vertiport operations. This section describes vertiport and supporting infrastructure along with descriptions of activities, responsibilities, and collaboration taking place by Incheon City and others to prepare for and implement this infrastructure.

Vertiports are the central component of AAM ground infrastructure. Full-service vertiports are large facilities with a passenger terminal and a surface area capable of managing and servicing multiple AAM aircraft. Vertistops have small-scale facilities for landing and takeoff and for unloading of passengers and cargo from a single AAM aircraft. For simplicity, the term "vertiport" will be used to represent both types except where distinctions between the two terms are needed. The planned progression, from early testing to vertiport placement and design within Incheon and surrounding areas, are described here.

Initial Pilot Programs and Testing

Incheon City plans to initiate pilot programs in 2024 to assess the feasibility and effectiveness of vertiport infrastructure and services. Initial trials will take place in temporary or limited size facilities away from population centers and heavily traveled air routes. These early operating areas will be used as proof of concept to identify the applicability of draft vertiport standards, assess city requirements, and develop airspace integration procedures. They will also provide valuable insights into the operational, technical, and regulatory challenges associated with integrating AAM aircraft and vertiport infrastructure into the urban transportation network. Data from these early experiments will be used to assess city impacts and to develop scenarios for assessing various locations and potential scaling of vertiports. The map below shows temporary vertiports being planned as part of the Korean-UAM Grand Challenge, a phased demonstration program to test the suitability of urban conditions and environments in supporting AAM aircraft operations.



K-UAM Grand Challenge vertiport locations and routes

Use of Existing Heliports

Incheon is investigating the early use of existing heliports. A primary advantage of collocating with these facilities includes minimal, if any, construction modifications. Air traffic activities are also known, and operational procedures established. Additionally, surrounding communities are familiar with aviation operations. While these attributes are useful for early tests, the scaled or routine use of existing heliports is unlikely as capacities are limited, many are prioritized for public use (primarily for emergencies), locations are not always aligned with transportation needs, passenger facilities are lacking, electric charging may not be available, and safety systems are not appropriate for electric vehicles. Furthermore, passenger access, amenities, and parking are deficient. If existing heliport facilities are to be used at scale, significant modification to those facilities and adjoining city infrastructure would be required to ensure structural loading is sufficient.

Vertiport Site Selection

Following initial vertiport and operational tests, Incheon plans to work collaboratively with partner organizations and private vertiport firms to build a network of strategically located vertiports. These vertiports will be placed in key areas such as transportation hubs, business districts, and other high demand areas; as well as locations having high-societal benefits, such as regional island communities. The specific location of vertiports will influence the size and design of that vertiport. Factors such as airspace capacity, electric utility support, local economic demand, and community support will influence the frequency and scalability of AAM operations to that site. Other factors include:

Safety: Considers risk factors such as aeronautical suitability and accessibility to emergency response facilities (e.g., fire stations and hospitals).

Transportation Need: Evaluate the demonstrated need for a vertiport based on factors such as long travel times or inadequate transportation accessibility.

Community Acceptance: Assess the level of local interest and support for vertiport development and operations in the community, and areas of sensitivity.

Business Case: Analyze the market demand and cost structure to ensure a viable business case for vertiport and AAM aircraft operators.

Real Estate Availability: Consider the readiness of available land or buildings, necessary improvements, and the cost involved in acquiring or renting the proposed location.

Infrastructure Development: Evaluate the building costs, complexity, and any restrictions associated with vertiport development, as well as the supporting infrastructure needs.

Utilities Support: Determine the availability and cost of utilities necessary for vertiport development, including parking facilities and other amenities required to support operations and passenger or cargo handling.

City Services: Consider the availability of monitoring, inspection, and emergency services that will support the vertiport infrastructure and operations.

Airspace Compatibility: Assess whether the airspace structures and procedures in the vicinity allow for safe and efficient arrival and departure flight operations.

Weather Conditions: Consider the presence of favorable surface winds and the availability of micro-level weather observation capabilities to ensure safe operations.

Structure/Terrain Interference: Evaluate the impact of buildings, towers, hills, and other obstructions on flight paths, navigation, and the generation of turbulent wind flows.

VERTIPORT DEVELOPMENT MAY REQUIRE CITY MODIFICATIONS AND UPGRADES TO UTILITIES, SAFETY SYSTEMS, ROADS, PARKING, AND SIGNAGE.

VERTIPORT DESIGN

Firms worldwide are envisioning, designing, and building prototype vertiports. Some are being developed by AAM aircraft manufacturers with designs tailor-made for their aircraft and use cases. Others are designing vertiports to accommodate a wide variation of aircraft and more extensive services. Optimal solutions for vertiports depend on a multitude of factors and there may be different solution needs for different areas. Incheon is in discussions with several vertiport firms to assess designs and capabilities best suited to Incheon's initial use cases and locations to be served.

Vertiport Structures

Vertiports may be constructed at ground level, atop an elevated structure (e.g., building), or on water surfaces on fixed or mobile decks. Some vertiports may adaptively reuse existing parking structures, train or bus stations, or other available city or private infrastructure. The size and capacity of vertiports will be based on city infrastructure constraints, building codes, zoning restrictions, safety requirements, and community concerns such as noise, visual nuisance, traffic, or parking. In some cases, vertiports may be designed with expansion in mind to meet future demands.

Design Specifications

Vertiports have similarities with heliports, but also distinctions in their design and operation. Shared attributes include landing pads, taxiways, and stands (parking areas). Though similar in character, the size, marking, separation distances, and protection areas associated with these features will, in most cases, differ from heliports and be based on vertiport-specific standards. Furthermore, the designs will be subject to unique city requirements based on location and operational volumes surrounding the facilities.

AAM aircraft performance characteristics will influence the size and design of final approach, takeoff, and landing areas which are expected to differ from helicopter parameters.

Vertiports will have systems, lighting, and markings unique to AAM aircraft operational needs. Vertistops—the minimal version of vertiports—will not have taxiways, standing pads, and may or may not have charging stations or other supporting facilities. Initial demonstration vertiports in Incheon are likely to be these minimal vertistop designs. Aircraft landing at vertistops may quickly drop off passengers or goods and then make a short flight to a vertiport with charging stations (also referred to as a deadhead operation).

Vertiport design concept

Notional near-shore vertiport infrastructure

SPECIALIZED VERTIPORT FACILITIES

Staging Vertiports

Certain vertiports might lack the necessary space to accommodate large holding areas for AAM aircraft. In such instances, adjacent staging areas could be established for the storage, charging, and maintenance of these aircraft.

These staging vertiports will likely adhere to similar design standards for AAM aircraft operations. However, they may not have the necessary facilities, personnel, or systems to handle passengers or cargo. Hence, these staging vertiports might be situated in more industrial areas. As operations scale, evaluation of the need for and placement of staging vertiports become a greater concern but is unlikely to be a focus during initial operations.

Emergency Landing Sites

To ensure safe operations during contingencies where an AAM aircraft needs to land prematurely, emergency landing sites—which may include but are not generally associated with established vertiports—will need to be identified and accurately surveyed to ensure availability and proximity to public safety services. Emergency landing sites may include existing helipads or rudimentary landing pads on parking lots, rooftops, or other prepared or unprepared surfaces. The location and possible use of emergency landing zones will require advance coordination and approval by city officials, private property owners (where it applies), and air traffic control authorities.

SUPPORTING INFRASTRUCTURE

Vertiports require internal and external digital and physical infrastructure to function. Incheon City and private developers will jointly develop the ground infrastructure needed to generate, process, and exchange digital information used to support vertiport and AAM operational needs. Vertiport physical systems and structures supporting passengers and aircraft will be developed based on specifications imposed by the city and federal government.

Digital Infrastructure

Vertiports will depend on a variety of systems and technologies to support the functioning of AAM aircraft and vertiport operations. These systems, at their core, rely on the exchange of digital information from sensors and processors to provide status information and aid in decision making. Specifics of this digital infrastructure will vary depending on the type of AAM aircraft being served, the volume of traffic at the vertiport, the location and layout of the vertiport, and the integration of vertiport systems with traditional ATC or third-party traffic management services and systems. Following is a list of digital infrastructure systems and technologies and their associated functions.

Communication Networks: Communication equipment and networks will be vital in coordinating operations, conveying vertiport status information, and alerting the city of issues requiring their services (e.g., police), as well as for the city to inform vertiport operators of information potentially impacting their operations (e.g., utility maintenance or road closures). Data networks will become increasingly important to future highly automated and autonomous operations. Pilots, fleet operators, and third-party service providers will require continuous exchanges of data concerning flight planning, environmental conditions, flight progress, system health, passenger state, traffic levels, and airspace, all of which may impact vertiport preparation and define capacity limits.

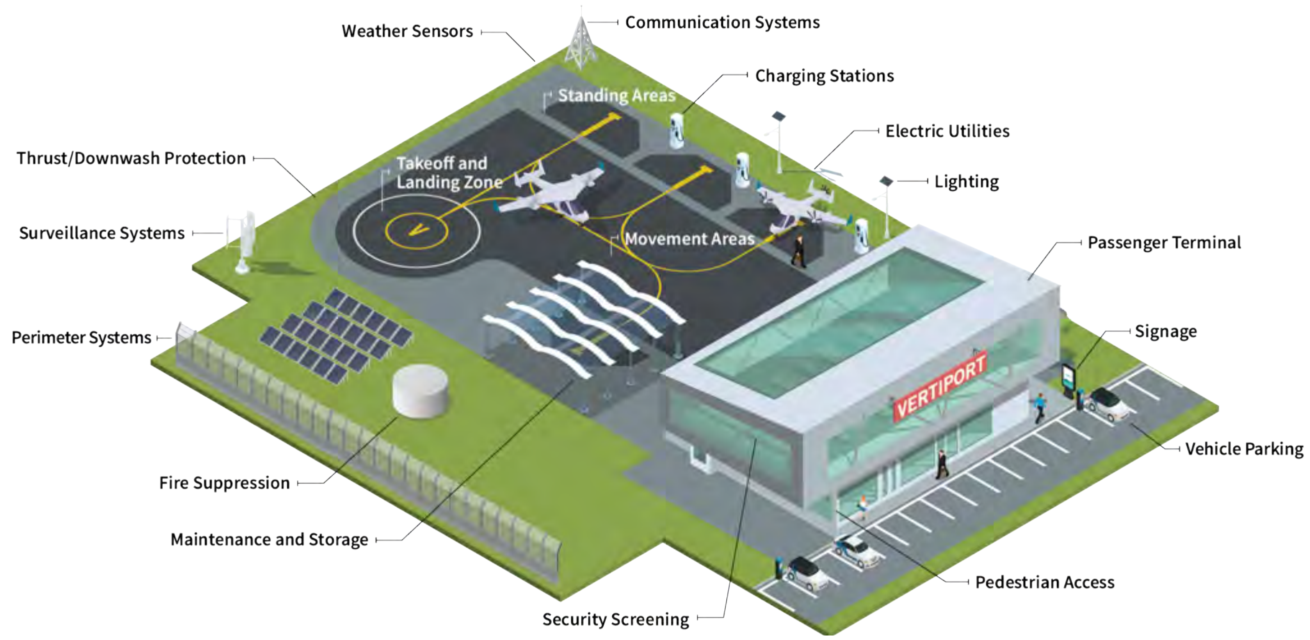
Air Traffic Management Systems: Technologies used in traditional air traffic control and management will apply to AAM aircraft operated in air traffic managed environments (ATC or third-party providers) and will additionally include ground systems to inform of local weather and vertiport conditions impacting AAM aircraft activities.

Surveillance Systems: Some vertiports may be equipped with ground-based surveillance sensors used to ensure accuracy of approaches and validate separation distances and may be used by AAM pilots and systems to augment detect and avoid capabilities.

Vertiport Control Systems: These systems will be used to manage ground operations on the vertiport, including takeoff, landing, and taxi sequencing, and parking and readiness of surfaces areas, passengers, and aircraft for flight.

Navigation Aids: Ground-based navigation aids and corresponding procedures enable safe flight into and out of vertiports. The extent to which these navigational aids are deployed and used will depend on weather conditions, navigational accuracy and integrity needs, automation dependencies, and operational density. Navigation aids used on the vertiport may include specialized markings, augmented GNSS devices, and other guidance technologies used to support precision landing, takeoff, and time sequencing of traffic.

Weather Monitoring Systems: Micro-scale weather events, especially winds and eddies produced by airflows near the surface around terrain and building structures, can have significant impacts on AAM aircraft. Weather monitors may be placed on the vertiport and on nearby structures and linked to meteorological equipment to be processed and aggregated with other weather data.



Vertiport features

Noise Conformance Monitoring: Noise levels will be monitored in areas surrounding vertiports to ensure compliance with accepted metrics.

Passenger Processing Systems: Systems will be needed to check-in passengers, handle cargo and luggage, and boarding procedures.

Cyber security systems and processes will be developed to encrypt and authenticate digital messages, and physical and software security measures will be in place to prevent breaches. Qualified personnel will be trained to oversee and manage the infrastructure. As added protection, insurance on the digital networks and service providers will be required.

Physical Infrastructure

The physical infrastructure associated with vertiports includes facilities for passengers, energy supply, storage, and security. Specific infrastructure will vary depending on the vertiport size and operational services offered but may include:

Passenger Terminals: Full-service vertiports have structures designed to process and manage passengers including accessible entry and exit points, signage, restrooms, waiting areas, workstations, and other features appropriate to accommodate the short-term circulation of travelers and vertiport personnel.

Security Systems: Vertiports have perimeter security, access control systems, surveillance, and other physical and cybersecurity systems to ensure passengers, crew, aircraft, and the operational environment and systems can remain free of or minimize security threats.

Electric Charging Systems: Vertiports require substantial electric charging infrastructure to support high-speed charging of batteries. Some vertiports will require additional systems to extract, install, transport, remotely change, and safely store batteries.

Storage and Maintenance Facilities: Vertiports store items needed to clean, prepare, inspect, maintain, and repair AAM aircraft and vertiport surfaces, structures, and systems.

Fire Suppression System: Specialized equipment and extinguishing agents may be needed to quickly detect and contain thermal runaway fires from batteries on aircraft and in storage.

Markings and Lighting: Vertiport surfaces are marked and well-lit to support aircraft landing, takeoff, movement, parking, and passenger safety.

Specialized Infrastructure: Some vertiports may require unique design elements or features to mitigate noise levels and limit the effects of thrust and downwash on the persons and equipment on and near the vertiport landing and takeoff areas.

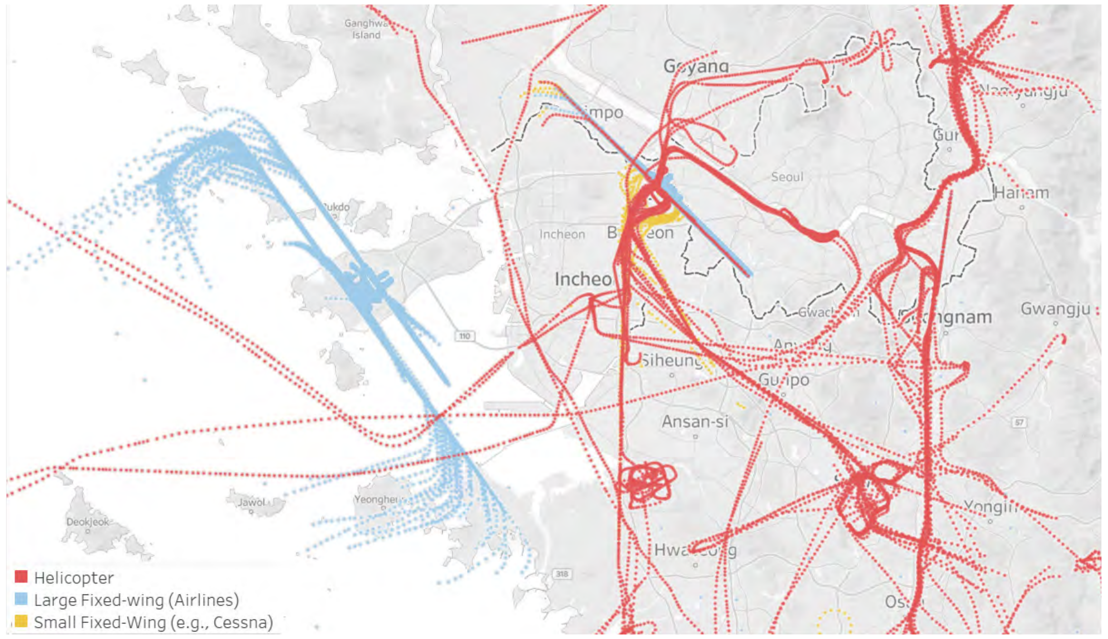
Airspace and Flight Operations

> Integrating AAM flight operations into the region will involve an evolutionary approach to modifying airspace and flight procedures to ensure AAM flights can safely coexist with current aircraft operations.

The airspace around the Incheon region supports a variety of flight operations, such as airlines serving Incheon International Airport, helicopters flying to Gimpo International Airport, and military exercises throughout the region. Successful integration of AAM operations in the airspace around Incheon will require coordination and collaboration between various stakeholders, including the Ministry of Land, Infrastructure and Transport; Ministry of National Defense; Incheon International Airport Corporation; airport and aircraft operators; and local communities.

The general operating trajectory for most AAM aircraft involves vertical take-off, horizontal flight, and vertical landing. Operating altitudes for AAM aircraft will depend on the specific mission and aircraft type but are anticipated to be a few thousand feet above ground level (AGL). The existing airspace structure and flight operations will shape how AAM operations can safely integrate into the airspace. AAM flight paths can be defined to maximize operational safety and efficiency while minimizing negative impacts on communities and other operations.

THE GENERAL OPERATING TRAJECTORY FOR MOST AAM AIRCRAFT WILL INVOLVE VERTICAL TAKE-OFF, SHORT TAKE-OFF, HORIZONTAL FLIGHT, AND VERTICAL LANDING.



Existing traffic flows below 2000 ft MSL in the Incheon region during March 1-7, 2023, indicating the need for integrated airspace

AIRSPACE STRUCTURE

The airspace in the Incheon region can be categorized as follows:

Controlled Airspace has defined dimensions within which air traffic control service is provided in accordance with the airspace classification (i.e., Class A/B/C/D/E). AAM aircraft flying through this airspace must establish two-way radio communications with ATC and follow ATC instructions. In Class E airspace, AAM aircraft flying under Visual Flight Rules (VFR) need not establish two-way communications and are not subject to an ATC clearance.

Special Use Airspace has safety or security restrictions in place. These areas are dangerous for aircraft not participating in activities, have hazards that may negatively impact other aircraft, or are prohibited for security reasons. AAM flights through some special use airspace may be permitted with prior coordination as some areas may not always be active.

Uncontrolled Airspace lacks ATC services because they are not necessary or cannot be provided for practical reasons. Uncontrolled airspace around Incheon includes Class G airspace and Class E airspace when operating under VFR. AAM flights will need to coordinate with other airspace users in this airspace using the principles of VFR.

The airspace around Incheon is structured around three main airports: Incheon International Airport, Seoul Gimpo International Airport, and Seoul Air Base. There are also numerous Special Use Airspace regions for security and military purposes. Much of the airspace in the Incheon region is controlled or restricted when operating above 1,000 ft. AAM operations remaining below 1,000 ft can utilize more uncontrolled airspace.

EXISTING TRAFFIC IN INCHEON

AAM operators must consider how to integrate with existing traffic flows. Fixed-wing traffic around the major airports typically follows constrained departure and arrival procedures and climbs above altitudes primarily used for AAM operations before dispersing towards their destination. Helicopter traffic is limited outside of a few busy areas such as military airports, military restricted areas, or helicopter routes along rivers.

OPERATING CONCEPTS

Flight routes and procedures to accommodate AAM flights will be developed incrementally. In initial phases, AAM operators will follow specific routes between origin and destination. For example, the routes for the K-UAM Grand Challenge 2 are designed to minimize impacts to existing traffic flows.

As the network of vertiports expands and AAM operators advance, there will be more options for the routes and procedures.

VFR Routes: During initial phases of operation, AAM operators with pilots onboard the aircraft will fly using VFR. Under VFR, pilots generally fly around controlled airspace and use standard navigation practices to visually avoid and remain well clear of other aircraft. For example, a pilot flying from downtown Incheon to a vertiport on Donggeom-Ri may choose to stay below 1,000 ft to avoid Class B controlled airspace. The pilot would not be required to communicate with ATC and could navigate on a direct path between the vertiports. This approach provides flexible navigation options without requiring changes to current operating rules but is limited to specific airspace, requires an onboard pilot, and may add additional environmental and noise concerns due to the low altitude. In some locations, specific routes may be developed to enable common situational awareness among VFR operators and minimize flight over areas sensitive to noise or environmental impacts.

AAM Corridors: As the frequency of AAM operations increases and AAM aircraft adopt increasing levels of automation, use of specific airspace routes and technologies can provide additional routing flexibility. Some use cases, such as airport shuttle, will require crossing into and through controlled airspace. As these options become available, the concept of an AAM corridor will offer safe and efficient routes. AAM Corridors combine airspace design and procedures to enable higher-tempo AAM operations in designated sections of controlled airspace while minimizing impact on other traffic. AAM corridors provide pre-coordinated routes and altitudes that will meet public interests, satisfy customer needs, and minimally impact existing operations. AAM corridors may also enable specific routes through restricted airspace to meet national security requirements. An example of using an AAM corridor is a flight between Incheon Port and Deokjeok-do. This corridor would cross controlled airspace and offer a safer transition given the operations going into Incheon International Airport.

AS THE NETWORK OF VERTIPORTS EXPANDS AND AAM OPERATORS FLY FURTHER, THERE WILL BE MORE OPTIONS FOR ROUTES AND PROCEDURES.

Digital Flight Rules: Eventually, the frequency of AAM operations may warrant a complete change to flight operating rules to maintain a safe and efficient airspace. New concepts such as Digital Flight Rules (DFR) will allow aircraft operators to use new technologies, automated information sharing, and cooperative procedures to ensure aircraft remain separated and are able to work together in integrated airspace. These rules will be used in all weather conditions and will reduce direct interactions with air traffic control. As the number of AAM operations increases, DFR will enable scalable and flexible processes and help harmonize various users' needs. Development of DFR will require regulatory changes.

AIRSPACE PLANNING

As the number of vertiports increases, there will be an operational network of routes, corridors, and procedures to support connections from any origin to any destination vertiport. AAM operations in large numbers pose unique challenges to designing airspace. The entire network of vertiports must be considered when optimizing AAM operations at scale. As new vertiports are added into a network, new route segments are needed, and new scheduling conflicts may arise. Simulations have shown the importance of understanding the tradeoffs between the placement of routes and merge points in an AAM airspace network. Strategic scheduling will be needed even with very few vertiports in the network. Strategic scheduling at airspace merge points be needed once there are at least 10 vertiports in the network.

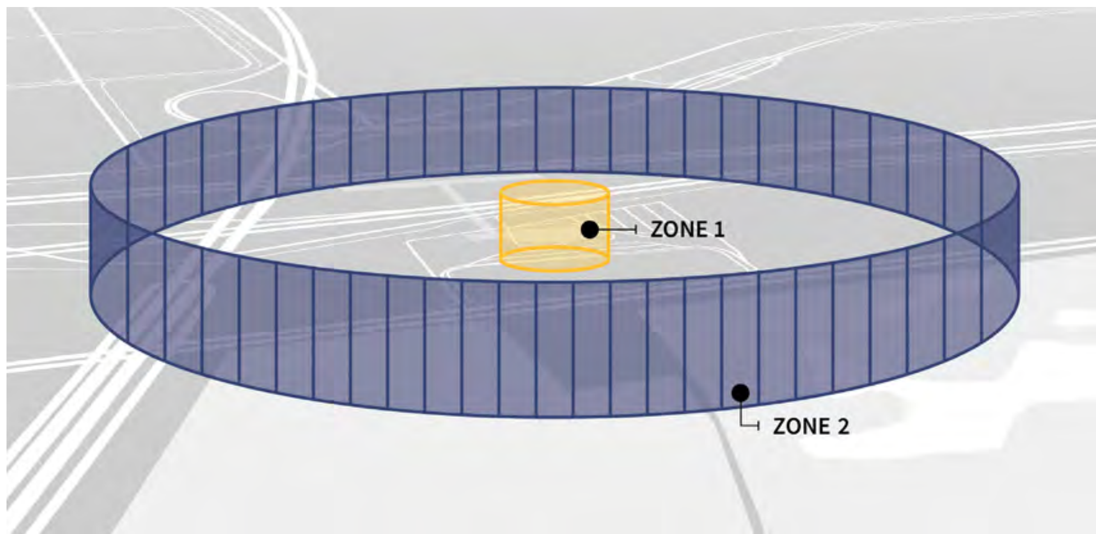
VERTIPORT FLIGHT PROCEDURES

Airspace requirements and flight procedures around a vertiport are different than those around an airport. Around airports, aircraft set up for final approach use long and steady descent gradients in one direction towards the runway. Around vertiports, eVTOL aircraft will utilize much steeper descents and may arrive from any direction. Flight patterns and operating procedures around vertiports will require thorough assessments and standard procedures, particularly as the frequency of AAM operations increases.

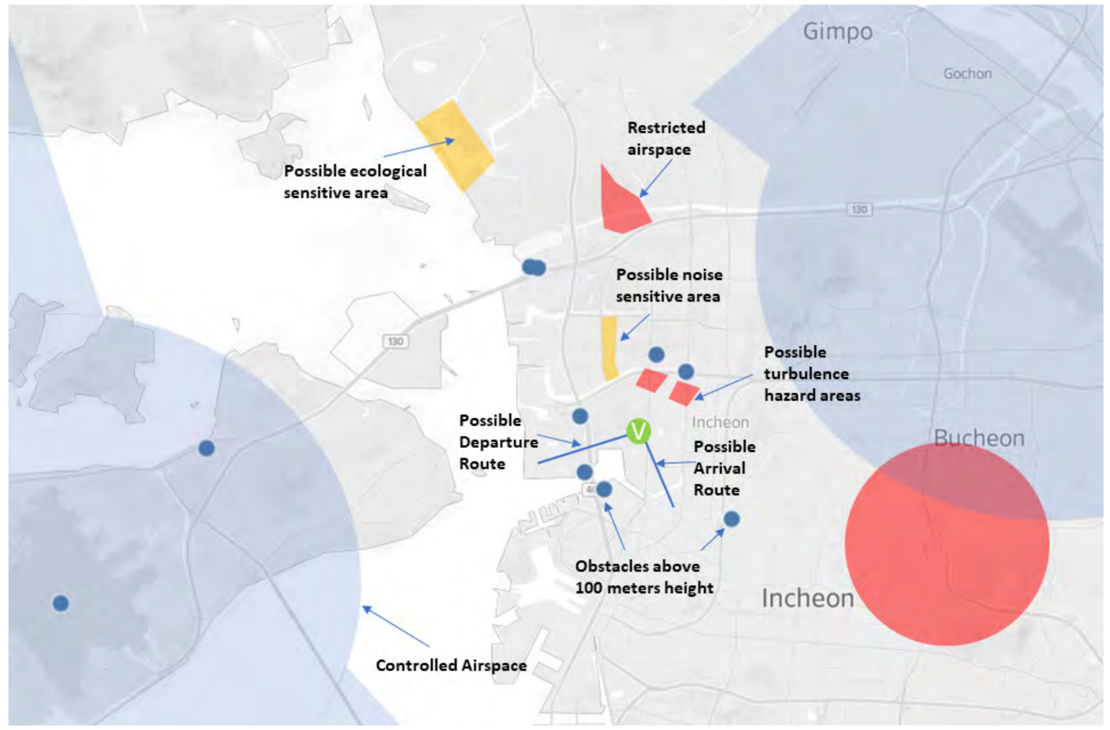
Airspace around vertiports will be designed to enable a variety of departure and approach trajectories above the vertiport and connections to enroute AAM corridors. The airspace may also need to accommodate nominal situations that require airspace alternatives such as holding patterns and emergency landing locations. The airspace can be organized into two zones.

Zone 1: The airspace supporting the vertical portion of flight above the vertiport must be completely protected to ensure stable takeoff and landing operations. In initial operations, pilots will use visual procedures to fly through this airspace and ensure deconfliction with obstacles and other aircraft using the vertiport. As operations increase, services will be needed to schedule an operator's use of this airspace.

Zone 2: The airspace within several kilometers of the vertiport must be organized to support arrival and departure procedures. In initial operations, pilots will use visual procedures to navigate the airspace. There may be other aircraft transiting this airspace that are not using the vertiport associated with this airspace. As operations increase, services will be needed to coordinate specific routes and strategically schedule merge points in the airspace.



Notional vertiport airspace zones



Considerations in vertiport flight procedure planning (This is a notional example chart based on an initial high-level analysis considering factors contributing to the selection of vertiport location.)

VERTIPORT PLANNING

Numerous airspace factors will influence arrival and departure routes around vertiports. These factors introduce constraints on vertiport placement.

Weather: The historic weather patterns at specific vertiport locations in Incheon (particularly related to fog, turbulence, and thunderstorms) will affect the design and development of flight procedures, as well as the vertiport usage rates.

Obstacles: Physical obstacles on the ground in the Incheon area, such as electric towers, buildings, and antennas, will affect procedure flexibility for take-off and landing in the airspace immediately around vertiports.

Avian Wildlife: Bird activity, particularly in low altitude areas around vertiports, can result in bird strikes that endanger aircraft operations. Flight procedures must also consider conservation areas and migration zones to minimize negative impacts to wildlife.

Aircraft Noise: Approach or departure paths should avoid noise-sensitive areas such as parks, playgrounds, schools, and residential zones. Vertiport airspace planning can consider operating hour restrictions, trajectory management that minimizes noise generation, and existing noise levels in a community.

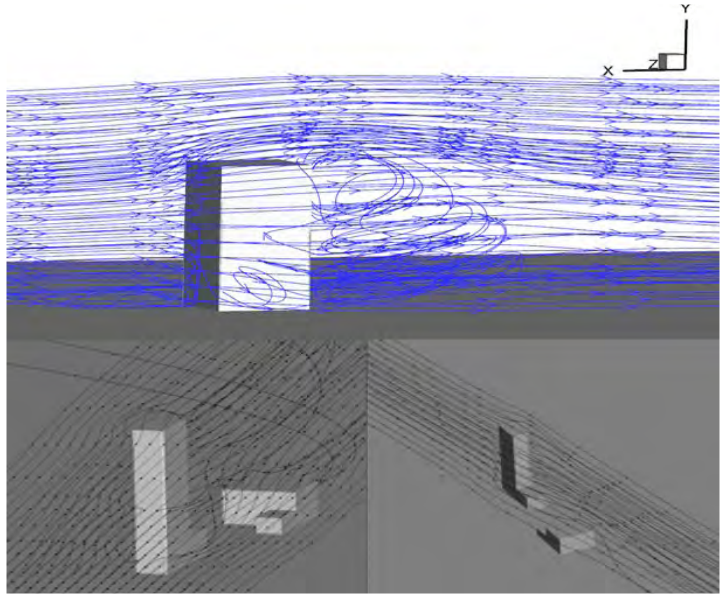
Drone and AAM Operations: Vertiport flight procedures must deconflict with routes servicing nearby vertiports and ensure deconfliction mechanisms in place with small drone flights in the areas around vertiports.

Nearby Airport Operations: Vertiport procedures must consider airspace constraints around nearby airports to ensure coordinated operations with IFR flight departure and arrival patterns and VFR transit routes.

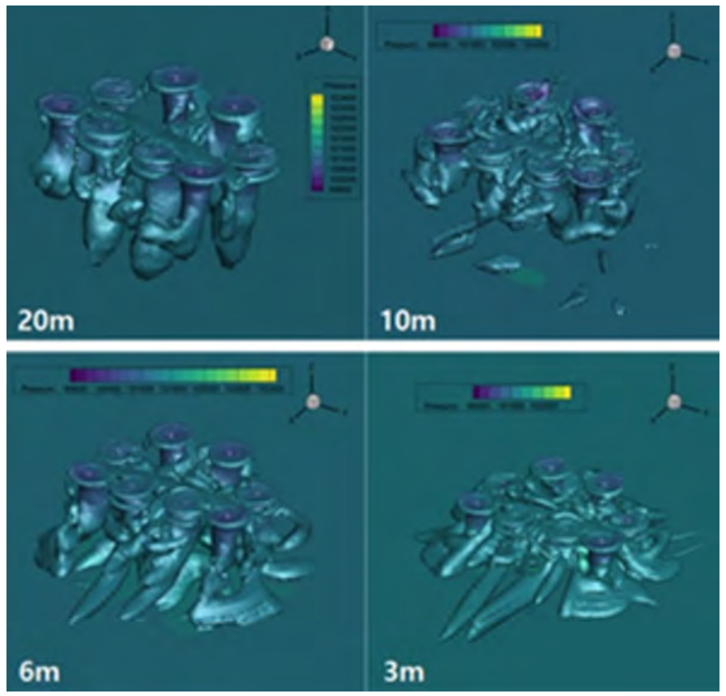
All factors that influence vertiports and their flight procedures must be considered together to optimize airspace layout. When all constraints are considered, there may be only a few available arrival and departure routes to service that vertiport.

WEATHER PLANNING

Many vertiports in Incheon will be located near urban structures such as buildings, towers, and stadiums or in rural settings with modest terrain variation such as Deokjeokdo. When normal wind conditions encounter these structures and terrain, hazardous wind conditions may develop. Research shows that two types of wind hazards must be considered for AAM operations. The first hazard, turbulence, arises from the variability and unsteadiness of wind speeds and directions. The second hazard, wind shear, is a sharp gradient in wind speeds over short distances and typically near buildings or obstacles. Specific studies are required to understand the microscale turbulence and wind shear considerations for potential vertiport sites around Incheon to ensure development of safe flight routes.



Simulation of winds around buildings



Flow around AAM aircraft with altitude variations

INCHEON AIRPORT INTEGRATION

One of the main use cases for AAM operations will be connecting airport passengers with residential areas, downtown hotels, and business locations. Placement of vertiports near Incheon International Airport will involve careful planning and consideration. There will be tight integration with airport services to maximize societal benefits, minimize environmental impacts, and ensure operational coordination with air traffic control. For example, a vertiport that is placed near the passenger terminal will allow AAM operators to deliver passengers more efficiently to gates. However, this placement also means AAM operators must cross runways or approach zones; doing so increases risk and workload for air traffic management.

Vertiport sites can be organized into different zones around the airport. Each zone has unique factors affecting the placement of a vertiport within that zone. Studies will be required to select the appropriate placement of a vertiport within a zone and to establish deployment timelines.

Zones for vertiport placement consideration around Incheon International Airport

Impact analysis of vertiport placement by zone at Incheon International Airport

Zone	Transportation Connectivity	Vertiport Infrastructure Integration	Safety and Operational Integration
1	Enables easy and smooth transition from vertiport to gates without requiring last-mile connections. Vertiports inside airport security perimeter eliminates waits in security line.	Proximity to terminal enables convenience and accessibility to existing airport infrastructure and services (e.g., electric power). Requires modification of existing terminal and gate space to accommodate vertiport landing site.	Requires close coordination with Incheon airport ATC since AAM operations will need to cross runways or final approach path. May require coordination with ATC for airline pushback and taxiing deconfliction. May require quick dropoff at terminal followed by deadhead operation to staging area for charging and preparation for passenger pickups.
2/3	Provides service near airport, but requires last-mile transportation to arrive at terminals. Connects passengers directly to parking lots and hotels near the airport. Vertiport sites are outside airport security perimeter.	Requires careful site identification due to limited availability of space relative to existing infrastructure (parking lots, hotels). Falls within current noise contour of Incheon airport, but may introduce additional noise impacts to hotel and golf participants.	Requires close coordination with Incheon airport ATC since AAM operations will need to cross runways or final approach path. Does not require flight through airport movement areas.
4/5	Enables easy access to Incheon cargo terminal for connection of goods (Zone 4 only). Requires additional modes of transportation to connect last few miles to airport terminals. Connects passengers to residential areas (Zone 5), hotels, golf courses, and other near-airport activities.	More available land area for vertiport placement than zones 1-3, particularly near Incheon Cargo Terminal, airport service buildings, and golf courses.	Zone 4 requires some coordination with Incheon airport ATC but special procedures may be able to minimize tactical communications since AAM will not need to cross final approach paths. Zone 5 flights may need to cross final approach paths except for AAM flights to island regions. May require coordination with Incheon airport helipad operators.

Background image source: IFEZ

Regulatory Evolution

AAM operations will require a regulatory framework at the national level. Regulatory changes will be necessary to enable AAM operations in Incheon.

Currently, aviation regulations and policies in Korea (and most other countries) apply separately to aircraft, pilots, airspace, and operations. AAM technologies and proposed operations challenge several inherent assumptions of this construct. Current regulations and policies contain language that anticipates either a fixed-wing airplane or a rotorcraft, powered by one or two combustion powerplants, controlled manually by an onboard human pilot who communicates with ground controllers via radio. Envisioned AAM operations generally do not conform to these assumptions. A broader set of safety objectives with more comprehensive regulatory and policy language is necessary for future AAM aircraft, pilots, airspace, and operations.

REGULATORY CHANGES

Although AAM technologies may in some ways be revolutionary, the integration of AAM operations in and around Incheon must be evolutionary so that existing aviation operations are not unnecessarily disrupted. A proposed path to integration is characterized in three steps: 1) Initial, 2) Progress, and 3) Advanced. Each phase is examined with respect to aircraft, pilots, airspace, and operations.

A BROADER SET OF SAFETY OBJECTIVES WITH MORE INVOLVED REGULATORY AND POLICY LANGUAGE IS NECESSARY FOR FUTURE AAM AIRCRAFT, PILOTS AIRSPACE, AND OPERATIONS.

KEY DETERMINANTS IN THE EVOLUTIONARY PATH

Several regulatory and policy areas will influence the evolutionary path. These areas are interrelated and must be considered simultaneously.

- New technologies
- New aircraft configurations
- New type certificates
- New modes of operation

- New skills
- New pilot licenses
- New type ratings
- New training

- New equipage requirements
- New corridors
- New separation standards

- New fleet considerations
- New forms of communication

The **Initial Phase** of the evolutionary path involves the integration of new technology, new aircraft, and new operations alongside existing airspace users with only minimal changes to allow operations. This initial phase of operations anticipates that AAM aircraft and operators will generally conform to current operational procedures while the volume of AAM operations is low; simultaneously, incumbent operators will experience minimal changes. This adaptation is feasible when small numbers of AAM are handled by exception.

PHASE 1: INITIAL

Aircraft

Operational policies and procedures must be adapted to accommodate aircraft that do not conform to expectations for fixed-wing airplanes or rotorcraft. Depending on the aircraft configuration and the phase of flight, AAM aircraft may be treated as fixed-wing airplanes, as rotorcraft, or as a hybrid of the two.

Pilot

Early operations will be performed with human pilots onboard the aircraft, even if the aircraft have simplified controls or the pilots only act in supervisory roles. Importantly, human pilots will be available for voice communication over radio. Aircraft will have automation features installed on the airframe although manufacturers and operators will only gather data in preparation to deploy greater levels of automated flight control in future phases.

Airspace

Early operations will use existing airspace classes and boundaries. This may mean that AAM aircraft will experience delays or be assigned non-preferred routing. The low volume of AAM operations will not require corridors during this phase although corridors may be used if they become available. Changes in airspace procedures will be required to maximize the benefit of corridors but these changes will not be effective during this phase.

Operations

Low-volume operations of AAM will be accommodated by exception. This means that existing procedures will be followed until an obvious and urgent need is identified to make modifications. In general, AAM will follow existing policies for separation, sequencing, and communications and will be expected to comply with instructions to hold, divert, go around, or maintain a given heading. Air traffic control will be offered primarily by traditional government service providers although private service providers may also emerge in this phase.

The **Progress Phase** of the evolutionary path involves making targeted changes to regulatory policies and procedures with the intent to encourage adoption of new capabilities by all airspace users. In this phase, AAM operators will make better use of their capabilities with more automation, more direct routing, and more digital communication; incumbent airspace users will likewise benefit from digitization and automation.

PHASE 2: PROGRESS

Aircraft

Aircraft definitions (such as powered lift) will be fully updated to reflect AAM capabilities and new aircraft types will be referenced in relevant regulations. Vehicle performance and safety standards will be established and the path to certification will be available for advanced capabilities such as remote operation and automation.

Pilot

Pilot licenses will be available for AAM aircraft although adoption will be slow. Simplified vehicle operations will be available as an endorsement to fixed-wing airplane, rotorcraft, and powered-lift pilot licenses. During this transition phase, there will be a mix of license types used by pilots of AAM aircraft. Manufacturers and operators will incrementally enable automation features onboard the aircraft as well as on the ground. Some operators will successfully remove human pilots from the aircraft for routine flights. Remote pilots will gain experience operating multiple aircraft simultaneously (1:n).

Airspace

Increased numbers of AAM operations will lead to greater congestion in both segregated (corridors) and non-segregated airspace. Performance-based requirements within corridors will allow reduced separation and a higher cadence of AAM operations. This will be achieved through use of high-precision navigation equipment and onboard sensing and communication that will enable AAM aircraft to continually update 4-D trajectories and maintain the uninterrupted flow of traffic.

Operations

The growing number of AAM operations will be increasingly handled by automated traffic management with a mix of public and private service providers. Human controllers will exercise supervisory control over corridor status but will not direct individual aircraft within the corridor. When aircraft exit the corridor, automated traffic management will provide initial strategic deconfliction in the adjacent airspace. Tactical maneuvering and emergency operations will still be possible by human controllers, but modification may be necessary to work with remote pilots and fleet operators.

Non-AAM aircraft with appropriate navigation, sensing, and communication equipment will be allowed to enter or cross corridors primarily used by AAM aircraft. This will lead to unified airspace where all aircraft can operate freely without airspace boundaries.

The **Advanced Phase** of the evolutionary path is marked by complete integration of AAM operations into the airspace alongside incumbent users where all participants utilize advanced technologies to interoperate. Rewritten regulations, policies, and procedures will allow new technologies, new aircraft, and new operations to flourish by reducing unnecessary obstacles. New operational paradigms, such as digital flight rules (DFR), will be embraced as the standard mode of operation by all airspace users.

PHASE 3: ADVANCED

Aircraft

Aircraft performance and safety requirements will be consolidated into a unified set of regulations that will reduce the need for further modifications when future innovations are introduced. Category or class-specific requirements will still be addressed for certain functions or capabilities (e.g., stall or hover). Accepted means of compliance may also address category, class, and type-specific design features.

Pilot

Higher levels of aircraft automation will replace the need for onboard human pilots. This means that flight control, navigation, traffic deconfliction, collision avoidance, and weather avoidance will all be automated by onboard and offboard capabilities. Furthermore, voice communications will be replaced by digital communications between control agents and ground-based network operations centers. Coordination for off-nominal events and for emergencies will be handled digitally. Onboard detection sensors coupled with avoidance algorithms will provide strategic and tactical deconfliction as well as evasive maneuvering and collision avoidance.

Airspace

Airspace will be unified and desegregated through the adoption of enhanced automation systems and real-time information exchange. AAM operations will be integrated in all airspace environments including close to airports..

Operations

AAM aircraft will use digital flight rules to achieve reduced separation and decreased voice communication while remaining compatible with existing traffic operating under visual or instrument flight rules. Traditional aircraft will also begin utilizing digital flight rules and other automation capabilities but in smaller numbers. AAM traffic will be managed primarily by private traffic service providers with extensive aid of automation systems.

PART FOUR

OPERATIONAL CONCEPT AND PATH FORWARD

Image source: Ongjin County, Incheon

Incheon AAM Operational Scenario

In a future advanced state, AAM operations will be an everyday occurrence. The operational system will be entirely interconnected and compatible with vertiports seamlessly integrated into the broader transportation infrastructure. AAM aircraft will be flown and managed by government-sanctioned operators and service providers using certified systems.

FLIGHT SCENARIO OVERVIEW

What follows is a description of a hypothetical flight taken by a resident of Baengnyeongdo Island who is traveling to Incheon City for a medical appointment. It takes place in the Advanced Phase, a stage in which AAM regulation, technology, and operational practices are fully mature. This flight scenario outlines the daily transportation of passengers and small cargo between the island and the mainland. The island's vertiport is situated near the population center, providing convenient access to public transportation and parking, while the Incheon vertiport is in a densely populated area and integrated into a multimodal transportation hub. Most air traffic at the island vertiport consists of commercial flights, with occasional government or medical emergency support services also utilizing the facility.

The flight is mostly over open water. A segment of the route passes just south of Incheon International Airport before turning northward through a corridor beneath the airport's incoming traffic flows, and then proceeds directly to the destination vertiport. In this scenario, innovative measures have been implemented to enable the use of this route with minimal impact on ATC operations. These measures consist of an air corridor that remains separate from nearby airport traffic, as well as the early adoption of digital flight rules. These updated rules provide ATC with both the intended flight plan and continuous real-time data on-demand. Consequently, voice communication becomes unnecessary between ATC and the AAM pilot.

Notional island route including use of air corridor near Incheon Airport

Overview of scenario phases of flight

FLIGHT PHASES

The scenario is divided into three flight phases: preflight, in-flight, and post-flight.

Preflight includes all activities involved in the planning and preparation for flight including managing and checking in passengers, preparing the aircraft, ensuring airspace capacity, and coordinating air traffic procedures.

In-flight includes takeoff, cruise, and landing portions and focuses on data exchanges, monitoring, and coordination of flight progression and vertiport readiness.

Post-flight involves the securing of the aircraft and collection of flight data as well as preparation of the aircraft for the next flight.

The AAM flight is one piece of the transportation journey. The departure and destination vertiport must be integrated into a multimodal transportation network to allow passengers to continue the journey to their onward destination. In this case, the passenger takes a short taxi ride from the vertiport site to the medical center.

SCENARIO ACTORS AND ROLES

Prior to and throughout an AAM flight, many people and organizations work together as consumers and providers of services and information. Their roles differ depending on the size, scale, and complexity of the operation, airspace, and vertiport environments. For the scenario described here, it begins at a small vertiport facility with one landing pad, few passenger amenities, and a low-density air traffic environment. From departure, the flight transitions to increasingly complex airspace and a surface environment changing from open water to an urban environment. Those involved in the scenario—the "actors"—each have different perspectives and responsibilities on the safety and efficiency of the operation. The five primary actors and their roles are:

Passenger

The passenger perspective follows the customer experience from check-in, security, boarding, flight, and deplaning. The passenger experience is not unlike existing commercial aviation transport in a small aircraft apart from displays and interfaces available for direct communication with the AAM operator.

AAM Operator

The AAM Operator is the organization responsible for managing the planning and flight of the AAM aircraft and includes three primary positions: dispatcher, pilot, and fleet operator.

The dispatcher is responsible for reviewing information on planned routes, developing and submitting flight plans, and checking for existing or possible restrictions (e.g., weather, closed vertiports, inoperable systems, air traffic constraints). The dispatcher also uses automated systems and tools to ensure the weather, maintenance, vertiport availability, and other conditions are appropriate for safe and predicable flight.

The pilot is responsible for the safe conduct of the flight. Operating at a facility remote from the aircraft, the pilot monitors automated systems on the aircraft and makes decisions in response to unanticipated changes in environmental conditions or systems. The pilot holds the authority to initiate, conduct, and conclude the flight. The transition to a remotely operated aircraft follows many years of testing and validation with pilots aboard the aircraft.

The fleet operator oversees the movement of the company's aircraft. This position coordinates closely with the Air Traffic Management Service Provider and vertiport operators to accurately estimate schedules, routings, and vertiport availability to maintain an optimal capacity balance of fleet-wide operations. Fleet operators ensure punctuality and minimize delay, as well as assist company pilots in managing contingencies.

Traffic Management

Air traffic management of AAM is conducted jointly by the Ministry of Land, Infrastructure and Transport (MOLIT) and AAM Air Traffic Management Service Provider (AATMSP). The AATMSP provides air traffic management services specific to the AATMSP community within prescribed airspace designated for AAM use. KOCA maintains authority over access to the airspace as well as modification or closure of the airspace. It coordinates with AATMSP on matters affecting legacy aircraft operations and on changes needed to maintain the safety and efficiency of the airspace. The AATMSP ensures all AAM operations stay within established boundaries and schedules and has communication protocols in place with KOCA to address any deviations or needs for assistance. Third party data and service providers support the AATMSP and supply the AATMSP, dispatchers, and pilots with forecast and real-time information needed for pre-flight and in-flight operations.

Vertiport Operators

Vertiports are operated by facility managers, passenger attendants, security staff, aircraft servicers, and surface operations crew. Facility managers oversee the general operation of the vertiport's infrastructure including its systems, staffing, maintenance, security, and coordination with the AATMSP and Incheon city officials.

These managers are also responsible for working through community concerns. Vertiport managers and staff members are responsible for passenger handling, aircraft servicing, aircraft inspections, debris removal, functionality checks, and charging station inspections. They also ensure that fire and other emergency equipment complies with local ordinances. Vertiport managers and staff may also be needed to assist in contingencies such as injuries, small fires, or system malfunctions.

PRIOR TO AND THROUGHOUT AN AAM FLIGHT, MANY PEOPLE AND ORGANIZATIONS WORK TOGETHER AS CONSUMERS AND PROVIDERS OF SERVICES AND INFORMATION.

City Managers

City managers represent officials and personnel tasked with the oversight of urban and regional transport infrastructure, data management, utility provision, emergency response, mishap investigation, vertiport communications, and community outreach.

These individuals may include Incheon city's smart city data managers, utility administrators, and first responders, among others. Their primary role is to ensure that vertiports are adequately powered, that they are secure and safe, and that they experience minimal interference or delays resulting from municipal operations (e.g., construction) or external conditions (e.g., special events). City managers also ensure that its residents, local businesses, and transportation users experience continued benefits from the introduction and scaling of vertiport operations.

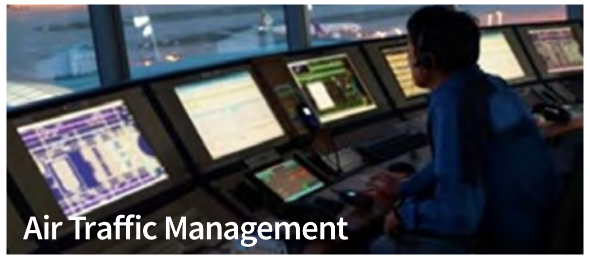
In large cities such as Incheon, data generated from vertiport operations are continuously assessed and compared to city monitoring systems to identify and correct inefficiencies or emerging safety or security concerns. Smart city data systems and management are critical in this role as they collect vast amounts of data from sources such as traffic sensors, weather stations, noise sensors, security cameras, and more. This data can be integrated with AAM operations to provide real-time information about surface traffic, road closures, emergency activities (e.g., police or fire activities nearby) and other factors that could affect flight schedules and routes. Furthermore, Incheon's digital twin can be used to manage AAM operations, simulate scenarios, and assist in optimizing or altering schedules based on sophisticated analytics.

ACTORS AND THE ECOSYSTEM

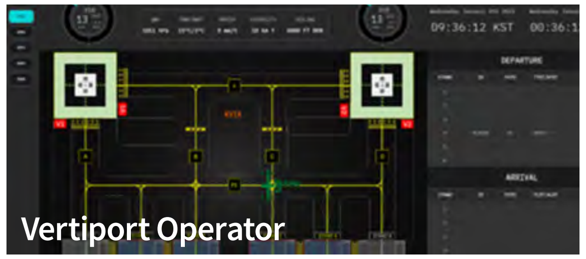
The roles and responsibilities of each AAM actor animates a complex AAM ecosystem composed of data exchange networks, advanced technologies, sensors, infrastructure, and aircraft.

- Books Flight
- Conforms to Safety Requirements

- Manages Flight Reservations
- Develops Flight Plan
- Secures Passengers and Cargo
- Ensures Flight Readiness
- Operates Aircraft and Systems



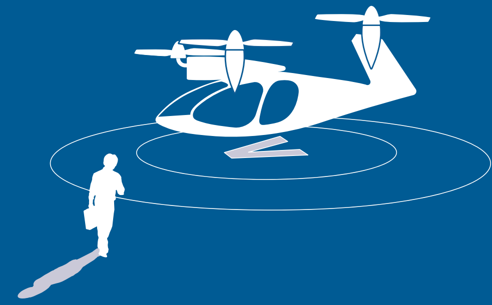
- Reviews and Clears Flight Plans
- Monitors Flight Conformance
- Provides Separation and Alerts
- Manages Contingencies



- Manages Flight Reservations
- Prepares Aircraft
- Provides Surface Prep and Security
- Manages Passenger Movement

- Monitors System Performance
- Oversees Safety Compliance
- Reports on Transport Status Changes
- Integrates Operational Data

Relationship and roles among actors in the AAM Ecosystem



During the **preflight phase**, passengers are processed, flight operations are planned and coordinated, aircraft are prepared for flight, and airspace availability is confirmed.

PERSPECTIVES DURING PREFLIGHT PHASE

Passenger

The passenger arrives via taxi at the vertiport located on the outskirts of Baengnyeongdo-myeon, the main town on the island. The vertiport is small and has minimal amenities. The passenger checks in via a vertiport kiosk or mobile application. During the check-in process, the passenger provides identification and proceeds to a streamlined security screening area. Most passengers arrive very near the departure time as departure times tend to be highly accurate and delays are rare.

When the aircraft is ready, the passenger hears an announcement to board the aircraft and simultaneously receives a notification on their mobile device. Because the aircraft is small, boarding proceeds quickly. Ground staff assist passengers carrying luggage to stow it on the aircraft. Automated sensors ensure all passengers are secure in their seat prior to doors being closed and latched. Prior to flight, a safety briefing begins on a video screen in front of the passenger seat. Passengers with questions or concerns may communicate with a remote assistant by pressing a nearby button.

AAM Operator

The company operating the AAM aircraft (the AAM operator) employs a dispatcher, pilot, and fleet operator to manage the flight.

- The dispatcher develops and reviews flight planning information, checks for any restrictions along the intended route, and validates critical data services (e.g., weather, vertiport availability). Contingency procedures and emergency landing zones along the intended route are also checked for availability. With this information, the dispatcher submits a digital flight plan (under newly developed digital flight rules) to the AATMSP which uses the information to guarantee routing capacity and to check on anticipated restrictions along the flight path.
- The pilot receives the dispatch report and flight planning information from the dispatcher and reviews automated checks of aircraft functions (e.g., navigation, communication, and propulsion), battery condition, weight and balance data, software updates, and supporting systems.
- The fleet operator, with the assistance of automation, monitors flight activities in the area and tracks conformance of arriving, departing, and enroute AAM aircraft to their planned fixes and schedules.
- Operator staff at the vertiport assist passengers and perform physical checks of the aircraft and environment as a final check of flight readiness. Prior to releasing the aircraft for automated flight, the pilot receives a notice from the ground staff, vertiport operator, and AATMSP provider that the movement areas and takeoff location are clear; this indicates readiness for taxiing to the takeoff pad. Once on the pad, the pilot receives a confirmation from the AATMSP, who in turn has received clearance from ATC, that the airspace is prepared for departure along the planned route. Throughout the process, the pilot maintains communication with the fleet operator, ground support staff, and the AATMSP to manage last-minute changes or delays prior to takeoff.

DURING PREFLIGHT, INCHEON CITY MANAGERS CONTINUOUSLY MONITOR AND ASSESS TRANSPORTATION NETWORKS, CONSTRUCTION ACTIVITIES, STREET OR RAIL CLOSURES, UTILITY PERFORMANCE, AND OTHER DATA.

Traffic Management

During the preflight phase, the AATMSP receives an operator's flight plan and validates that the plan is strategically deconflicted from currently planned traffic. If conflicts exist, the AATMSP will negotiate an updated flight plan with the AAM operator. As the AAM aircraft nears the planned departure time, the AATMSP continues to monitor conditions and may provide minor departure time modifications to deconflict with enroute traffic.

The AATMSP also stores flight plan information and shares with MOLIT for common situational awareness. The AATMSP provides takeoff clearance to the AAM operator.

Vertiport Operator

In preparation for flight, the vertiport operator manages passenger services and oversees all ground operations including the arrival and departure of AAM vehicles, recharging activities, and the flow of passengers and cargo. The vertiport operator also coordinates with facility and systems maintenance teams, implements passenger and facility security measures, and ensures adherence to safety regulations.

Incheon City

During preflight, Incheon city managers continuously monitor and assess transportation networks, construction activities, street or rail closures, utility performance, and other data.

Information potentially impacting vertiport operations is conveyed to the affected vertiport operator. The city also supplies digital messages and signage alerting AAM passengers of delays or closures that may impact their journey prior to arrival at the vertiport, and may suggest alternative vertiports, transport modes, or schedules.

City managers track flight performance and oversee vertiport operations for city regulatory compliance. This ensures AAM passengers are protected from potentially overlooked safety or security measures at the vertiport.

Conceptual vertiport lounge

The **in-flight phase** encompasses the departure, climb, cruise, approach, and landing of the aircraft. Aircraft performance is monitored and airspace is managed to ensure safe and efficient flight operations.

PERSPECTIVES DURING THE IN-FLIGHT PHASE

Passenger

During takeoff, cruise, and arrival, passengers experience a quiet flight and have access to onboard flight status information. Minor and expected turbulence is experienced. As the passenger settles into reading, other passengers turn to entertainment on their seat display or gaze out the window at the scenic landscape. As the flight progresses, the passenger uses the display to monitor flight progress and to make verbal inquiries to a remote customer service agent about the destination vertiport. As the flight begins descent, passengers are notified to prepare for landing.

AAM Operator

The AAM operator monitors aircraft systems and flight progress via aircraft communications and AATMSP reports.

- The dispatcher monitors data services (e.g., weather, vertiport availability) for changing conditions that may impact the routing or timing of flight and conveys this information to the pilot and fleet manager.
- The pilot manages occasional request from ATC or the AATMSP to change speeds to maintain separation standards or track to scheduled constraint points. Throughout the flight, the pilot monitors onboard detect and avoid system as it surveils the airspace for unexpected aircraft. Aircraft share position and intent information with each other, and aircraft receive continuous data on navigation aids and vertiport status. The pilot monitors the functioning of these exchanges, but onboard automation performs normal background actions based on the received information.
- Prior to entering the corridor adjacent to Incheon airport, the on-board flight management system receives an automated clearance from MOLIT to enter the corridor. The remote pilot continues to monitor surveillance information on nearby aircraft. During approach to the vertiport, the remote pilot confirms the pre-planned approach procedure and receives vertiport readiness status. The pilot monitors micro-weather data near the landing zone and monitors the progress of the aircraft until landing is confirmed. The pilot verifies motor shutdown.
- The fleet operator oversees the progress and adherence to planned routes during flights, evaluating any updates from the dispatcher regarding changes in conditions. If these changes require adjustments to the flight path or vertiport destination, the fleet operator communicates this information to the pilot, dispatcher, AATMSP, and relevant vertiport operator. While in flight, the fleet operator addresses passenger inquiries and makes announcements about any alterations to the planned route. Both the fleet operator and pilot can respond to irregularities or unforeseen circumstances by monitoring or intervening with the aircraft's automation if actions seem unusual or potentially unsafe. In this scenario, there are no unexpected conditions or situations that require any changes to the planned flight.

PRIOR TO LANDING, GROUND STAFF REPORT THAT THE SURFACE IS CLEAR AND PREPARE FOR THE LANDING AND MOVEMENT OF THE AAM AIRCRAFT TO THE ASSIGNED HOLDING AREA.

Traffic Management

The AATMSP monitors the progress of the flight and shares updated airspace status information with the AAM Operator as necessary. Most flights are conducted under Visual Flight Rules and the AATMSP does not provide traffic management services during these times. As the aircraft approaches the AAM corridor adjacent to Incheon airport, the AATMSP coordinates with Incheon Air Traffic Control systems to verify corridor availability. Once verified, the AATMSP sends final clearance instructions to the AAM pilot to safely manage its trajectory through the corridor. In nominal conditions, many of these communications may be conducted using automated systems. During off-nominal conditions, if the AAM aircraft needs to deviate from the corridor, communications procedures are in place to manage safe deviations relative to Incheon airport traffic. After exiting the corridor, the AAM aircraft approaches the mainland and begins descent to the vertiport.

Coordinating with the AAM operator, the AATMSP sends an updated schedule time at the final approach fix to adjust for another AAM aircraft that was delayed in departing the vertiport. The AAM pilot executes a speed adjustment to meet the new scheduled time. The AATMSP provides a final landing clearance to the vertiport.

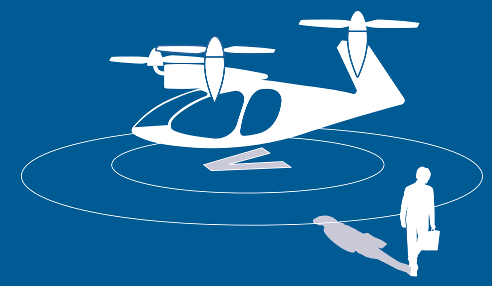
Vertiport Operator

The arrival vertiport in Incheon has many takeoff and landing pads and a staging area for charging and maintenance services. The vertiport operator provides ongoing status of vertiport conditions and services to the AAM operator, pilot, and AATMSP. Under nominal conditions, vertiport staff perform routine duties throughout the day, such as verifying status of infrastructure and flight support systems and managing the continuous flow of arrivals and departures.

Off-nominal conditions may require additional duties, such as alerting emergency crews and handling special equipment. In this scenario, operations at the vertiport are proceeding on schedule and landing pads are predicted to be available for arrival. Prior to landing, ground staff report that the surface is clear and prepare for the landing and movement of the AAM aircraft to the assigned holding area.

Incheon City

During flight, the city has no active responsibilities apart from collecting flight progress data and keeping a channel open for assistance in the event of contingencies such as an unplanned landing at an emergency landing location. During the takeoff and landing phases, ground sensors and track data are monitored to ensure noise and other environmental constraints are followed.



Post-flight activities focus on inspection and turnaround preparation for a new flight. Post-flight data is used to assess operational and system performance and to identify potential anomalies.

PERSPECTIVES DURING THE POST-FLIGHT PHASE

Passenger

After landing, taxiing to the assigned staging area, and turning off the power, passengers are instructed to unbuckle. The aircraft door opens automatically, and ground staff are available to assist with deplaning and baggage. Passengers then approach the terminal where signs show information about ground transport options. The passenger walks across the street to the metro station for a one-stop ride to the station nearest the medical center.

AAM Operator

After the AAM aircraft has landed, an automated taxi tug moves the aircraft to an assigned staging area.

- The dispatcher records landing time, aircraft reserves, and system and environmental conditions that may impact turn around time for the next scheduled flight.
- The pilot turns off the aircraft systems and performs final safety checks before allowing passengers to deplane. The fleet operator sends charging instructions to ground crews to ensure the aircraft is prepared for the next flight. The pilot confirms flight data is downloaded to data management systems and submits any required flight reports to the fleet operator.
- The fleet operator processes information downloaded from the aircraft as part of safety management system procedures that evaluate conformity and identify any anomalies indicating unsafe conditions or trends.

Traffic Management

Immediately upon landing, the AATMSP receives a digital notice from the AAM operator on flight termination; this is quickly followed by a report from the vertiport operator on pad availability.

This information affirms that no adjustments are needed concerning other planned or active AAM aircraft in the system. Any changes to predetermined schedules would then be managed by replanning aircraft speeds, routes, or landing locations; it may also include ground holds to ensure optimal capacity and safety of operations. Aircraft flight data is incorporated into trajectory prediction systems to enable more accurate scheduling decisions in the future.

Vertiport Operator

Upon arrival, ground crews perform functions to receive the aircraft and prepare it for the next flight. The ground crew tows the aircraft to the staging area, begins charging the battery, performs checks on the airframe and systems, and cleans the cabin for newly arriving passengers. Charging systems include data download ports to ensure flight data is collected to assess performance during flight. Maintenance or technical issues, if any, are reported.

Incheon City

Incheon smart city managers receive data from the vertiport operator concerning landing times, planned turnaround times, and any data changing the normal flow of operations.

This data is used to ensure compliance with overflight and landing constraints at the site, and to facilitate the accommodation of passengers with integrated public transport and the picking up, dropping off, and parking by private vehicles. Post-flight data are also used for trend analysis and city planning for expansion or changes to city infrastructure or services.

Priorities and Path Forward

The Republic of Korea and the Incheon Metropolitan City are set to be world- leaders in the introduction and advancement of AAM. This concept of operations provides a look into the path to achieve that future. To get there, Incheon City, in partnership with its citizens, the national government and international partners, will follow a set of priorities.

PRIORITIES

Top priorities for Incheon and the national government are to ensure the safety and well-being of its citizens, to involve the community to gain its trust and acceptance, and to improve mobility through greater accessibility and efficiency.

Safety

The highest priority is and will always be safety. Integration of AAM will include comprehensive safety measures involving not only rigorous testing and validation of AAM aircraft, technical systems, and personnel, but also assurances from MOLIT and Incheon City officials that AAM operations, data, systems, and third-party services will be overseen and continuously evaluated. Safety management system principles will be instituted for the aviation and urban domains to identify and manage safety risks and promote a safety culture. Similar processes will be set in place for the security of systems and operations to identify and prevent harm.

Community Acceptance

A key challenge in the successful integration of AAM in an urban environment will be securing public trust and acceptance. Informing the public about the safety, utility, and potential effects of AAM will be a major priority in meeting this challenge. Also critical will be the creation of an AAM ecosystem that results in tangible, positive social impacts to the community through improving quality of life, affordability, and accessibility. The well-being of Incheon residents and local businesses will be continuously monitored, and feedback sought and assessed to make certain the introduction of AAM operations enhance the well-being of residents in their daily lives.

Improved Mobility

The driving impetus behind AAM in Incheon is to improve the speed, efficiency, and accessibility of transportation to its citizens. This is in line with the city's goals of enabling a one-day life—allowing people from nearby islands to visit mainland Incheon and return home within the same day—and providing a 30-minute travel option for Incheon City dwellers to travel anywhere within the broader Incheon and Seoul metropolitan areas. AAM will be an integral part of Incheon's multimodal transport network by offering a novel transportation alternative in city and regional areas not currently served by aviation. AAM will also improve access to remote and hard-to-reach locations. By utilizing sustainable energy sources, AAM will lessen transportation's environmental footprint and may alleviate travel time inefficiencies experienced today.

THE PATH FORWARD

Phased Implementation

Moving forward will be an incremental and deliberate process. The path to AAM integration will follow an evolutionary growth across three phases.

PHASE 1: 2020-2025 RESEARCH, DEVELOPMENT, AND DEMONSTRATION

In this phase, the focus will be on developing and validating AAM technologies and establishing a collaborative ecosystem, culminating in flight demonstrations.

Focus Areas:

- ▷ Application of research and systems engineering to develop technology, infrastructure, and safety systems.
- ▷ Establish incentives to drive innovation and collaboration and to attract investments.
- ▷ Establish policies and initiate infrastructure development to support initial commercial operations (phase 2).

Outcome: High-value use cases serving the public good will be demonstrated for public awareness and technology validation.

PHASE 2: 2025-2030 INTEGRATION AND INITIAL COMMERCIAL DEPLOYMENT

In this phase, the focus will be on integrating and deploying AAM technologies for initial commercial operations, growing additional infrastructure, and developing a growth framework based on lessons learned.

Focus Areas:

- ▷ Deployment of AAM technologies for initial commercial operations, targeting early adopter markets.
- ▷ Creation of specific routes and corridors for AAM, coordinating with air traffic control for safety and efficiency purposes.
- ▷ Development of a regulatory framework and policies to guide the scalable implementation and use of AAM.

Outcome: Initial commercial AAM operations will be launched, serving early adopter markets and laying the groundwork for future expansion.

PHASE 3: 2030-2040 MATURATION AND EXPANSION

In this phase, the focus shifts towards the maturation and expansion of AAM operations, leading to an integrated and routine operation, while adopting additional use cases to expand applications.

Focus Areas:

- ▷ Integrate AAM seamlessly with multimodal transportation systems, working closely with ground transportation providers to ensure a smooth and efficient transition between ground and air travel options for passengers and cargo.
- ▷ Expansion of AAM infrastructure, including the construction of numerous vertiports around the Incheon region to support a comprehensive network of flight operations.
- ▷ Continuous improvement of policies and regulations to ensure safe adoption of automated flight technologies.

Outcome: AAM operations mature and expand, becoming an integral part of Incheon's transportation network, serving a wide range of use cases and benefiting the broader population.

Key Development Activities

To achieve full integration, Incheon City will pay special attention to the following key activities:

PILOT PROJECTS

In preparation for AAM operations, flight demonstrations within Incheon and the region will be conducted as early as 2024 to test the feasibility, safety, and security of the AAM operations and systems; to familiarize the public with AAM operations; and to alleviate concerns over noise or other disruptions.

The demonstration vertiport locations and routes will be carefully considered to ensure low-risk environments. The city and partnering organizations will inform the public, especially residents near demonstration sites, well ahead of the initial flights, and invite them to share their opinions. Feedback will be collected throughout the testing process. Although pilot projects are not expected to directly affect air traffic operations, flight routes in low-altitude airspace will be coordinated in advance. This coordination may include testing communications and procedures for routine operations and emergency situations.

Early use cases will focus on those having significant public and government backing, such as emergency medical transport to remote island communities. The data collected from these initial trials will be instrumental in validating AAM concepts and technologies, as well as contributing to further research. Furthermore, data and experiences from Incheon's pilot projects will be shared with domestic and international cities to benefit all in assessing the technologies, practices, and lessons learned. This action will facilitate cooperation among cities to foster the use of best practices, especially as relates to accident prevention and preparations for unplanned events that may impact the real or perceive safety risk to city residents.

APPLIED RESEARCH

The evolution and improvement of AAM technology and operations—aimed at addressing aspects such as airspace integration, autonomy, electricity supply, energy conservation, noise mitigation, and vertiport design, among others—requires persistent research and development. This calls for active engagement with Korean applied research entities and academic institutions, in conjunction with international partners. Insights gained from research, experimentation, and early implementation in the Republic of Korea and globally will be carefully evaluated and assimilated when suitable. Similarly, knowledge derived from research and demonstration initiatives will be shared collaboratively with other research institutions, cities, and aviation authorities worldwide.

FINANCIAL INVESTMENT

Research and infrastructure development will involve significant investment. Potential sources and methods for financing are being explored and include both public and private funding. Public funding will come from Incheon City and the national government to stimulate economic development or provide public services. Private investment will come on the part of AAM companies, operators, and suppliers. A common model for large infrastructure projects is public-private partnerships where investments may be shared between the AAM industry and Incheon government. In these partnerships, the industry would focus on AAM-enabling technology and expertise and Incheon government would focus on city infrastructure and services. Other finance sources include bonds, grants, and subsidies from the national government for AAM projects within Incheon demonstrating significant public benefits, such as reducing congestion or emissions. Lastly, user fees collected from operators and passengers may pay for continued maintenance and improvements within Incheon City. Public investments in AAM will require a cost benefit economic analysis for the specific needs of the Incheon Metropolitan region.

LEGISLATION AND POLICY

As AAM technology advances, corresponding legislation and policies will be developed to guide the safe implementation and use of this new aviation mode. For Incheon City, this involves a careful evaluation of existing land-use policies, ordinances, zoning, and permitting requirements to ensure the utility work, roads, signs, and other essentials to secure the infrastructure necessary for vertiport development will proceed in a minimally disruptive, cost effective, and sustainable manner. For MOLIT and the national government, it will be necessary to reevaluate and potentially adjust aviation rules, policies, guidelines, and procedures to accommodate new aspects of airspace structures, air traffic management processes, secure data communication networks, and innovative operational ideas.

TRAINING AND EDUCATION

Educational initiatives, training programs, and transition processes will be crucial for AAM and vertiport personnel, air traffic controllers, and emergency service providers. Furthermore, government authorities responsible for approving and supervising AAM operations and technologies will need targeted training and familiarization with their duties. For cities, departments will need to educate personnel on implications and new procedures or rules associated with the development of new zoning or other regulations. Coordination with Seoul, regional municipalities, and cities worldwide will be encouraged to ensure consistency and efficiency to the greatest extent possible. Specialized training may be needed for new roles such as vertiport inspection and in coordinating and managing vertiport operations.

Additionally, it is essential to keep the public updated on the progress of AAM integration and applications of vertiports, and to establish ways for them to provide feedback.

COLLABORATION AND STANDARDS

Urban integration of AAM is a multifaceted endeavor requiring cooperation and partnerships among many stakeholders including government authorities, urban planners, politicians, technology companies, international partners and, most importantly, the public. These entities will need to work together towards industry standards and best practices to create a comprehensive, sustainable, and widely accepted blueprint for AAM that do not apply only to Incheon and its surrounding areas, but also more broadly to other cities.

Operational Expansion

The true value of AAM integration will only be realized with repeatable scaled operations to progress from initial to advanced operations. Leveraging lessons learned from all the topics above, a deliberate effort will be undertaken to scale operations in multiple areas of the region. Scaling will allow for increasing the amount of value brought to the population at large while also allowing for significant data collection on usage trends, data, reliability, and associated metrics. Availability of data in larger quantities from increased operations will further accelerate deployment, improve safety, and lead to wider adoption and expansion of associated benefits.

Background image source: IFEZ

CLOSING REMARKS

The integration of AAM operations in Incheon promises to revolutionize the region's transportation landscape by improving connectivity, accessibility, and sustainability. This CONOPS serves as a blueprint for the successful implementation of AAM in Incheon and offers valuable insights for other cities worldwide. By prioritizing safety, community acceptance, and improved mobility, Incheon aims to become a world leader in AAM operations.

Through careful planning, investment, collaboration, and a phased approach to implementation, the city will reap the numerous benefits of AAM. Including enhanced quality of life for its citizens, economic growth, and environmental sustainability." As Incheon embarks on this transformative journey, it sets a precedent for the future of urban transportation globally. Incheon City is dedicated to becoming a top AAM advanced city, highlighting its commitment to modern transportation solutions.

ACRONYMS

AAM	Advanced Air Mobility
AATMSP	AAM Air Traffic Management Service Providers
ADS-B	Automatic Dependent Surveillance-Broadcast
ATC	Air Traffic Control
ATM	Air Traffic Management
CONOPS	Concept of Operations
DFR	Digital Flight Rules
DSRC	Dedicated Short-Range Communications
EVTOL	Electric Vertical Takeoff and Landing
FATO	Final Approach and Takeoff
GFC	Green Climate Fund
GBAS	Ground-Based Augmentation System
GNSS	Global Navigation Satellite System
GURS	Global UAM Regional Summit
ICAO	International Civil Aviation Organization
IFEZ	Incheon Free Economic Zone
KARI	Korea Aerospace Research Institute
KOCA	Korea Office of Civil Aviation
K-UAM	Korea UAM
LIDAR	Light Detection and Ranging
MOLIT	Ministry of Land, Infrastructure and Transport
NASA	National Aeronautics and Space Administration
RAM	Regional Air Mobility
SDSP	Supplemental Data Service Provider
SMS	Safety Management System
TLOF	Touchdown and Liftoff Area
UAM	Urban Air Mobility
UTK	UAM Team Korea
USD	United States Dollars
VTOL	Vertical Takeoff and Landing
VFR	Visual Flight Rules

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This report was developed jointly by MITRE and IAIAC in close consultation with Incheon City. Every image in this document is either procured through artificial intelligence software or crafted by graphic artists at MITRE. Images that do not originate from these sources are explicitly indicated. Basemap data shown on map graphics is generated by Mapbox and OpenStreetMap.

Incheon Metropolitan City

Incheon City is a vibrant and dynamic metropolitan area located in the northwestern part of the Republic of Korea, near the capital city of Seoul. As the country's third-largest city, Incheon boasts a rich history, diverse culture, and thriving economy, making it an attractive destination for both business and leisure. The city is a key transportation hub, home to the Incheon International Airport, one of the world's busiest and most advanced airports, and an extensive network of highways and railways that connect it to the rest of the country. Incheon's strategic location along the Yellow Sea has also established it as a major seaport and logistics center, facilitating international trade and commerce. The city is committed to fostering innovation and sustainable development, with a focus on industries such as aerospace, information technology, renewable energy, and bioscience technology. Incheon's dedication to progress and collaboration has positioned it as a leading global city, poised for continued growth and success in the 21st century.

Institute for Aerospace Industry-Academia Collaboration

The **Institute for Aerospace Industry-Academia Collaboration (IAIAC)** in Korea is a leading organization that promotes synergistic partnerships between the nation's aerospace industry and academic institutions. By facilitating cooperation and knowledge exchange, IAIAC plays a vital role in advancing Korea's aerospace sector and enhancing its global competitiveness. The institute supports research and development in various areas, including engineering, aviation, and computer science, to address the challenges and opportunities in the ever-evolving aerospace landscape. Through its commitment to fostering innovation and nurturing talent, IAIAC contributes significantly to the growth and success of Korea's aerospace industry, ensuring a sustainable and efficient future for air transportation systems both domestically and internationally.

MITRE

The MITRE Corporation is a not-for-profit organization that operates federally funded research and development centers (FFRDCs) in the United States to provide innovative solutions for critical challenges in the public interest. With a strong foundation in systems engineering, MITRE has extensive expertise in aviation, working closely with government agencies, industry partners, and academia to advance the safety, efficiency, and effectiveness of aerospace and transportation systems. Leveraging its multidisciplinary team of experts and unique research facilities, MITRE has been at the forefront of research, development, and strategic planning to enable safe and efficient advanced air mobility operations in the US and internationally. By fostering collaboration and innovation, MITRE continues to play a pivotal role in shaping the future of aviation and ensuring the seamless integration of emerging technologies into the global airspace system.

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