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Organization and Management of Urban Air Mobility (UAM)

A modern classification of UAM is presented, which includes the categorization of vehicles and ports. The roles and regulations for the application and use of vehicles, ports, and corridors are defined, along with the requirements and functions of operators. The potential and obstacles to the implementation of UAM are characterized.

As the population of megacities continues to grow, increasing urbanization and the transportation situation push ground transport systems to their limits. Moving urban mobility into the third dimension opens up the potential to create a faster, cleaner, safer, and more integrated transportation system. Autonomous aerial vehicles and flying cars are no longer science fiction; projects and tests are already underway around the world. Major aviation and automotive manufacturers, city authorities, and technology companies are working on innovative urban mobility solutions.

Without skilled planning and innovative smart solutions, cities risk losing their economic edge, as issues like congestion and pollution begin to outweigh the benefits of scale, leading to a decline in quality of life and loss of economic dynamism. In the European Union alone, traffic congestion currently costs approximately 100 billion euros per year, and this is expected to rise to around 300 billion euros per year by 2030. As a result, cities need effective and viable mobility solutions.

UAM has the potential to revolutionize urban transport by providing faster, more efficient, and environmentally friendly alternatives to traditional ground transportation. It could significantly reduce road congestion, improve air quality, and offer city residents seamless and convenient transportation options [1-5].

UAM is a new safe, secure, and sustainable system for air transportation of passengers and goods in an urban environment, created through new technologies and integrated into multimodal transportation systems. Transportation is carried out by electric aircraft with vertical takeoff and landing, either remotely piloted or with a pilot on board.

There are various types of UAM use cases, the most well-known of which are:

Air taxis: This program involves the use of automated drones for fast and efficient passenger transport over short distances in an urban context.

Goods delivery by automated drones: This provides faster delivery while simultaneously reducing road congestion. The delivery of medical goods (e.g., samples and medicines) is an important use case in this context.

Infrastructure inspection: Assessing the integrity of critical infrastructure can be enhanced using drones, especially in hard-to-reach places, potentially lowering operational costs.

Public safety and security: Drones can be used by emergency services, such as police and firefighters, when a rapid response is needed, and when there is a need to assess safety in hazardous situations before ground crews intervene.

Challenges for the full deployment of UAM include integrating infrastructure elements like vertical ports (vertiports) and landing pads into the city, particularly concerning urban planning, as well as air traffic management systems and infrastructure needed to ensure that drone operations are safe and reliable. Another concern is the noise generated by the aircraft, which must be kept at an acceptable level for the urban environment.

Governments worldwide have begun discussing changes to airspace regulations to accommodate the large number of autonomous or semi-autonomous aircraft operating at low altitudes. NASA and EASA have proposed concepts regarding the requirements for the Urban Air Mobility (UAM) system. NASA's concept, known as ConOps, envisions designated corridors for UAM vehicles that must follow specific protocols while in these corridors. EASA’s regulatory approach leaves decision-making to "local actors" and instead focuses on certifying the aircraft themselves to ensure their safety. They have developed special conditions for certifying the VTOL class of aircraft, which had not previously been defined.

The classification of Urban Air Mobility (UAM) includes the categorization of vehicles and ports used for air transport in urban environments. UAM focuses on developing air transportation systems designed for operation within and around urban areas, offering an alternative to ground transportation. The classification typically includes various types of vehicles (often referred to as eVTOL) and the infrastructure, such as ports, that support them.

Currently, the following classifications are distinguished:

eVTOL (Electric Vertical Take-Off and Landing vehicles): Multirotor eVTOLs resemble drones, using multiple rotors for lift and movement. They generally have simpler designs and are suitable for short trips.

Lift-and-cruise eVTOLs: These vehicles have separate systems for lift and forward motion, typically with rotors for lift and wings or other mechanisms for horizontal flight.

Tilt-wing/tilt-rotor eVTOLs: These designs include wings or rotors that can tilt between vertical takeoff/landing and horizontal flight modes.

Hybrid eVTOLs: These vehicles may combine electric propulsion with other types of engines (e.g., internal combustion engines) to increase range or payload capacity.

Drones:

Passenger drones: Smaller vehicles designed to carry one or more passengers, often fully autonomous.

Cargo drones: Specialized eVTOLs designed to transport goods instead of passengers.

Autonomous aerial vehicles: Fully autonomous eVTOLs equipped with advanced navigation and control systems that reduce or eliminate the need for onboard pilots.

Hybrid electric aircraft: These vehicles use a combination of electric propulsion and traditional jet or turbine engines, typically for covering longer distances or carrying heavy loads.

Piloted vehicles: Require a pilot onboard.

Unpiloted vehicles: Operated remotely or fully autonomous.

The organization of traffic service for such aerial vehicles is carried out at UAM ports (Vertiports). A Vertiport is a designated area that meets the requirements to support UAM operations for departures and arrivals. A UAM Vertiport provides information on available resources for current and future UAM operations (e.g., open/closed, availability of pads) to support UAM operators' planning and PSU's strategic conflict resolution. Information about the UAM Vertiport is accessible to operators through a federated network of services, with additional information potentially available through SDSP. UAM Vertiport information is used by UAM operators and PSU for planning UAM operations, including strategic conflict resolution and demand-capacity balancing (DCB); however, the Vertiports themselves do not provide strategic conflict resolution or DCB services.

UAM Vertiports are classified based on the types of aircraft they can support, determined by the design and operational characteristics of the facility. Vertiports and vertistops support passenger and cargo operations for aircraft operating under visual flight rules (VFR), instrument flight rules (IFR), and automated flight rules (AFR). It is expected that UAM operators will use the vertiport configuration that meets their operational needs.

Currently, the classification of Vertiports includes:

Urban Vertiports: Located in densely populated urban areas, designed to handle high traffic volumes, often with multiple takeoff and landing pads.

Suburban Vertiports: Located in less densely populated areas, serving transportation between suburbs and urban centers.

Rural Vertiports: Situated in rural areas, connecting remote regions to urban areas.

Rooftop Vertiports: Positioned on building rooftops, mainly in urban settings, to maximize space utilization.

Floating Vertiports: Located on bodies of water, ideal for cities with large water areas.

Mobile Vertiports: Temporary or movable platforms, useful for events, emergencies, or developing areas.

Vertihubs: Larger and more complex structures serving as central hubs for multiple vertiports, often including maintenance, charging, and passenger facilities.

Skyports: Specialized facilities supporting larger vehicles and potentially longer journeys, including intercity or regional travel. All vertiports require infrastructure for charging electric vehicles and performing routine maintenance.

Airspace management for UAM vehicles has a regulatory feature that distinguishes low-altitude airspace - specifically allocated for UAM vehicles, typically below traditional aviation routes - and urban air corridors, defined air routes within cities to manage traffic and minimize disruptions.

The operational classification consists of:

Short UAM flights: For trips within a single city or metropolitan area;

Intercity UAM flights: For longer trips between cities or regions;

On-demand vs scheduled services: Differentiation between services available on demand and those that adhere to a fixed schedule.

These classifications are key to developing UAM infrastructure and vehicles, ensuring safety, efficiency, and integration with existing transport systems.

For UAM management, corridors must be defined. The concept of UAM corridors ensures safe and efficient UAM operations, which in certain situations may not require traditional air traffic control (ATC) services. These corridors are available for any aircraft properly equipped to meet performance requirements and can be created/implemented where operationally advantageous. UAM corridors can help increase operational tempo by enhancing capabilities (e.g., aircraft performance), the structure of UAM corridors, and UAM procedures. In cases of high UAM traffic, UAM corridors may become a mechanism for separating and distinguishing between different regulatory frameworks—those applicable to UAM operations and those under existing (e.g., IFR, VFR) or UTM regulations.

The definition of UAM corridors is available to stakeholders for planning and operational use. ATC will be involved in implementing and enforcing UAM corridors in the airspace for which ATC is responsible. Other users of the National Airspace System (NAS) will be informed about UAM corridors through airspace familiarization related to flight planning or ATC flight plan approval or recommendations. When developing UAM corridors, the following considerations must be taken into account:

Minimal impact on existing ATS and UTM operations while maintaining fairness for all operators.

Stakeholder needs of public interest (e.g., local environment and noise levels, safety, security).

Utility for stakeholders (e.g., customer needs).

In the initial stage, UAM corridors may support point-to-point UAM operations. As UAM operations evolve, UAM corridors may be segmented and connected to create more complex and efficient networks of available routes between points (e.g., vertiports). UAM operators may conduct operations as regular flights or as on-demand services requested by individual customers or intermodal operators. UAM operators are responsible for complying with regulatory requirements and all aspects of UAM operations. The term "UAM operator" in this document refers to airspace users who choose to operate through shared management in the UAM environment.

The UAM operator receives up-to-date data from PSU (Flight Management Service Providers) and SDSP (Supplementary Data Service Providers) (e.g., environmental information, situational awareness, strategic operational demand, vertiport availability, additional data) to determine the desired UAM Operational Intent. This may include the flight location (e.g., vertiport locations), route (e.g., specific UAM corridors), entry or exit point from the UAM corridor, and estimated flight time.

UAM operators must have a confirmed UAM Operational Intent to operate within UAM corridors. UAM Operational Intent data perform the following key functions:

Inform other UAM operators about neighboring operations within the UAM corridor to enhance safety and shared awareness.
Ensure strategic conflict resolution.
Enable the identification and dissemination of known airspace constraints for the anticipated operational area.
Allow for the dissemination of spatially and temporally relevant advisories, weather information, and supplementary data.
Support shared separation management services (e.g., compliance monitoring, advisory services). The UAM operator also plans actions for non-standard events. This includes understanding alternative landing locations and airspace classes adjacent to the UAM corridor(s) for the operation. After completing the operation, the UAM operator reports to the PSU [5-8].

Conclusion

Today, UAM is not just a concept of the future but a reality that is gradually gaining momentum thanks to technological advancements and regulatory frameworks. The use of UAM enables the creation of new opportunities for efficient and rapid transportation of both passengers and goods, which is particularly relevant for densely populated urban areas. With the development of vertiports, UAM corridors, and air traffic management services, such systems ensure safety, reliability, and integration with existing transport infrastructure. Implementing UAM offers the potential to reduce congestion, decrease environmental impact, and enhance overall population mobility. UAM technology fosters the development of new business models and the creation of jobs in the fields of manufacturing, service, and transport system management.

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