9. The Use of Unmanned Aircraft Systems for Fast Delivery Goods

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Unmanned aircraft systems (UAS) are implemented in all spheres of human activity and have a wide range of applications in many fields like environmental hazards monitoring, traffic management, search for power line damage, losses in heating networks, inspection of industrial facilities, construction of maps of land plots and forests, pollution monitoring and logistics. The booming UAS and drone's industry are creating new markets and huge business opportunities, particularly in terms of urban mobility and service delivery [1]. Unmanned aircraft systems are a new component of the aviation system, one which ICAO, States and the aerospace industry are working to understand, define and ultimately integrate [2]. These systems are based on cutting edge developments in aerospace technologies, offering advancements which may open new and improved civil/ commercial applications as well as improvements to the safety and efficiency of all civil aviation.

The rapid growth of civil and military Remotely Piloted Aircraft System (RPAS) has increased the demand for them to access non-segregated airspace [3]. Due to the absence of a pilot on-board the aircraft, technical solutions have been developed to control the aircraft through data-link from a remote location. The absence of a pilot on-board also brings the challenge of matching the ability of the pilot to ese and avoid other traffic, managing dangerous situations, like potential collisions with other airspace users, clouds and severe weather conditions, obstacles and ground operations at airports. The use of RPAS at lower altitudes is now a driving force for economic developments. Many of these smaller RPAS operate at altitudes below 500ft.

According to ICAO Annex 2 this is the lowest available VFR (Visual Flight Rules) altitude, and thus creates a possible boundary between smaller RPAS and manned aircraft. However, nearly every State allows manned operations below this altitude, and coexisting with small undetectable RPAS poses a safety challenge. For now, no restrictions have been put in place regarding the maximum number of small RPAS allowed to operate in a certain area. Integration of RPAS into the airspace between 500ft and 60,000ft as either IFR (Instrument Flight Rules) or VFR is challenging due to the fact that RPAS will have to fit into the ATM environment and adapt accordingly. Many RPAS aspects such as latency and see and avoid have never been before addressed within this environment for manned aviation, simply because of the fact that a pilot is on-board the aircraft, capable of handling these issues in a safe and timely manner. Also, these human capabilities have never been translated into system performance as they were placed under "good airmanship" for see and avoid, or simply not addressed at all. RPAS has increased the demand for them to access non-segregated airspace.

The safe integration of UAS into non-segregated airspace will be a long-term activity with many stakeholders adding their expertise on such diverse topics as licensing and medical qualification of UAS crew, technologies for detect and avoid systems, frequency spectrum (including its protection from unintentional or unlawful interference/cybersecurity), separation standards from other aircraft, and development of a robust regulatory framework. The goal of international aviation organizations and their projects in addressing unmanned aviation is to provide the fundamental international regulatory framework, to underpin routine operation of UAS throughout the world in a safe, harmonized and seamless manner comparable to that of manned operations.

Moreover, it also poses a significant and complex challenge in terms of Air traffic Management (ATM), given the expected large number and heterogeneous nature of these aerial vehicles. Highly automated vehicles which include single-pilot operations, urban air mobility aircrafts, cargo drones, and so on, will require new forms of traffic management and air-ground system integration. At the same time, interest is growing again in the potential for operating vehicles at very high altitudes, which will need access to and from the stratosphere via managed airspace.

The need for change is becoming even more pressing, as we can already observe the limits of the current system resulting in increasing delays and disruptions. Pressure to optimize trajectories is higher than ever before, and there is a growing need to enable new forms of flight that are attracting a significant share of global investments. Moreover, there are areas where they have no alternative. The development of unmanned aircraft belongs to the most promising innovation platform of the 21st century.

9.1 ADVANTAGE OF USING UNMANNED AERIAL SYSTEMS

Unmanned aircraft systems are characterized by a number of advantages over manned aircraft. These advantages primarily include:

- lower costs - better economic performance;
- the use of environmentally cleaner drives - minimum emissions of harmful gases;
- indirect reduction of harmful emissions due to reduction of the number of delivery vehicles;
- indirect reduction of congestion in traffic;
- the ability to access difficult terrain and remote locations;
- expanding territorial accessibility which is of great importance for users;
- lack of need for crew and its life support system, airfields;
- much lower training costs for external (remote) pilots compared to flight crew training for manned aircraft;
- relatively low cost and low costs for the creation, production and operation of UAV
- relatively smaller characteristics compared to high reliability, considerable duration and range, maneuverability and nomenclature of the target load, which is placed on board, and, crucially,
- much lower cost of flight hours.

A striking example of the rapid technological development of unmanned aviation is its use for the delivery of goods.

According to the criteria of efficiency, this is one of the most promising directions of development of urgent delivery of goods.

In this regard, the definition of the type of UAV, which would best correspond to the possibility of delivery of goods within a certain settlement or territory, will Unmanned aircraft systems are implemented in all spheres of human activity.

For practical application and development of UAV, it is important to classify them on different grounds.

9.2 CLASSIFICATION OF UAS BY MAIN CHARACTERISTICS

UASs can be classified by a broad number of performance characteristics. Aspects such as aerodynamics, weight, landing and vertical take-off, range, speed and wing loading are important specification that distinguish different types of UASs and give rise to useful classification systems. The cost, wing span, types and number of engines with their maximum powers are also features which can be considered to compare and classify UASs.

All the UASs considered in this section are presented in the following tables which displays main the performance characteristics mentioned above. This tables can be used as a reference to look up specific values of performance for any UAS.

Based on Aerodynamics
Many of UAV system has been developed and in the advancement phase, some of them includes the Fixed-wing aircraft [4,5], chopper, multi-copter , motor parachute and glider, UAV with vertical take-off and landing , congregating ready-made parts and commercialized UAV, all of them are specified for a specific mission and have their advantages and disadvantages.

Fixed wing drones are very simple but saturated in designing and manufacturing, because of successful generalization of larger fixed-wing planes with slight modifications and improvements. Fixed wings are the main lift generating elements in response to forward accelerating speed. The velocity and steeper angle of air flowing over the fixed wings controls the lift produced. Fixed wing drones require higher initial speed and the thrust to load ratio of less than 1 to initiate a flight. If fixed wing and Multirotor are compared for a same amount of payload, fixed-wing drones are more comfortable with less power requirement and thrust loading of less than one. Rudder, ailerons and elevators are used for yaw, roll and pitch angles to control the orientation of aircraft.

Fixed wing drones cannot hover over a place, and they cannot maintain their low speed. Subsequently, it can be seen that lift to drug ratio denotes the lift generated by a wing counter to drag generated. Fixed wing drones are more compatible with larger L/D ratio and with higher Reynolds number [5]. Unfortunately, fixed-wing drones are less noticeable for L/D‹10 for the reason that Reynolds number and efficiency decreases for smaller drones.

Fig. 1 shows the force applied on fixed-wing aircraft.

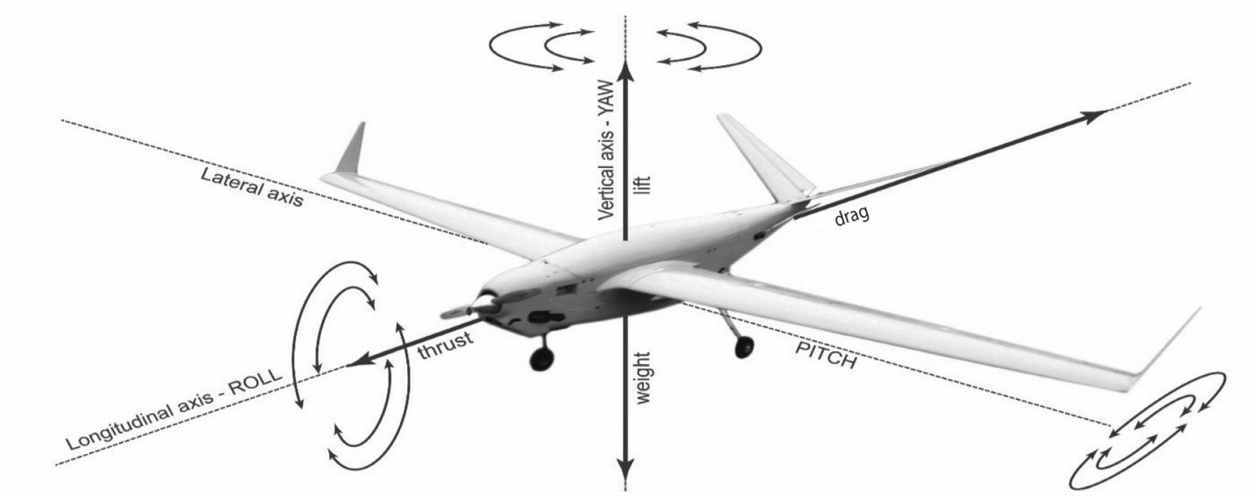

Fig. 1: Fixed Wing UAV Aerodynamics

Figure 1 shows the following notation:
Drag. Drag is the force that opposes thrust.
Lateral axis. The lateral axis of an aircraft extends from wingtip to wingtip.
Lift. Lift is the force that pushes an aircraft upwards.
Longitudinal axis. The longitudinal axis of an aircraft extends from wingtip to wingtip.
PITCH. Pitch is rotation along the lateral axis of an aircraft.
ROLL. Roll is rotation along the longitudinal axis of an aircraft, also called bank.
Thrust. Thrust is the force that pushes an aircraft forward.
Vertical axis. The vertical axis of an aircraft is the axis running perpendicular to its wings, from centre of gravity to the bottom of the aircraft.
YAW. Yaw is rotation along the vertical axis of an aircraft.

Flapping wing drones are primarily inspired by birds and insects, such as small hummingbirds to large drag on flies [6]. The lightweight and flexible wings are inspired from the feathers of insects and birds which demonstrate the utility of weight and flexibility of wings in aerodynamics. However, these flapping wings are complex because of their complicated aerodynamics. Flapping drones can support stable flights in a windy condition, unlike fixed-wing drone. Light, flexible and flapper wings provide the flapper motion with an actuation mechanism. Intensive research on flapping wings has been carrying out by drone community and biologist because of their exclusive manoeuvrability benefits [7].

Fixed/flapping-wing: Integrated effect of the fixed and flapping mechanism is used where fixed wings are used to generate lift whereas flagging wings are used for generation of propulsion [13]. These types of drones are inspired by a dragonfly which uses two pairs of wings in order to increase the lift as well as thrust forces. Hybridisation using fixed and flapping wing increases overall efficiency and aerodynamic balance [8].

Multirotor: Main rotor blade produces a forceful thrust, which is used for both lifting and propelling. Multirotor unmanned aerial vehicles are capable of vertical take-off and Landing (VTOL) and may hover at a place unlike fixed-wing aircrafts [5,8]. Multirotor are designed by number and location of motors and propellers on the frame. Their hovering capability, ability to maintain the speed makes them ideal for surveillance purpose and monitoring. The only concern with Multirotor is that they need more power consumption and makes them endurance limited. Approximate equations are used for exact calculation of power and thrust requirements in multirotor aircraft:

$$Power\ [W] = Pitch \times (Diameter)^4 \times (RPM)^3\ (5.33 \times 10^{-15}). \tag{1}$$

$$Thrust\ [OZ] = Pitch \times (Diameter)^3 \times (RPM)^2 \times (10^{-10}). \tag{2}$$

Multicopter is divided into specific categories based on number and positioning of motors, each category belongs to a specific type of mission [9], and based on the mission requirement they are classified in various configuration such as Monocopter, Tricopter, quadcopter, hexacopter (x, + configuration) Mode, Octocopter (x, + configuration).

Based on Landing and Vertical take-off
Horizontal take-off and landing (HTOL) and vertical take-off and Landing (VTOL): HTOL may be considered as the extension of fixed-wing aircraft. They have high cruise speed and a smooth landing. VTOL drones are expert in flying, landing and hovering vertically, but they are limited by cruise speed because of the slowing down of retreating propellers.

Vertical take-off and landing UAVs are those that are able to generate downward thrust and take off within very limited space. This section contains UAVs that overlaps with the other categories. However, VTOL UAVs are selected to form a class of their own because the unique capability of taking off and landing vertically is critical for some missions. For missions where run way facilities are inaccessible, such as operations in forest or bush areas, or launching and recovering from non-carrier battleships. Therefore, it is obvious that VTOL UAVs are a very important fleet to the military

Based on Weight and Range

Unmanned aircraft systems consist of the aircraft component, sensor payloads, and a ground control station. The latter, operated by one or more people in addition to a dedicated human "pilot" or in the modern name "Remote Pilot" [10] (supplemented in some cases by an additional "spotter" to ensure safety), varies widely in its configuration depending on the platform and mission. Remote Pilot is a person charged by the operator with duties essential to the operation of a remotely piloted aircraft and who manipulates the flight controls, as appropriate, during flight time

Table 1: Unmanned aerial Vehicles classification based on weight and range

Type	Maximum Weight	Maximum Range	Category
MAV (Micro (or Miniature) Air Vehicles); Nano	200 gr	5 km	Fixed wing, multirotor
NAV (Nano) Air Vehicles; Micro	2 kg	25 km	Fixed wing, multirotor
LASE (Low Altitude, Short-Endurance)	2-5 kg	30 km	Fixed wing, multirotor
LASE Close (Low Altitude, Short- Endurance)	2-5 kg	40 km (flight altitude up to 1,500 m)	Fixed wing
Mini	20 kg	40 km	Fixed wing, multirotor
Light	50 kg	70 km	Fixed wing, multirotor
VTOL (Vertical Take-Off & Lending)	20-50 kg	30 km	multirotor
Small	150 kg	150 km	Fixed wing
LALE (Low Altitude, Long endurance)	600 kg	150 km	Fixed wing
MALE	800 kg	200 km	Fixed wing
HALE	1000 kg	250 km	Fixed wing
Heavy	2,000 kg	1,000 km	Fixed wing
Super Heavy	2,500 kg	1,500 km	Fixed wing

Dedicated control systems may be devoted to large UAVs, and mounted aboard vehicles or in trailers to enable close proximity to UAVs limited by range or communication capabilities. The smallest categories of UAVs are often accompanied by ground-control stations consisting of laptop computers and other components small enough to be carried easily with the aircraft in small vehicles, aboard boats, or in backpacks. In any case it is executed operational control. Operational control is the exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of safety of the aircraft and the regularity and efficiency of the flight.

Some researchers and organisations have classified the drones based on weight and range. Table 1 presents the list of unmanned aerial vehicle based on weight and range.

MAV (Micro (or Miniature) or NAV (Nano) Air Vehicles): are so called because of their size, which typically enables military versions of these aircraft to be transported within individual soldiers 'backpacks. Many of the other performance characteristics are related to the weight of the UAV. For example, more lift and thrust will be needed for increased weight therefore wingspan will increase and the type of power plant chosen will differ. The light weight UAVs use primarily electric motors while the super heavy weights commonly use turbo jets or turbo fan engines.

These aircraft tend to operate at very low altitudes (<330 m), with size limitations on battery capacity leading to short flight times in the vicinity of 5–30 min. This included the Dragon Eye, FPASS, Pointer, Silent Eyes, and UAS designed in National Aviation University: Oko, Oko 2 NAU.

TOL (Vertical Take-Off & Landing): These aircraft require no take-off or landing run, and are therefore typically chosen in situations where limitations of terrain require this specialized capability. Aircraft of this type operate at varying altitudes depending on their mission profile, but predominantly fly at low altitudes. High power requirements for hovering flight limit the flight durations for VTOLs, except in the largest sizes where increased lifting capabilities accommodate large fuel capacity. UAS designed in National Aviation University: policopters.

LASE (Low Altitude, Short-Endurance): systems, also known as **sUAS, small unmanned aircraft systems**, also obviate the need for runways with aircraft optimized for easy field deployment/recovery and transport. The aircraft component of these systems typically weights 2–5 kg, with wingspans <3 m to enable launching from miniature catapult systems, or by hand.

Compromises between weight and capability tend to reduce endurance and communication ranges to 1–2 h and within a few km of ground stations. (for example, Ovod NAU).

LASE Close: This category describes small UAS whose aircraft do require runways, but whose larger size and weight confer increased capabilities. These systems operate at up to 1,500 m altitude and may remain aloft for multiple hours, although these limits have been substantially exceeded by specially-modified "record-breaker" aircraft. This includes the RPO Midget.

LALE (Low Altitude, Long Endurance): Typically, at the upper end of the "sUAS" weight designation by the United States Federal Aviation Administration (FAA), these UAS may carry payloads of several kg at altitudes of a few thousand meters for extended periods. (for example, Module NAU).

MALE (Medium Altitude, Long Endurance): aircraft are typically much larger than low-altitude classes of UAVs, operating at altitudes up to 9,000 m on flights hundreds of km from their ground stations lasting many hours. This includes the Hunter and Raven up to the Phoenix and Lark NAU.

HALE (High Altitude, Long Endurance): These are the largest and most complex of the UAS, with aircraft larger than many general - aviation manned aircraft. These UAVs may fly at altitudes of 20,000 m or more on missions that extend thousands of km. Some HALE aircraft have flight durations over 30 h, and have set records for altitude and flight duration.

Heavy. Have weight UAS which would be weight between 1000 and 2000 kg. The "Have weight UAS" classification all UAS similarly to the A-160, the Outrider and the Fire Scout.

Super Heavy. Super Heavy weight UASs which are those with take-off weights of over 2 tones. According to the classification adopted here will include X-45, Herron, Darkstar, Predator B and Global Hawk.

For the purposes of simplicity, we will describe some characteristics of the various size platforms for supporting civilian remote sensing and scientific research applications from the former identified categories of UAS (MAV, LALE, LASE, MALE, HALE, and VTOL).

Based on Endurance and Range

Another useful classification method for UAVs is to categorize them by endurance and range. These two parameters are usually interrelated as obviously the longer a UAS can say airborne the larger its radius of operation is going to be. It is important to consider range and endurance because it enables the UAV designer to determine the type of UAS required depending upon how far the mission objective is from the launch site. Also, it determines how regularly refuelling is required and would affect how much time can be spent with the UAS performing its task and how much time it needs to spend grounded. Three levels of classification can be proposed and these are long, medium and short endurance/range.

1. The long endurance UAVs are those that can stay airborne for 24hours or more. The range for these UAVs is also high, starting from1500 km up to 22000 km for the Global Hawk.
2. The medium endurance UAVs are those with endurance between 5 and 24 hours. These include the shadow 600 up to the Predator. This is the most common type of UAV.
3. The third class is the low endurance UAV which have less than 5 hours endurance. These are used for short missions such as 'seeing over the next hill' which is a safer method of reconnaissance than sending troops into unfamiliar territory.

Table 2. Range and Endurance

Category	Endurance	Range	Example
High	> 24 hours	> 1500 km	Predator B, Global Hawk
Medium	5 – 24 hours	100 – 400 km	Silver Fox, Pioneer
Low	< 5 hours	< 100 km	Pointer, Shadow

Categories of operations

The essence of the proposed classification of unmanned aircraft is as follows. Unmanned aircraft, irrespective of their mass, can operate within the same Single European Sky airspace, alongside manned aircraft, whether airplanes or helicopters.

As for manned aviation, a uniform implementation of and compliance with rules and procedures should apply to operators, including remote pilots, of unmanned aircraft and unmanned aircraft system ('UAS'), as well as for the operations of such unmanned aircraft and unmanned aircraft system.

Technologies for unmanned aircraft allow a wide range of possible operations. Requirements related to the airworthiness, the organizations, the persons involved in the operation of UAS and unmanned aircraft operations should be set out in order to ensure safety for people on the ground and other airspace users during the operations of unmanned aircraft. The rules and procedures applicable to UAS operations should be proportionate to the nature and risk of the operation or activity and adapted to the operational characteristics of the unmanned aircraft concerned and the characteristics of the area of operations, such as the population density, surface characteristics, and the presence of buildings.

When choosing a class of UAS it is necessary to take into account the issues of its certification and the possibility of practical application, taking into account the risk of use. The risk level criteria as well as other criteria should be used to establish three categories of operations: the **'open'**, **'specific'** and **'certified'** categories. Proportionate risks mitigation requirements should be applicable to UAS operations according to the level of risk involved, the operational characteristics of the unmanned aircraft concerned and the characteristics of the area of operation.

- 'Open' category (low risk): safety is ensured through operational limitations, compliance with industry standards, requirements on certain functionalities, and a minimum set of operational rules. Enforcement shall be ensured by the police.

- 'Specific operation' category (medium risk): authorization by National Aviation Authorities (NAAs), possibly assisted by a Qualified Entity (QE) following a risk assessment performed by the operator. A manual of operations shall list the risk mitigation measures.

- 'Certified' category (higher risk): requirements comparable to manned aviation requirements. Oversight by NAAs (issue of licenses and approval of maintenance, operations, training, Air Traffic Management (ATM)/ Air Navigation Services (ANS) and aerodrome organizations) and by EASA (design and approval of foreign organizations).

The unmanned aircraft systems whose operation presents the lowest risks and that belong to the "open" category of operations should not be subject to classic aeronautical compliance procedures.

The design, production and maintenance of UAS operated in the "certified" and "specific" categories shall be certified if the UAS meets any of the following conditions:
– it has a characteristic dimension of 3 m or more, and is designed to be operated over assembles of people;
– it is designed for urgent transporting especially of important cargoes or people;
– it is designed for purpose of transporting dangerous goods and requires a high level of robustness to mitigate the risks for third parties in case of accident.

In the document [12] of the European Commission classes C0, C1, C2, C3 and C4 of UAS are entered. Table 3 and Table 4 characterize the valid and invalid action when using these classes of UASs in the airspace.

Table 3. Activities that have to be done while flying a drone of the appropriate class

Do	*C0*	*C1*	*C2*	*C3*	*C4*
Make sure you are adequately insured	+	+	+	+	+
Check your drone before each flight	+	+	+	+	+
Plan your flight	–	–	+	–	–
Make sure the electronic identification and geo-awareness system of your drone is up-to-date	–	+	+	+	+
Before each flight, check the limitations of the area where you want to operate, as defined by the National Authority of that country, and respect them	+	+	+	+	+
Familiarise yourself within the area where you want to operate your drone	–	+	+	+	+
Check the weather conditions	–	+	+	+	+
Keep the drone in sight at all times	+	+	+	+	+

Maintain a safe distance between the drone and people, animals and other aircrafts	+	+	+	+	+
When flying close to people, activate the low speed mode and keep a horizontal distance from them of at least the height of the drone (1:1 rule), but never less than 5 m	–	–	+	–	–
Operate your drone within the performance limitations defined in the instructions provided by the manufacturer	+	+	+	+	+
Inform your national aviation authority immediately if your drone is involved in an accident that results in a serious or fatal injury to a person, or that affects a manned aircraft	+	+	+	+	+

Table 4. Activities that mustn't be done while flying a drone of the appropriate class

Do not	*C0*	*C1*	*C2*	*C3*	*C4*
Do not make changes to the drone, unless approved by the manufacturer	+	+	+	+	–
Do not fly higher than 120 m from the ground	+	+	+	+	+
Do not fly near manned aircrafts	+	+	+	+	+
Do not fly in the proximity of airports, helipads, areas affecting public safety or where an emergency response effort is ongoing	+	+	+	+	+
Do not fly over sensitive or protected sites (prisons, military bases, power plants, etc.)	+	+	+	+	+
Do not use the drone to carry dangerous goods	–	+	+	+	+
Do not fly over large groups of people	+	+	–	–	–
When flying over other people`s property, do not fly less than 20 m above the property without their permission	–	+	+	+	+
Do not take photographs, videos or sound recordings of people without their permission. Respect people`s privacy	+	+	+	+	+

The choice of the type of unmanned aerial vehicles at the present stage of development can be described as follows.

The most promising and massive for civil use is UAV for the delivery of small, usually up to 100 kg, goods. Analysing the above UAV classification, it can be assumed that the most suitable for cargo transportation, taking into account demand, are UAS classes from NAV to LALE (Tab.1). Their weight up to 600 kg allows you to carry most small-sized and small cargoes. Small cargoes can be sized up to 3 meters.

Low-altitude UAV is best suited to deliver goods, as high-altitude flight echelons require greater integration and coordination with manned aviation to maintain security levels in the region's airspace.

Taking into account the integrated flights of UAS and manned aircraft systems (MAS) in accordance with the table of cruising flight level in the airspace, the desired flight altitudes may be as follows:

– for the path line from 0 degrees to 179 degrees

Table 5. Flight level in the sector from 0 to 179 degrees

Feet	Meters
1000	300
3,000	900
5,000	1,500
7,000	2,150

– - for the path line from 180 degrees to 359 degrees

Table 6. Flight level in the sector from 180 to 359 degrees

Feet	Meters
2,000	600
4,000	1,200
6,000	1,850
8,000	2450

Using higher flight levels requires more time and fuel per set of heights and declines for landing. In addition, there are stronger winds which UAS all classes are difficult to resist.

Given that the delivery of goods takes place between neighbouring settlements or within one point, it is necessary to provide for the ground placement of aircraft data. It is clear that cheap, reliable and reusable UAS is needed for the delivery of goods. They are one of the components of the logistics complex. Moreover, since the delivery of the same goods to different settlements is often carried out, they create decentralized networks of warehouses.

Therefore, it makes no sense for UAS to overcome the maximum possible distances, which causes their use at close ranges. For such distances there is no need to use expensive high-speed UAS, and it is enough to have a speed of up to 120 km/h.

9.3 EUROPEAN STRATEGY FOR THE DEVELOPMENT OF AIR FREIGHT

The rapid growth of civil and military Remotely Piloted Aircraft System (RPAS) has increased the demand for them to access non-segregated airspace. Due to the absence of a pilot on-board an aircraft, technical solutions have been developed to control an aircraft through data-link from a remote location. The absence of a pilot on-board also brings the challenge of matching the ability of a pilot to See and Avoid other traffic, managing dangerous situations, like potential collisions with other airspace users, clouds and severe weather conditions, obstacles and ground operations at airports. The use of RPAS at lower altitudes is now a driving force for economic developments. Many of these smaller RPAS operate at altitudes below 500ft AGL. According to ICAO Annex 2 this is the lowest available VFR altitude, and thus creates a possible boundary between smaller RPAS and manned aircraft. However, nearly every State allows manned operations below this altitude and coexisting with small undetectable RPAS poses a safety challenge. For now, no restrictions have been put in place regarding the maximum number of small RPAS allowed to operate in a certain area. Integration of RPAS into the airspace between 500ft and 60,000ft as either IFR or VFR is challenging due to the fact that RPAS will have to fit into the ATM environment and adapt accordingly. Many RPAS aspects such as latency and see and avoid have never been before addressed within this environment for manned aviation, simply because of the fact that a pilot is on-board the aircraft, capable of handling these issues in a safe and timely manner. Also, these human capabilities have never been translated into system performance as they were placed under "good airmanship" for see and avoid, or simply not addressed at all. RPAS has increased the demand for them to access non-segregated airspace.

Further development of the use of unmanned aerial vehicles is associated with combining airspace design and technological solution. With this approach it becomes possible to solve the problem of integration of all aerial vehicles, manned and unmanned.

A number of new rules and systems are being introduced to support a number of classes of remotely controlled unmanned aircraft system.

Small size RPAS operated on pre-programmed very low level long free routes outside Remotely Piloted Aircraft System (RPAS) restricted areas and will self-avoid all fixed or mobile obstacles, and stay clear from aerodromes. They will be operated above and clear from the highest buildings in their neighbourhood, although always below 150 m. The right of way will always belong to any manned air vehicle. A remote operator will oversee the flight and he will be provided with an override capability which will trigger a high level "return to programmed base" command in case of navigation issues.

A basic level of piloting will be expected, mostly based on an understanding of flying skills. Surveillance will be implemented, positions will be recorded, and an operation flight planning system will be set up. Because of the similarity of the technologies used by those RPAS, the current telephony mobile architecture is expected to provide the communication backbone for such operations, with a dedicated robust telecommunication layer providing availability, continuity and integrity, as well as sufficient continuation of service for surveillance and positioning purposes. Satellite communication will be contributing to fill gaps of the mobile telephony network in some hard to reach areas. The realization of the vision [1,11] also depends on the integration of the wide variety of new aerial vehicles accessing the airspace alongside conventional manned aircraft. This is U-space, a framework designed to fast-track the development and deployment of a fully automated drone management system, in particular for but not limited to very low-level airspace. Scalable by design, U-space relies on high levels of autonomy and connectivity in combination with emerging technologies. Alongside U-space there is the need to integrate large remotely piloted aircraft systems into manned traffic, with special provisions designed to compensate for the fact that a pilot is not on board an aircraft. The roadmap covering drone integration is incorporated into edition of the European ATM Master Plan [1].

By 2040, increasing numbers of aerial vehicles (conventional aircraft and unmanned aircraft, such as drones) will be taking to Europe's skies, operating seamlessly and safely in all environments and classes of airspace. Trajectory based free-route operations will enable airspace users (civil and military) to better plan and execute their business and mission trajectories within an optimized airspace configuration that meets safety, security and environmental performance targets and stakeholder needs. These challenges must be addressed. In addition, the emergence of rapidly growing drone traffic (and also the recent emergence of interest in very high-altitude aerial vehicle operations) is perceived as both a challenge (safely and efficiently integrating these new aerial vehicles into the controlled and uncontrolled airspace) and an opportunity (drones and the relevant services can serve as a testbed, for example for connectivity and virtualization technologies that can then be applied to manned aviation).

The system infrastructure will progressively evolve with the adoption of advanced digital technologies, allowing civil and military ANSPs and the Network Manager to provide their services in a cost-efficient and effective way irrespective of national borders, supported by secure information services. Airports and other operational sites (e.g. landing sites for rotorcraft and drones) will be fully integrated at the network level, which will facilitate and optimize airspace user operations in all weather conditions. ATM will progressively evolve into a data ecosystem supported by a service-oriented architecture enabling the virtual defragmentation of European skies.

Innovative technologies and operational concepts will support a reduction in fuel and emissions while also mitigating noise impact, in support of the EU's policy of transforming aviation into a climate-neutral industry. Performance based operations will be fully implemented across Europe, allowing service providers to collaborate and operate as if they were one organization with both airspace and service provision optimized according to traffic patterns. Mobility as a service will take intermodality to the next level, connecting many modes of transport, for people and goods, in seamless door-to-door services.

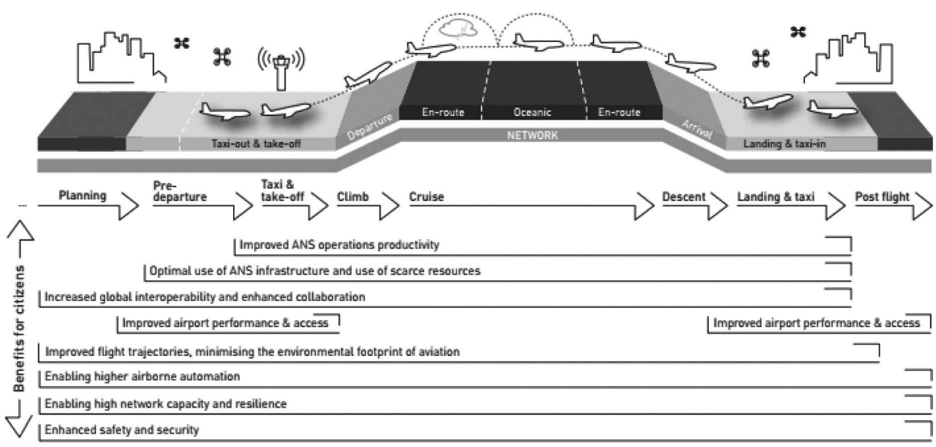

Fig. 2. Improving the provision of unmanned and manned aircraft at every stage of their activities [1].

The use of drones for the urgent delivery of goods is extremely effective given the last mile. Last mile delivery is defined as the movement of goods from a transportation hub to the final delivery destination. The final delivery destination is typically a personal residence. The focus of last mile logistics is to deliver items to the end user as fast as possible. Last mile logistics has become a popular area of interest for retailers due to the growing demand for fully integrated omnichannel retailing. Omnichannel supersedes multichannel and includes channels such as physical locations and environments, ecommerce, mobile applications, social media and emerging formats like augmented and mixed reality or dynamically personalized video [13]. Evolving omnichannel needs have forced retailers to evaluate current transportation network capabilities and make adjustments accordingly.

Focus has been placed on last mile logistics because, in many cases, this is a key differentiator for retailers. Because consumers can easily shop for product alternatives retailers and their supply chain partners must provide exceptional service to gain market share and build brand loyalty. Last mile delivery is becoming more important than ever due to the surge of online orders. Retailers must begin to prepare their transportation networks for traffic fluctuations caused by the expected growth in online sales. In order to accommodate faster shipping times, changing regulation and infrastructure limitations retailers and their transportation partners have started to research delivery alternatives including click-to-collect locations, local regional carriers, drones and other unmanned systems.

By focusing on last mile delivery alternatives retailers are able to provide and guarantee exceptional service levels to their customers and adapt to the constantly changing omnichannel retail environment.

9.4 CONCLUSION

Fast delivery of goods is a complex problem, which includes not only means of transport, but also effective system management. This system should be based on improving air navigation services productivity. Air navigation services (ANS) productivity will improve thanks to the introduction of increased levels of automation support in air traffic control (ATC), the move from voice to data communications, and better connectivity and information sharing between ground systems. This means that controllers will perform fewer manual and repetitive tasks, since these will be automated and delegated to the system, allowing controllers to concentrate on more complex work. At the same time, new capabilities will be introduced to enhance the interface between air and ground and enable data exchange, as well as separation management. These enhancements will mean that the system will be more scalable to meet growing demand. ANS productivity will also increase thanks to the shift to a new air traffic management service urgent delivery goods. This will enable capacity on demand — more dynamic delegation of the provision of air traffic service to an alternative center with spare capacity. In addition will result in a substantial improvement in air navigation service operations and productivity especially in urgent air cargo delivery.

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