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Consulting & Solutions Srl

THESEUS

get future today

The Theseus concept stems from the synergy between ON-AIR's expertise in the aerospace field and the proactive listening to the operational needs of the Armed Forces. The positive recognition of the validity of the project presented in Horizon2020 (Seal of Excellence Ares(2016)670117) and the subsequent obtaining of a co-financing in the National Plan of Military Research, together with the cooperation agreement with the Experimental Flight Department, allow us to develop and test the aircraft in full harmony with the Italian Air Force.

www.onaircs.com

The THESEUS DRONE

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About Us

ON-AIR Consulting & Solutions is the result of forty years of experience in high technology, especially in the sectors related to Aerospace and Defense.
It arises from the consideration that small and medium-sized enterprises often have strong potential, but few tools for interfacing with organizations and institutions.

ON-AIR therefore aims to offer its strategic advice to SMEs, in order to identify the most appropriate fields of action, exploit new opportunities, improve existing operations and develop strategies and processes commensurate with the needs and aspirations of each company.

Thanks to extensive knowledge in highly technological fields, ON-AIR Consulting & Solutions ensures collaboration with the top management of national SMEs, for the construction of new strategies and new programs based on innovation, networking, and the competitiveness and profitability of products and services.

ON-AIR develops own products too: disrupting solutions for solving more efficiently and effectively a wide range of technological problems

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Decades of experience in aerospace and defence fields.

Drone Industry Races Forward

"Drones" have seen an increasing amount of attention as an evolving industry. Up until recently, drones were mostly used for defense. The development of small and cost-effective drones has led to a variety of uses that businesses and public institutions are starting to leverage to reduce risk, optimize processes and drive new forms of customer and societal value. Drones traditionally used for defense purposes are also being used more in a support to civil government authorities' role.

However more robust technology is still required before many applications are commercially viable and accepted. Additionally, regulation and societal concerns related to privacy and safety remain constraints for some applications already feasible from a technical perspective. In terms of regulation, a new framework around the operations of drones is proposed by the European Union as a common basis to harmonize regulation across Europe and enable more applications, such as initial permissions for beyond visual line of sight (BVLOS) drone operations.

In general, the efforts of Europe have been focused on designing automatic flying capabilities, building integrated platforms to manage drone flights and to analyze information captured via drones. These efforts have attracted capitals on the range of multi-billion euros in defense, R&D and private investments.

THESEUS

a tilting body UAV

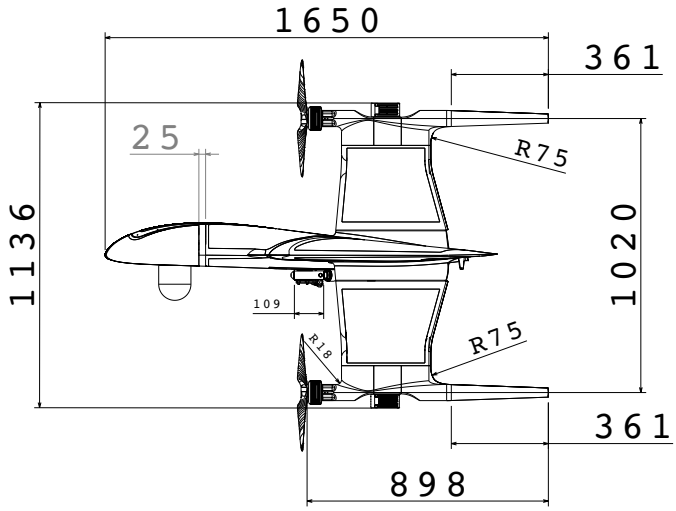
Overview

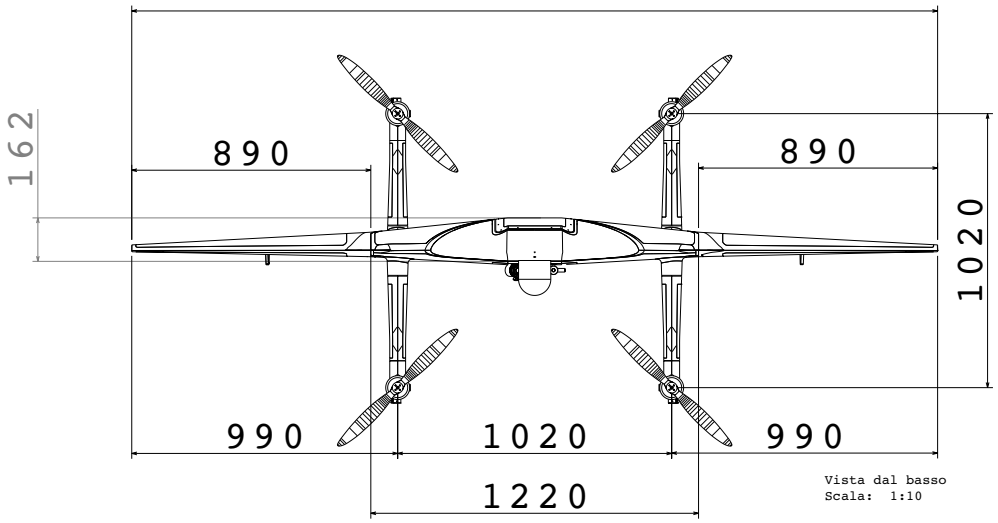
On-Air Consulting & Solutions has developed a brand-new drone, named Theseus, based on a proprietary patent. The design has been derived from the regulatory aspects, recently confirmed by EU Regulations (see Annex 1), and from market request (Annex 2).

Theseus objective is to develop and tune-up an appealing and innovative UAV (Unmanned Aerial Vehicle) to safely & efficiently carry out missions in challenging contexts such as the urban areas and open sea.

AMONG THE SPECIAL FEATURES OF SUCH UAV EMBODYING FUNCTIONALITIES, WE HERE RECALL:

- VTOL (Vertical Take-Off and Landing) capability with electrical propulsion
- Takes off and lands like an helicopter, body tilts, flies like a plane
- Patented stabilization, not requiring moving controls (e.g. ailerons and stabilizers)
- Visual Line Of Sight (VLOS) and Beyond Line Of Sight (BVLOS) operations;
- High degree of autonomy;
- Hover standing configuration for short periods to fulfil special mission objectives;
- Capacity to be equipped with EO, LIDAR and mini SAR sensors.





Vista dal basso
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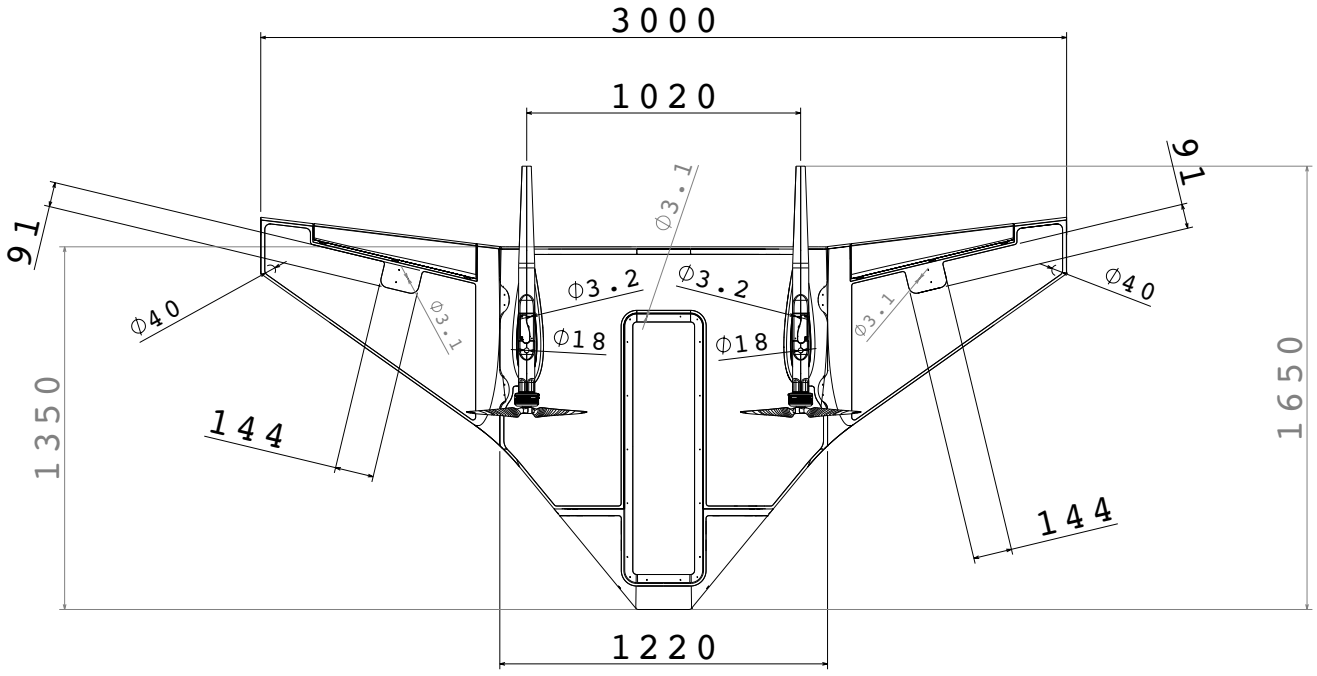


Technical details

Theseus baseline technical details are given in the following table:

THESEUS UAV PERFORMANCE			
		THESEUS M	THESEUS S
PROPULSIVE SYSTEM			
MOTORS # X MAX. POWER	kW	4x10	4x2
GENERATOR MAX. POWER	kW	15	2
AERODYNAMICS & PERFORMANCE			
LIFT TO DRAG RATIO		10.1	10
MAX HORIZONTAL SPEED	km/h	250	110
HORIZONTAL CRUISE SPEED	km/h	138	70
STALL SPEED	km/h	89	48
ABSOLUTE CEILING	m	5000	5000
TYPICAL OPERATING CEILING	m	3000	120
ENDURANCE @ HOVERING	s	300	300
ENDURANCE	h	6	10

The on-board functions are controlled by a computer, which is fully redundant for its pivotal role in all manoeuvres and payload control functions. Various sensors are connected to this On Board Computer to constitute an Air Data & Attitude Heading Reference System. A GPS receiver will solve the dead reckoning problem (accumulation of errors or drift), realizing an Inertial Navigation System. One of its additional functions is to create correct telemetry packets, receiving all the data from motors, range extender, generator, pitch control, temperature sensors. Among the sensors, it is worth mentioning the proximity sensors that will detect the distance from the terrain during the descent phase for landing.

Three situations have been studied and implemented, for the aerodynamic attitude:

- The VTOL phase.
- The transition from vertical to horizontal flight and viceversa.
- The "aircraft" mode or horizontal flight.

To fly BVLOS and in segregated areas over urban environment, suitable Sense and Avoid (S&A) systems have to be embarked on board the UAV to avoid fixed obstacles and other traffic. Theseus will make use of a non-cooperative sense and avoid COTS system for a fully autonomous flight.

Theseus will have, in a critical mission over urban areas:

- Primary system of command and control.
- Capacity to continue operations in case of data link loss.

A system of flight termination fully independent from the command and control one is capable, when activated, to immediately ground the UAV
It is worth noting that the new IOT satellite constellations in Low Earth Orbit will provide a new mean of communication for long range UAV guidance and data download.

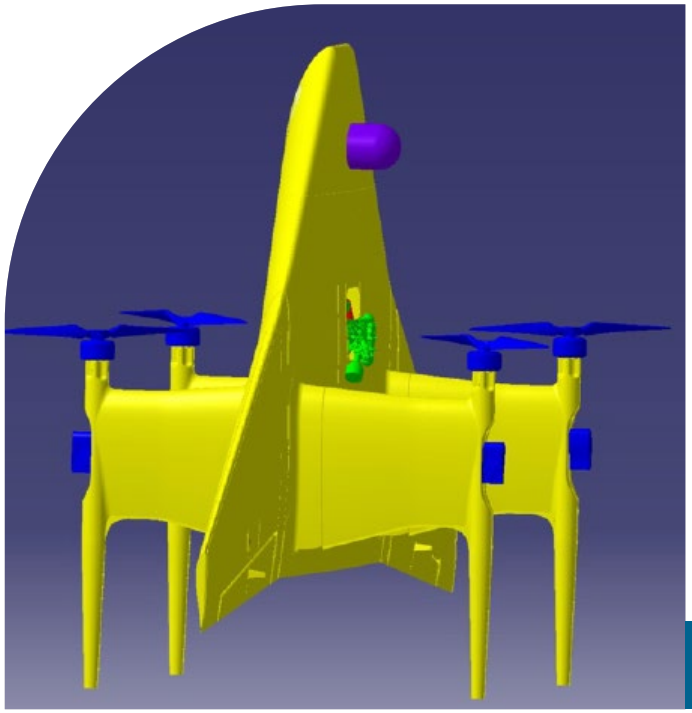
A complete Ground Control System will be housed in a shelter, which also hosts all the antennas for the required communication links:

- telemetry and telecommand from/to Theseus;
- radio link for the payload data from Theseus;
- wired (or radio) from the GCS to a higher-level coordination centre.

Theseus UAV can be hosted in the same shelter, from which it can be extracted and prepared for the flight in less than an hour, including the pre-flight checks.

During the flight, the Theseus onboard cameras will continuously transmit data that could also be recorded on an on-board memory with full mission duration capacity.
The nominal flight operation starts with a control centre having the full capability to write the flight plan for the UAV before each flight or to select it from a pre-organised menu. The control centre will have the possibility to change the flight plan, during the mission, inserting new destinations with relevant timing.
The overall system cost is highly competitive with respect to existing UAVs, thanks to an optimized proprietary design. The final design will be tailored to the production facilities and to the production pace.

Concept



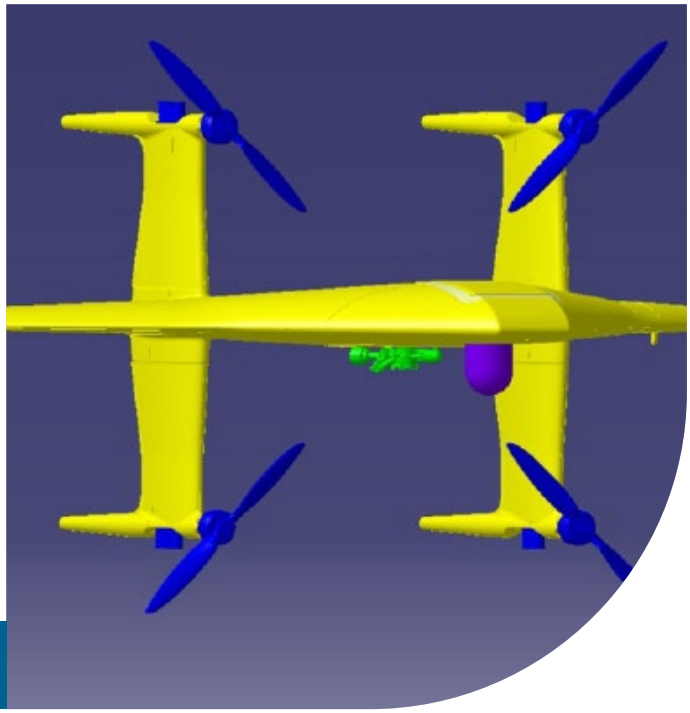
The following pictures show the Theseus UAV in its two operational attitude positions.

Theseus UAV R&D has been completed and the 25 kg model underwent flight tests under Italian Military Aeronautics control. A definitive production model will be designed, once the production line characteristics are identified.
Two Theseus models can serve a segmented market

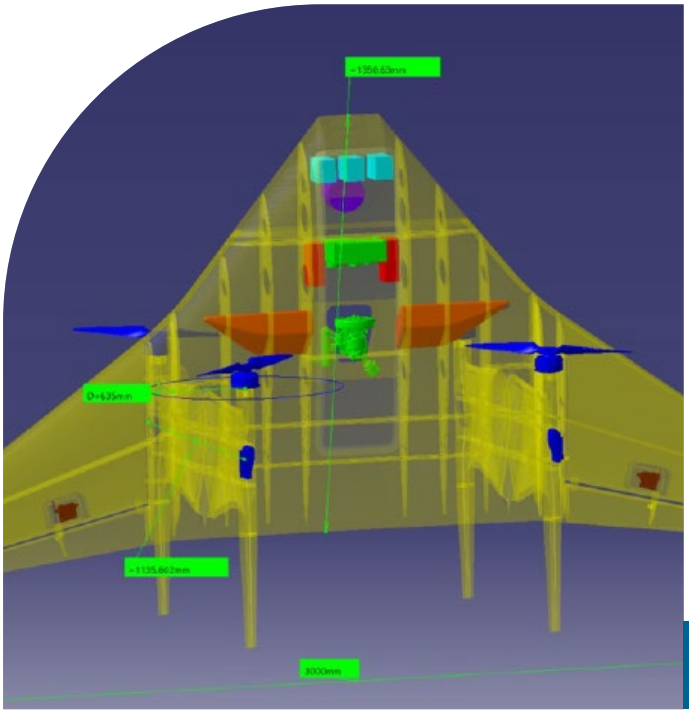
THESEUS UAV at take-off & landing

Theseus-S

Theseus-S, having a Maximum Take Off Weight (MTOW) of 25 kg, can host a 2kg payload and fly at a typical altitude of 500 m, with a 5-10 km range and a 6 hours autonomy. Theseus-S will support services not too far away from the Ground Control Station. The stall velocity has been designed as low as possible for close infrastructures monitoring.



THESEUS UAV during level flight



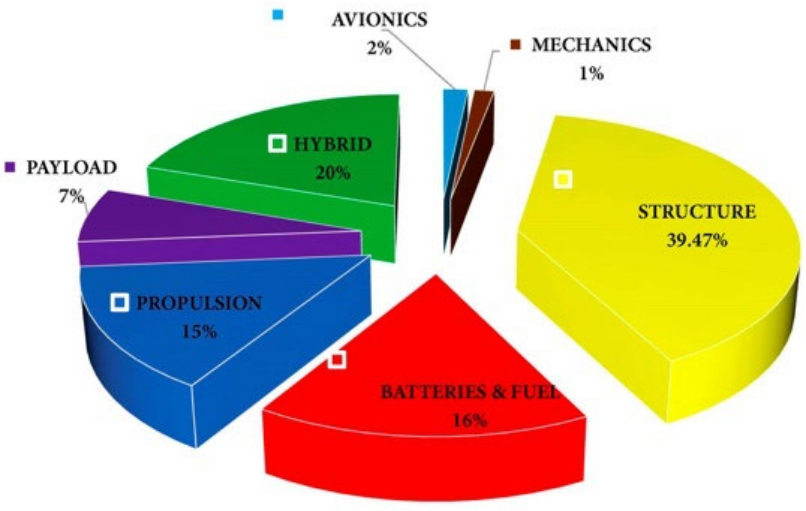
Theseus-M

Theseus-M, having an MTOW of 150 kg, can host a 20kg payload and fly at an altitude of up to 3000 m, with a 200 km range and up to 8 hours autonomy. Theseus-M will be support services at considerable distance from the take-off site, greatly increasing productivity (observed km2 per flight hour). Since loitering will be far away from the control station, the cruise speed has to be enhanced and the stall velocity will be higher than for S model.

Theseus subsystems and weight distribution

The four propellers, which deliver the thrust required to take-off vertically and to fly horizontally, are designed and positioned such as to provide the control moments required to maintain the vehicle stable along the entire flight envelope.

In addition to lithium-ion batteries, storing enough energy for 5-minute operations in hovering, Theseus is equipped with a last-generation endothermic hybrid propulsion system for long-endurance missions.



Services

Thanks to the special Theseus UAV features, most of the shortcomings related to the approaches currently adopted for critical infrastructures inspection/monitoring can be overcome, with the offer of lower cost, more flexible, safer and fast-response inspection & monitoring services:

Cost effectiveness.

The configuration allows the development of new services, very efficient in terms of engaged human resources, as the Theseus UAV control staff are not required to change their operational location even when Theseus UAV flies at great distances.

Performance.

The Theseus UAV features a sub-centimetre accuracy, which cannot be reached with other techniques such as satellite, whose accuracy is inadequate for the inspection/monitoring of infrastructures and the revisit time is not adequate; helicopters and airplanes cannot go as close to the target as needed to offer a comparable resolution.

Convenience & timeliness.

The complete system, carried to the site under control, can monitor a wide area around the site, avoiding operations slow down. Service will be organized to timely obtain the desired results and to minimize the customer involvement in operations.

Environment friendliness.

Lifting in the sky a 25 kg Theseus UAV requires much less energy than lifting a manned airplane or helicopter. Theseus infrastructure is environment friendly because it utilizes electrical energy and range extenders for long-distance missions, similarly to a very small hybrid car.

Work safety is one of the major concerns of regulators. One should expect that Theseus, relieving humans from dangerous tasks, would receive a high acceptance level.

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THESEUS PROJECT

Annex 1: Regulations

The European Commission has adopted EU rules to ensure that increasing drone traffic is safe and secure. The rules will replace existing national laws and apply to both professional operators and those flying drones for leisure. The new European drone rules will come into force as of July 1st 2020.

Drone operators will be required to register with national authorities.

Drones will need an e-identification or geo-fencing. Geo-fencing uses GPS/Galileo or radio frequency identification to define geographical boundaries and help prevent drones from flying close to sensitive locations such as airports and power plants.

Operators of drones weighing less than 25kg will be able to fly without prior permission under certain conditions; for example, the drone must not exceed an altitude of 120 m and the operator must keep it in his/her visual line of sight (VLOS) and away from people.

Three categories have been specified and Theseus can be operated in any of the three categories:

1. the open category includes low-risk drones. They do not require prior authorization by the competent authorities, nor a declaration by the drone operator before the operation takes place, but, if the weight is higher than 250 grams, they will need to be registered.
2. Specific operations category refers to drones used for mailing, infrastructure inspections and commercial or industrial operations which all require authorization. Drone operators must perform a risk appraisal according to the specific operations risk assessment (SORA) methodology. The requirements refer to line of sight operations (VLOS), maximum platform weight of 25 kg, maximum altitude 120 m a.g.l., limited flight over uninvolved people. Autonomous operations are excluded.
3. Finally, the highest-risk category is certified operations and covers the use of delivery, passenger drones or UAVs flying over large bodies of people.

Member states may define 'no-fly zones' where drones are not be permitted to enter, as well as areas where UAVs have more freedom, such as for beyond visual line of sight (BVLOS) flights.

Credit: U-Space Concept of Operations: A Key Enabler for Opening Airspace to Emerging Low-Altitude Operations

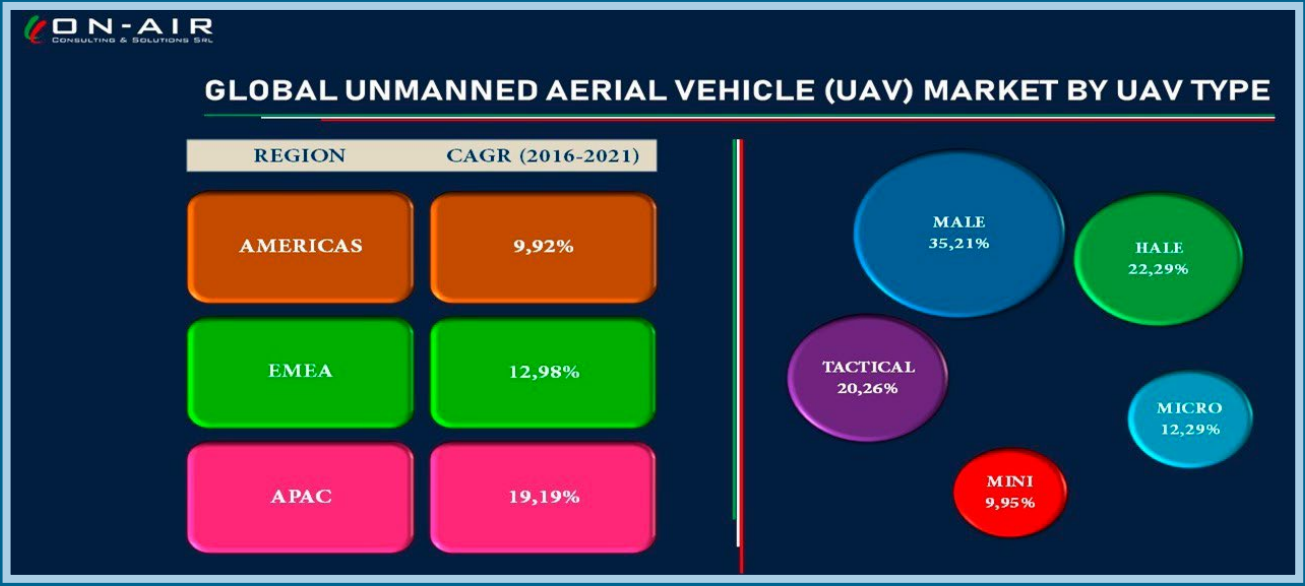
Annex 2: Market

Drones in Europe are a rapidly developing sector. It is expected that, within 20 years, the European drone sector will directly employ more than 100,000 people and have an economic impact exceeding €10 billion per year, mainly in services.

Commercial Drone Opportunities in Europe

While the US and Israel currently dominate the world markets for military drones, European commercial firms are growing, and law-makers opinion is that the consistent regulatory framework will encourage development. Technavio categorizes the global UAV market into five segments: (i)Medium-altitude long endurance (MALE) UAV, (ii) High-altitude long endurance (HALE) UAV, (iii)Tactical UAV, (iv) Micro UAV, (v) Mini UAV.

The top three revenue-generating UAV segments in the global UAV market are discussed below.



Medium-altitude long endurance (MALE) UAV

Medium altitude long endurance UAVs occupied a majority 35% of the global market in 2016. These aerial vehicles typically fly at altitudes greater than ten thousand feet for up to 48 hours. Some of the major MALE UAVs are IAI Heron and General Atomics MQ-1 Predator.

High-altitude long endurance (HALE) UAV

HALE UAVs are high-altitude airborne vehicles capable of uninterrupted long-distance flights. Global HAWK is one of the primarily used HALE unmanned aerial vehicles deployed by the US and its allied countries. These drones are capable of flying at altitudes up to 60,000 feet and can maintain an uninterrupted flight of 32 hours.

Tactical UAV

Tactical UAVs are most commonly used for short-range strategic missions. There has been a recent surge in the development and procurement of these tactical drones, which is driving the growth of the market segment".

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ON-AIR Consulting & Solutions
Viale Regina Margherita, 278
00198 - Roma
Italy

+39 06 889 78 701
info@onaircs.com
www.onaircs.com