



PROSPECTIVE Drone-Taxis or “E VTOL”

Should we believe in it? What technical and legal frameworks should be in place, particularly in anticipation of the Paris 2024 Olympic Games? A project that is hardly feasible for this deadline, especially in view of the regulatory constraints. But it is not prohibited to dream.

In a more or less near future, cabs and hybrid bikes and other formulas such as carpooling, carsharing etc., may have a serious competitor: the taxi-drone or E-VTOL. In other words, a flying cab without a driver initially planned to allow participants in the Paris 2024 Olympic Games to reach the center of Paris in 15 minutes from the airports of Orly or Roissy, by flying over the traditional traffic jams of the Paris region.

It's the car of the future, it's a space vehicle, and it's not science fiction, because the autonomous flying cab is almost already a reality. The race between constructors is on: no fewer than eight taxi-drone projects have a good chance of coming to fruition in the future. Airbus is also positioning itself in this niche.

But the road to make it technically and legally usable is still quite long in light of the constraints of certification and integration of the UAV in the air navigation and the need to reconcile on the one hand a certain flexibility for this promising sector and on the other hand the strictest safety and security (especially in urban areas and for commercial passenger transport), not to mention the respect of personal data and the privacy of the people transported and overflowed whether within the "smart city" or outside, without forgetting the cyber risk (the issue of computer security on

board the drone cab, which must be protected against hacking attempts).

The context: urban air mobility

The French and Europeans, very impatient with the arrival of drone cabs, a remedy for land congestion

French people's expectations for flying cabs are high: more than 4 out of 10 people say they are ready to board an automatic (unmanned) drone shuttle for a specific journey. French people are aware that drones are no longer simple toys and their use is widespread in various civil and military fields.

Even if a drone for transporting people is not yet available on the market, 43% of French people declare that they are willing to go on board, especially at the time of the Olympic Games in Paris in 2024. This willingness rises to 51% among men and is even stronger among the youngest with 54%, the same score as among the higher socio-professional categories.

Paradigm shift

The flying cab could constitute, if not an alternative, at least a useful complement for tomorrow's urban displacements and would bring :

- a real change of paradigm' for urban mobility, in the face of the innovation brought by the "flying shuttles without driver" ;
- a real time saving, out of traffic jams, on the transport of goods or people without equivalent in urban area; a reasonable cost (without comparison with the cost of a helicopter, moreover very polluting).

It should be noted that this mode of transport is in line with a major trend² observed in the change of mobility consumption modes (V-lib, carpooling, car sharing, etc.).

An equation that is nevertheless complex

Indeed, the regulations of the airspace regulation are such that, in general, drones must circulate within dedicated air corridors ("segregated spaces" at a maximum of 120 meters/ground, unless an express exemption is granted by the Direction Générale de l'Aviation Civile), and it is easier to do so with an "autopilot" than with a human. In urban areas, for safety reasons, it is excluded to allow a pilot to fly the aircraft, even if he is trained, because most people cannot fly in three dimensions, even if they are assisted.

The concept of the drone taxi is very disruptive and will represent a serious alternative for tomorrow's urban transportation. Such support from French people is both surprising and very encouraging for the dozens of projects currently being developed.

Definition, characteristics (still low autonomy), manufacturers and issues

The eVTOL (electric Vertical Take-off and Landing) is a vertical take-off technology which allows the operation of an aircraft in an autonomous way³ in remote control, or with a pilot on board. It represents one of the latest innovations in the aerospace industry, especially since the propulsion is electric and therefore in line with the industry's constant ecological concerns (decarbonization⁴ of aviation, which represents a major challenge in the face of "plane bashing").

In concrete terms, the omnidirectional, streamlined propellers allow the device to take off and then move in all directions. Although designs vary according to the developers, most of them are similar to "classic drones". They are powered by electrical energy, hence the name eVTOL. They can be powered by other types of energy, including green energy.

The principle of the "air taxi" is based on vertical take-off. The displacements are generated by the inclinations of the propeller blades. The transition from take-off mode to displacement mode of the module is a critical element of the flight. At this point, it should be noted that there is no eVTOL design that involves a helicopter-like structure.

In addition to the Chinese company EHang, the major aeronautical manufacturers, BOEING and AIRBUS, play an important role in the development of eVTOL.

Airbus is working on its VAHANA (single-seater) and CityAirbus (four-

seater) concepts. As for Boeing, the company is even collaborating with luxury car manufacturer PORSCHE to develop a high-end eVTOL vehicle.

Uber created Uber Elevate in 2016 to develop a vehicle for air ride-sharing services. The company sold Uber Elevate in December 2020 to another aviation company, Joby Aviation. In turn, Joby Aviation has partnered with automaker Toyota to develop another air cab service. This service involves five-seat eVTOL air taxi with a range of 150 miles and top speeds of up to 200 mph.

Several U.S. airlines are also exploring this technology (partnering with start-ups). Earlier this year, United Airlines announced its partnership with the air mobility company Archer to develop eVTOL vehicles. The goal is to design short-haul electric air cabs for dense urban environments. Archer is developing its own eVTOL vehicle, which it hopes to deploy in Los Angeles by 2024.

On a technical level and as an example, the white paper of the project developed by Uber Elevate on the eVTOL aircraft details the following specifications:

- **Capacity for four passengers (including a possible pilot).**
- **Gross vehicle weight of 1800 kg.**
- **500 kW of power for one minute during take-off and landing.**
- **71 kW of power required in flight at a speed of 150 mph.**
- **120 kW of power required in flight at 200 mph.**
- **At a cost of \$0.12 per kWh.**
- **With a function capacity of approximately 40 hours per week for one year.**

The eVTOL technology is currently for point-to-point travel, with the ambition of developing larger aircraft in the future. This type of technology allows for operation without a runway, and is designed for use on larger aircraft in the future. This type

of technology allows for runway-less operation. This is an ideal scenario for highly populated urban areas.

The "Velocity", a VTOL (vehicle with vertical take-off and landing), an all-electric aircraft from the German manufacturer Volocopter, performed a remarkable flight demonstration in 2021. In the audience, Patrick Ky, the executive director of EASA (the European Aviation Safety Agency) had his eye on this creature capable of carrying:

- two people including a pilot,
- at a speed of 110 km/h and
- at an altitude of 400 to 500 meters
- with a range of 35 km.

Following on from the first "DOA" certificate obtained at the end of 2019 ("DOA" for Design Organization Approval), certification of the drone (requested in May 2021 by the manufacturer Volocopter) is in progress. After a successful test, EASA has authorized test flights of the aircraft in limited areas. This is a world first, before a commercial green light is given, which is expected by a few years on the coveted market of flying cabs. The future market for flying cabs⁵ could, in fact, represent more than 35 billion dollars in 2035. It would concern 60 to 90 cities in the world, especially the congested megacities of Asia and America.

This Drone-Taxi can "now be operated in a clearly defined low-risk area clearly delineated area", including in the vicinity of high-risk areas like a city or a sports stadium explained the EASA. Nevertheless, great caution must be observed, given the characteristics of the "vehicle" itself (subject to air law - see 1-14 infra), its social acceptability, its limited autonomy⁶ compared to an aircraft with a technical engine and the enormous challenge of its certification.

Indeed, the reliability of the aircraft must be proven in accordance with the regulations. To this end, it must be demonstrated that the probability of a "*catastrophic failure*" - the shutdown of several rotors at the same time, for example - is less than one per billion flight hours, which remains a considerable challenge in this field.

In a pragmatic and secure way, it is necessary to agree that a probationary period will be necessary with a pilot on board before considering a total autonomy...

The "urban air mobility" sector and infrastructures

How can eVTOL and *vertiports* be integrated into the *smart city* of 2024 / 2030? Although there are many airports, they are usually not located in the middle of busy cities. Most passengers will use eVTOL drones for short trips. Therefore, it will be necessary to build take-off and landing areas in large, busy cities.

Among the changes, electric charging stations are also needed. The drone cab will also need infrastructure when not in use. Maintenance hangars or parking lots will have to be built not far from the central hubs. Cities and municipalities will need to plan locations as early as possible, in collaboration with technology providers and regulatory authorities.

Note that the urban evolution of drone cabs will take place within the "*Smart city*⁸": this "*smart city*" will be equipped with a quantity of sensors that will collect a multitude of data in order to improve the quality of life of city dwellers. Developing a smart city will require finding the perfect balance between public and private actors, on the one hand, and between the protection and innovation on the other hand, with the overriding issue of privacy protection.

Drone-taxis could play a key role in supporting (in a way that is appropriate during a health crisis) numerous urban applications such as the transportation of people, but why not also (and in a combined way if necessary) the delivery of health products, goods, etc. In addition, for several months now, under the impetus of the Ile de France region, Aéroport de Paris (ADP) and RATP, an experimental vertiport set up on the Pontoise airfield (95) has been used to test drone-taxis and all the components of this service: parking areas, equipment in terms of energy, maintenance, and even the route of future passengers.

But the emergence of these smart cities will modify the existing legal framework. Big data, whose purpose is the undifferentiated collection of a large amount of information for purposes not known in advance, undermines the GDPR and in particular the principle of purpose. Moreover, the legal fragmentation of cyberspace leads to individuals being subjected to different risks and degrees of protection. The creation of a "*secure e-zone*" is therefore necessary to avoid these disparities within cyberspace, which has no physical borders.

The legal regime of E-vtol

The legal regime of E-vtol is not well defined⁹ for the moment, and we are thinking about the possibility of subjecting Drone-Taxis to the European "*certified*" category and the constraints associated with that category. At the moment, except by express exemption, French and European regulations do not allow remotely piloted aircraft to transport passengers or goods by air in urban areas. Much has been written about the future legal regime for Drone-Taxis; under certain conditions, the Drone-Taxi could join the "*certified*" category.

As of December 31, 2020, drones are classified into 3 operating categories, based on the level of risk:

- the "*Open*" category for low-risk operations (direct visual flight in geographical areas that represent a low risk to air traffic and people);
- the "*Specific*" category for moderate risk operations (direct or out-of-sight flight in conditions different from the Open category);
- the "*Certified*" category for high-risk operations requiring a high level of reliability of the aircraft and the operations envisaged (for example, the transport of people via drone cabs, the transport of goods, etc.).

The "*certified*" category requires authorization and is intended for special applications in the industrial and transportation sectors, as in this case. The authorizations and certifications required concern both the drone and the user/pilot. The certification process, under the direction of EASA, promises to be lengthy given the diversity of E-VTOL projects and the requirements of the "*rules of the air*".

Classification in the "*certified*" category may be necessary if the risk assessment does not allow the device to be classified in the "*specific*" category.

The very delicate issue of the integration of Drone-Taxis in air navigation

In addition to the need to equip Drone-Taxis with precise airspace mapping, the question that arises here is that of the integration of Drone-Taxis into air navigation and the inadequacy - as it stands - of current air traffic control and the necessary but complex development of the U-Space/Corus concept (automated "*low layer*" air traffic control with the help of artificial intelligence).

The management of this new air traffic is referred to in Europe as "U-Space". The objective is clear: to guarantee air safety and security in the face of the increasing number of aerial drones. As such, the Agency for Innovation in Transportation (AIT), created at the initiative of Jean-Baptiste Djebbari, Minister of Transportation, has launched a call for projects to accelerate the implementation of the "U-Space" program, in partnership with the Defense Innovation Agency (AID), launched by the Minister of Armed Forces, Florence Parly, in 2018.

« *The French Air Force wants to develop a real-time display of drone and manned aircraft traffic and decision support,* » explains Colonel Nicolas, a U-Space expert with the Air Defense and Air Operations Command (ADOC).

In addition, the Corus or "*Concept of Operations (ConOps) for U-Space*" articulates three different types of airspace volumes, called X, Y, and Z. The number and nature of U-Space services differ in the three volumes and, as a result, the density and complexity of operations that can occur in each volume differs. The goal is to divide the airspace into X, Y, and Z based on air risk, ground risk, traffic demand, and other factors, and thus the cost and complexity of providing and using U-space services will be proportional to the need to use them.

The air traffic will have to integrate the aircraft already in service as well as the other eVTOL aircraft. All eVTOL aircraft will have to be able to communicate with each other and detect each other, by means of various equipment which are not perfect (ADS-B, transponders, Flarms etc...).

In practice, the implementation of an unmanned air traffic management system proves to be very complicated and will not be ready for the Paris 2024 Olympics (which, of course, does not prevent us from dreaming and multiplying our efforts in this direction).

There are three key elements that should make this possible, ultimately beyond 2024:

- Reliable monitoring
- Effective communications
- Consistent navigation

The eVTOLs will have to develop flight plans and communicate with other aircraft.

The reservations of a former Airbus flight test director

Air traffic management is already an expensive and complicated process. The need for good traffic management due to eVTOL will increase considerably. The skies are becoming more congested as time goes by.

According to Claude LELAIE, "*if there are no more pilots on board, gigantic control systems will be needed to coordinate the trajectories of all the aircraft (...)* Their reliability will have to be at least that required of today's aircraft, i.e. less than one breakdown for a billion hours of flight", knowing that beyond the technical feasibility, cost and profitability, the real challenge is that of computer security with the issue of "*hacking*".

In general conclusion

The provision of unmanned Drone-Taxis will hardly be possible for the Paris 2024 Olympics, but it is not forbidden to dream and even less to pursue research in this exciting field.

On the regulatory front, the considerable challenge is to find the right balance between, on the one hand, flexibility for this promising sector and, on the other hand, the strictest safety and security (especially in urban areas and for commercial passenger transport), not to mention respect for personal data and privacy of the people transported and flown over, whether within the "*smart city*" or outside, without forgetting the cyber risk (question of computer security on board the drone cab, which must

be protected against hacking attempts).

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Notes

- (1) According to the in-depth study by Carvea Consulting, which is to be commended for its near-exhaustiveness (2/12/2020)
- (2) Note from CREOGN of 20/09/2020
- (3) By analogy: currently the autonomous flight of a drone, that is to say the programming of the machine so that it flies alone, without assistance and out of sight is completely prohibited in France. What is authorized is the automated flight as long as the device remains within sight
- (4) In this regard, we welcome the Safran Group's growing Safran Group's growing role in the production of electric motors for drones and E-vtols, especially from its Villaroche plant in Paris (Usine Nouvelle May 2019).
- (5) According to a study by consulting firm Oliver Wyman released in November 2019
- (6) This raises the question of the "reserve" of autonomy - especially under IFR - which would allow a diversion (cf. case of bad weather) and that of its measurement according to the battery charge, as explained by Nicolas Marcou (*Director of the UAV program at the Directorate of Civil Aviation Safety*)
- (7) According to Claude LELAIE, former director of flight tests at Airbus (Aviation et Pilote March 2018)
- (8) "*Smart cities: the tools of a controlled legal revolution*" June 2021 Dalloz IP/IT - Cassandra Rotily and Laurent Archambault
- (9) Except that the existing liability rules (in terms of transport of goods) constitute a serious basis for application of "*Drones et transport de marchandises : demain c'est (encore) loin*" Dalloz IP/IT 2018 Jean-Baptiste Charles et Pascal Dupont