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# Military Drones in Europe

Research Report by
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## The European Defense Market and the Spread of Military UAV technology

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# Abstract

This report provides the critical insights that national governments and defense companies need in order to navigate the European military drone landscape and offers a guide to their strategic planning and investment. Observing the international proliferation of military Unmanned Aerial Vehicles (UAV), also known as drones, the report puts together a comprehensive overview of military drones in Europe to conceptualize the diffusion of UAV technology and the competition dynamics on the European defense market. This political-strategic comparative analysis identifies and qualitatively assesses the key developments in the European military drone landscape. The report puts forward that despite the continuing proliferation of military drones in Europe, significant differences in military drone capabilities persist among European countries. Importantly, no European indigenous advanced drone has achieved full operational capability yet. In this respect, the North Atlantic Treaty Organization (NATO) and the European Union (EU), each via its own institutional logic, act as facilitators of the military technology diffusion through various enabling, funding, and networking mechanisms. The commercial sector further animates the European defense market in the category of smaller UAVs. The next-generation UAV technology driven by the increasing level of autonomy and the concepts of manned-unmanned teaming and swarming, together with the development of counter-drone systems, will characterize the future drone race on the European defense market.

The report proceeds in three steps. First, it maps the military drone capabilities in selected seventeen European countries with respect to all three main classes of drones: advanced, tactical, and small. The resulting drone clubs are based on countries' procurement strategies and defense cooperation patterns. Second, the report adds an institutional layer to the analysis. It assesses the strengths and weaknesses of both NATO and the EU in terms of existing institutional channels central to the development of UAV capability, especially in the context of the emerging EU-wide regulatory framework and its growing role in the defense and security domain. Third, the concluding analysis of future trends in the military UAV technology further elaborates on drone warfare and defense cooperation in Europe.


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# Executive Summary

This report provides a close look at the diffusion of military UAV technology in Europe. It identifies the key developments on the European defense market with respect to all main categories of military drones, based on their aerodynamic characteristics (advanced HALE and MALE, tactical, and small), and assesses the role of NATO and the EU in shaping the European military drone landscape. This institutional add-on reflects the context of the emerging EU-wide regulatory framework for drone market and the EU's growing role in defense and security. Ultimately, the report provides the critical insights that defense companies and national governments need in order to navigate the European military drone landscape and offers a guide to their strategic planning and investment.

Observing the international proliferation of military UAVs, the report identifies the key developments on the European defense market with respect to military UAVs by assessing the following criteria: 1) innovation; 2) NATO-EU interface; and 3) transatlantic framework of cooperation. This report has put together an up-to-date database that consists of open-sourced data about military UAVs in seventeen European countries, which constitutes the critical sample of the European military drone landscape. This made it possible to conduct a political-strategic mapping of existing national military UAV inventories, procurement practices, and future investment plans in unmanned technologies in Europe. The report then analyses existing NATO's and EU's enabling, funding, and networking mechanisms that are central to the development and spread of military UAV technology.

The findings indicate the following ten main take-aways:

1. **European countries lag behind the United States in the development of military UAV technology.** They have not succeeded in producing an operational advanced European drone yet. European countries continue to depend on the imports of American, and to a lesser extent Israeli, UAV platforms. The unhealthy condition of the transatlantic relationship further strengthens the call for strategic autonomy among the EU member countries.

2. **No country in Europe possess the largest HALE surveillance drone and only ten European countries are operating or procuring advanced MALE drones from abroad.** The United Kingdom is the only European country which has used armed drones in lethal operations. France will become the second European weaponizer of MALE drones.

3. **European countries have kicked off several projects aimed at developing advanced drones,** as the acquisition of foreign technology goes against **European industrial interests** and compromises EU's industrial autonomy. Today the most important one is the Eurodrone project, supported by the European Defence Agency, that may deliver a European MALE drone by 2025 and introduce more competition vis-à-vis the United States. France, Germany, Italy, and Spain are leading these development efforts. Yet, as of now, **Europeans have not moved from design concepts and demonstrators to operational platforms.**

4. The continuing **popularity of American small and tactical drones** among European countries is linked not only to the fact that they are **readily available, proven, and interoperable platforms,** but also to the European countries' **experience from Afghanistan** where they learnt how to operate them.

5. **Rapid developments and innovation driven by the commercial market are typical for the category of small and tactical drones.** Commercialization and the development of dual-use drone technology have changed how and where the military procures its equipment. This has resulted into the civilian sector setting the trends in lower classes of unmanned technology. **Yet the European drone market remains atomized and uncoordinated,** with a room for improvement with regard to civil-military relations.

6. **Congested European airspace poses major technical challenges to military drone operators.** Safety regulations and standards remain an obstacle for flying military drones in non-segregated European airspace, affect the acquisition process of UAVs from outside Europe, and make the development of certified UAV platforms more expensive.

7. **NATO and the EU act as important enablers of military technology diffusion,** each via its own institutional logic. On the one hand, **NATO focuses on military operational needs** and orients its support towards military expertise and interoperability, in addition to providing the strategic ISR drone capability

to its member countries. On the other hand, **the EU concentrates on developing financial and regulatory tools** to create, among others, a globally-competitive common European drone market and to improve the (autonomy of) European technological and industrial base. The interactions of these two institutional logics usually result in a competition for "customers", though often the NATO and the EU Staffs have difficulties to get a sense of what the other side is doing, where the compatibilities lie, and act upon them.

8. **The proliferation of military drones, including their armed and armable versions, will continue in Europe.** Some European countries have already been making sure not to miss the train with respect to the development of the future-generation combat UAVs. This could lead to further pressures on the EU from the civil society to adopt a common position on armed drones.

9. **The number of both civilian and military UAVs will increase in Europe.** While civil commercial users will be going bigger and higher, entering the MALE category (cargo, transport of passengers), the military will be getting multipurpose drones that are smaller, stealthier, able to fly longer, and equipped with stronger, multifunction sensors.

10. The European military and defense market will expand in the area of **counter drone technologies and unmanned maritime systems,** especially through NATO and the EU institutional cooperative mechanisms. The importance of these two regional security institutions will grow with the increasing sophistication of unmanned technology that already surpasses the expertise of individual countries (especially in case of smaller states).

The assessment of the key dynamics on the European defense market in the respective drone categories is summarized in Table 1. The resulting "good competition" indicates innovation leading to more and better UAV capabilities in Europe, complementarity of NATO and EU activities, and European countries thinking in a transatlantic context. In contrast, "bad competition" points to industrial protectionism, duplication of efforts, and uncoordinated NATO and the EU initiatives.

## TABLE 1 Key dynamics on the European defense market

| UAV category | Characteristics | Competition |
|---|---|---|
| **High Altitude Long Endurance (HALE)** | • Beyond resources of a single country<br>• NATO as principal enabler (AGS) | • **No competition**<br>• Monopoly of American platforms<br>• Future procurement of Triton by Germany and the United Kingdom |
| **Medium Altitude Long Endurance (MALE)** | • Clusters of countries around competing multinational projects<br>• Interdependence<br>• EDA as important enabler<br>• Military-industrial complex | • **Bad competition**<br>• Rivalry (national industrial policies)<br>• Eurodrone operational in 2025 (vs American MQ-9)<br>• EU defense policy instruments and EU strategic autonomy |
| **Tactical drones (TUAV)** | • Recently decreased interest in these platforms<br>• No mature thinking as to their future use<br>• Atomized and uncoordinated market | • **Weak competition**<br>• Potential for more NATO-EU cooperation, especially in the maritime domain<br>• Possibility to arm them |
| **Small drones (SUAV)** | • Commercialization (market-driven, SMEs)<br>• Growing dual-use drone market<br>• Civil-military relations: spill over from civilian sector to military; military as end-users<br>• Very dynamic but unstructured | • **Good competition**<br>• EU regulation and funding: emerging common European drone market<br>• American platforms remain popular<br>• Potential for more NATO-EU cooperation in developing counter-drone technologies |

**HALE UAVs**
European countries continue to rely on the technology from the United States as the company Northrop Grumman which produces Global Hawk and Triton platforms holds the monopoly on HALE drones. Importantly, acquiring and operating this strategic UAV capability has been beyond the resources of a single country. The only attempt at developing this large type of drone – the German EuroHawk program – was eventually cancelled in 2013. Yet NATO will soon provide its member countries with a strategic UAV capability thanks to the Alliance Ground Surveillance program. NATO will own and operate a fleet of five Global Hawks on behalf of all 29 member countries. The system is expected to be delivered in 2019 and be fully operational in 2020. In addition, in the near future Germany and the United Kingdom could become the first European countries to operate HALE drones, as both have recently announced the purchase of the American surveillance drone Triton.

**MALE UAVs**
In the MALE category, the picture is more diversified. Italy, the United Kingdom, France, Germany, Greece are already operating MALE drones, while the Netherlands, Spain, Belgium, Switzerland, and Poland are at various stages of the acquisition process. Thus only 10 countries in Europe have been able to afford advanced drones so far.

European countries remain dependent on the imports of this UAV technology from the United States and Israel. Despite several attempts during the 2000s and the early 2010s, no R&D program in Europe, either individual or collaborative, led to the production of a European MALE drone. Yet the European Council's announcement in 2013 that made a European MALE drone a capability priority has been considered a game changer. Thanks to this political impulse, Germany, France, Italy, and Spain formed a consortium in 2015-16 with an intention to develop together a European advanced drone – the European MALE RPAS or the Eurodrone, project – within the OCCAR framework and supported by the EDA's work on the air traffic integration of drones into European airspace. This effort is understood as an attempt to prevent further purchases of MALE drones from the United States and to allow European industries to access their own European market. Furthermore, Eurodrone was selected as one of the PESCO projects in November 2018 and will receive funding through this European Commission's new financial tools that aim to strengthen the EDTIB. In this context, the Eurodrone project plays a crucial role in improving the European industrial and strategic autonomy.

Yet, despite the new EU funding opportunities, it is unlikely that EU countries will change the way they procure drones in a short to mid-term.[1] Since Eurodrone, a European armable version of the American Reaper, is expected to be operational only in 2025, Belgium, France, Italy, the Netherlands, Spain, and the United Kingdom continue to buy American MQ-9s, albeit as an interim measure. Lastly, the United Kingdom is the only European country that flies armed drones. France has recently approved the option to arm its expanding fleet of Reapers. Furthermore, France, Germany, and Spain are working together on a new-generation combat drone. There are also other bi and multinational projects, such as the Franco-British, Franco-German, Anglo-Swedish, and French-led nEUROn projects, developing combat drone prototypes; all these combat/next-generation drone projects exist outside the EU and NATO institutional frameworks.

**TUAVs and SUAVs**
The situation in the categories of small and tactical drones (Class I and II) has been significantly different since the developments are driven by the civilian market, especially with respect to SUAVs. Although originally UAVs are military technology, today they are vastly outnumbered by civilian drones. These smaller drones are in general cheaper and more affordable, since the demand is higher and the customer base is diversified. The European militaries have been increasingly turning into an end-user that buys commercial, off-the-shelf, solutions.

The drone technology in Europe has turned into a lucrative business that keeps growing. Very often there is no clear-cut distinction between civilian and military technology, and the notion of dual-use drones has become popular. Apart from the military, these drones are operated by police, firefighters, farmers, delivery services, and private hobbyists. The European drone market is dynamic but atomized. The role of the EU as a policy entrepreneur has become central to the creation of a common European drone market. The European Commission has been working on a set of air space and market regulations targeting both drone manufacturers and drone service providers.

While American military platforms remain popular due to the legacy of the NATO mission in Afghanistan, numerous European countries produce and operate their own tactical drones, yet with a different success rate. Virtually all European armed forces have experience with military-grade small drones. The popularity of the smallest micro drones is growing among SOF in the form of personal reconnaissance systems. Tactical drones are finding their way into the maritime domain in the form of VTOL-capable UAVs, while several countries have expressed their interest into armable versions of TUAVs. Although countries would probably need an outside impetus from the EDA and NATO to coordinate their efforts in these two UAV categories, more market competition and more collaboration among NATO and the EU is expected in the future, notably with respect to counter-drone technologies and maritime unmanned systems (underwater, surface, and air vehicles).

The current situation in Europe points to an institutional division of labor: on the one hand, NATO has built a community of military experts and will acquire the strategic UAV surveillance capability; on the other hand, the EU has been supporting the development of European indigenous MALE drone capability and its integration into European airspace. However, this would be a simplistic observation. Both NATO and the EU have become important enablers of military technology diffusion by sponsoring R&T and R&D projects, shaping requirements and national standards in all UAV categories, providing procurement support, and creating networking fora. To improve capabilities of their respective member countries, they do not only facilitate the exchange of information, but they also create the knowledge that is further shared and implemented on the national level to allow for better cooperation and improved interoperability.

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# Abbreviations

| | |
|---|---|
| A2/AD | Anti-Access/Area Denial |
| AGS | Alliance Ground Surveillance |
| ATI | Air-Traffic Integration |
| ATM | Air Traffic Management |
| AWACS | Airborne Warning and Control System |
| AWS | Anti-Submarine Warfare |
| BVLOS | Beyond Visual Line of Sight |
| C2 | Command and Control |
| C4ISR | Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance |
| CARD | Coordinated Annual Review on Defence |
| CDP | Capability Development Plan |
| CMRE | Centre for Maritime Research and Experimentation |
| CBRN | Chemical, Biological, Radiological, and Nuclear |
| CNAD | Conference of National Armaments Directors |
| CODABA | Collaborative Database |
| CONOPS | Concept of Operations |
| C-UAS | Counter/Countering Unmanned Aerial Systems |
| EASA | European Union Aviation Safety Agency |
| EDA | European Defence Agency |
| EDF | European Defence Fund |
| EDIDP | European Defence Industrial Development Programme |
| EDTIB | European Defence Technological and Industrial Base |
| ELINT | Electronic Signals Intelligence |
| EU | European Union |
| EUROCAE | European Organization for Civil Aviation Equipment |
| EW | Electronic Warfare |
| FCAS | Future Combat Air System |
| FMS | Foreign Military Sale |
| FP | Framework Program |
| GCS | Ground Control Station |
| GPS | Global Positioning System |
| HALE | High Altitude, Long Endurance |
| HAPS | High Altitude Pseudo Satellite |
| ICAO | International Civil Aviation Organization |
| ISR | Intelligence, Surveillance, Reconnaissance |
| ISTAR | Intelligence, Surveillance, Target Acquisition, Reconnaissance |
| JCGUAS | Joint Capability Group on Unmanned Aircraft Systems |
| JISR | Joint Intelligence, Surveillance, Reconnaissance |
| JSTARS | Joint Surveillance and Target Attack Radar System |
| LAWS | Lethal Autonomous Weapon Systems |
| MALE | Medium Altitude, Long Endurance |
| MTOW | Maximum Take-Off Weight |
| MUC | MQ-9 Users Community |
| NATO | North Atlantic Treaty Organization |
| NAD | National Armaments Directors |
| NADREP | National Armaments Directors Representatives |
| NDPP | NATO Defence Planning Process |
| NIAG | NATO Industrial Advisory Group |
| NNAG | NATO Naval Armaments Group |
| NSPA | NATO Support and Procurement Agency |
| OCCAR | Organization for Joint Armament Cooperation, Organisation Conjointe de Coopération en matière d'Armement |
| OPA | Optionally Piloted Aircraft |
| PADR | Preparatory Action on Defence Research |
| PESCO | Permanent Structured Cooperation |
| PRS | Personal Reconnaissance System |
| R&D | Research and Development |
| RPA | Remotely Piloted Aircraft |
| RPAS | Remotely Piloted Aircraft System |
| R&T | Research and Technology |
| RUAS | Rotary Unmanned Air System |
| SACEUR | Supreme Allied Commander Europe |
| SCAF | Système de Combat Aérien du Futur |
| SEC | Single European Sky Expert Community |
| SES | Single European Sky |
| SESAR | Single European Sky ATM Research |
| SESAR JU | Single European Sky ATM Research Joint Undertaking |
| SHAPE | Supreme Headquarters Allied Powers Europe |
| SIGINT | Signal Intelligence |
| SME | Small and Medium-Sized Enterprise |
| SOF | Special Operations Forces |
| STANAG | Standardization Agreement |
| STO | Science and Technology Organization |
| SUAV | Small UAV |
| TUAV | Tactical UAV |
| UAS | Unmanned Aerial System |
| UAV | Unmanned Aerial Vehicle |
| UCAV | Unmanned Combat Aerial Vehicle |
| VTOL | Vertical Take-off and Landing |

## Section One:

# Report Context

Unmanned aerial vehicles (UAVs), in everyday language known as drones, have become an integral part of modern warfare. Thanks to their versatile employment, UAVs have become "a key capability in today's operational environment".[2] Usually deployed in "3Ds" – dull, dirty, dangerous – missions, drones are used to keep troops out of harm's way. Although UAVs are often labeled as emerging technology, it is because since the first drone flight during the First World War[3] this technology has matured, become more reliable, and is able to carry a great variety of sophisticated payloads. While for most of the 20th century drones supported artillery units, today they serve as an intelligence, surveillance, and reconnaissance (ISR) platform in all armed services.[4] Especially after the 9/11 attacks, some countries have weaponized their drones to use them in strike operations. For a long time, Europe has been considered a laggard in a field of military UAVs that depends on imports of foreign technology, and the continent was largely ignored in the analyses of the international studies expert community. However, over the past few years the EU has been developing regulatory tools to Europeanize the drone market and make it globally competitive. It has also started to financially motivate member countries and industry into defense research and development (R&D) projects that would strengthen the European Defence Technological and Industrial Base (EDTIB). And while NATO is about to acquire a fleet of large surveillance drones, rising national defense budgets of European countries will allow for greater investments into national military capabilities, including unmanned technology.

This report examines the diffusion of unmanned military technology in Europe to provide the critical insight that defense companies and national governments need in order to navigate the European military drone landscape and to offer a guide to their strategic planning and investment. Over the last decade both civilian and military drones have become very popular in Europe and this report examines how their use has spread across selected European countries. It provides a comprehensive overview of the current European military drone landscape and a qualitative analysis of the key dynamics in terms of R&D, procurement, and investment into military UAV technology and capabilities. This report captures the formation of various drone clubs in Europe, since whether the acquisition of advanced drones is successful and efficient largely depends on technological availability, industrial base, expertise, capacity to overcome technological and organizational obstacles, and domestic political institutions in a given country.[5] Importantly, this report looks at how NATO and the EU have facilitated the spread of unmanned military technology in Europe over the last decade.

**Research Questions**

- What are the key dynamics on the European defense market regarding military UAVs?
- How do regional institutions shape the European military drone landscape and supply what their member countries demand?
- Which trends are likely to affect the development, deployment, and employment of UAV capabilities by European countries?

Across the globe, countries have been systematically integrating unmanned technology into all branches of their armed forces.[6] The Global War on Terror has kicked off an unprecedented growth in drone deployment. For instance, as the United States increased its spending on drones from $363 million in 2001 to $2.9 billion in 2013, the American drone inventory grew by 4400% in less than a decade, accounting for one third of all military aircraft in 2012.[7] This increasingly dronified American strategy has influenced to a great extent the high demand for military drones elsewhere, including Europe. In 2017, the worldwide military UAV production amounted to $2.8 billion, projected to reach $9.4 billion in 2025, with the United States representing 77% of total military worldwide research and development (R&D) spending on drones.[8] Israel is one of the leaders in drone technology development and the largest military drone exporter. The commercialization of UAVs has allowed new industrial players to enter the military market and a larger number of countries to compete for technology and innovation leadership.[9] For instance, China's role on the global UAV market is growing, especially as it has found its niche in countries who cannot, or prefer not to, buy drones from either the United States or Israel (countries in the Middle East and Africa).[10] The United States, while remaining a leader in armed UAVs, has already lost its monopoly: in 2017, 30 countries had their forces equipped with, or were making efforts towards developing, armed drones[11], with China becoming the largest exporter of armed drones in 2018.[12]

This Europe-focused report assesses the recent developments in all major UAV categories and conceptualizes the competition dynamics on the Europe defense market. The report provides details about the proliferation of military UAVs on the national level (drone clubs in Section Two) and analyzes the institutional mechanisms central to the development of drone capability (NATO and the EU in Section Three). The final section outlines future trends in the military UAV technology and the transatlantic defense cooperation relevant to future requirements for unmanned military capabilities in European countries.

## Conceptual Note

NATO defines Unmanned Aircraft System (UAS) as "an aircraft which is designed to operate with no human pilot on board and which does not carry personnel."[13] The EU describes drones as "any aircraft capable of initiating flight and sustaining controlled flight and navigation without any human presence on board."[14] In general, the EU prefers to use the term Remotely Piloted Aircraft System (RPAS). This refers to a subset of UAS or even UAV,[15] since UAS includes both the airborne unmanned vehicle, which can be either remotely piloted or flies fully pre-programmed, and the ground control station (GCS) and communications.

Crucially, drones come in many shapes and sizes. They can be divided into categories according to numerous criteria, such as range, altitude, weight, endurance, payload, function, or employment. The simplest classification of drones distinguishes between armed vs unarmed and advanced vs basic drones.[16] Most often military drones are divided into large High-Altitude Long-Endurance (HALE) and Medium-Altitude Long-Endurance (MALE) drones,[17] tactical drones (TUAV), and small drones (SUAV). This report uses the classification of military UAVs developed by NATO and also used by the EU Military Staff (see Table 2, simplified).[18] Finally, the utility of UAV depends on the combination of a vehicle and its payload, that is the capability packages (such as video and communication systems, targeting mechanisms, and missiles) attached to unmanned aircraft, and the way they could be integrated into existing Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) environment.[19]

## TABLE 2 Unmanned Aerial Systems Classification

| Class | Category | Employment | Altitude | Range | Example |
|---|---|---|---|---|---|
| **Class III (> 600 kg)** | HALE | Strategic / National | Up to 65,000 ft | Unlimited (BLOS) | Global Hawk |
| | Strike/ Combat | Strategic / National | Up to 65,000 ft | Unlimited (BLOS) | Reaper |
| | MALE | Operational /Theatre | Up to 45,000 ft | Unlimited (BLOS) | Heron |
| **Class II (150 kg – 600 kg)** | Tactical | Tactical Formation | Up to 18,000 ft | 200 km (LOS) | Hermes 450<br>LUNA<br>Watchkeeper<br>Patroller |
| **Class I (< 150 kg)** | Small (> 15 kg) | Tactical Unit | Up to 5,000 ft | 50 km (LOS) | Scan Eagle<br>Fulmar |
| | Mini (< 15 kg) | Tactical Sub-unit | Up to 3,000 ft | Up to 25 km (LOS) | Skylark<br>Raven |
| | Micro (< 66 J) | Tactical Sub-unit | Up to 200 ft | Up to 5 km (LOS) | Black Widow; Black Hornet |


Photo from www.safran-electronics-defense.com

In general, while armies mostly use TUAVs and SUAVs and special operations forces (SOF) find very useful the smallest mini and micro drones, air forces employ the largest Class III UAVs (see Table 2). However, using only technical aspects to differentiate between small and tactical drones can be rather arbitrary. Given that endurance and the maximum take-off weight (MTOW) are the most significant features, the separation between TUAV and MALE is more evident and important than between TUAV and SUAV.

In case of ISR drones, as a general rule one has to look at what the information collected by a drone will do and where it will go. Ideally, ISR drones operate within a wider system architecture: satellites send pictures of lower resolution to a HALE drone which can search for bigger objects with wide-area sensors. This large drone flying at very high altitudes then can transfer information to a MALE drone to conduct closer surveillance and reconnaissance with radars. This information is then received by a TUAV that provides a detailed look with electro-optical sensors over a smaller area as part of tactical reconnaissance and usually refers to the commander up to the brigade level. However, the differentiation between strategic, operational, and tactical assets largely depends on who is the customer and whose decision-making will be improved (which level of command) with the information provided by the ISR drone. In general, while HALE drones provide situational awareness over longer periods of time and cover large areas fulfilling strategic needs, MALE drones are usually deployed for a specific theatre of operations. In reality, HALE drones provide mostly in-theatre situational awareness, while MALE and even tactical UAVs can have strategic effects if, for instance, employed smartly by smaller states who do not possess large advanced drones.

## TABLE 3 UAS per armed service

| Class III | | | Class II | | |
|---|---|---|---|---|---|
| **Platform (origin)** | **Service** | **Country** | **Platform (origin)** | **Service** | **Country** |
| **Reaper (US)** | Air Force | France, Italy, the Netherlands, Spain, United Kingdom | **Camcopter (Austria)** | Navy | Belgium, France, Norway |
| **SkyGuardian (US)** | Air Force | Belgium | **Hunter (Israel)** | Air Force | Belgium |
| **Protector (US/UK)** | Air Force | United Kingdom | **Ranger (Israel, Switzerland)** | Air Force | Finland, Switzerland |
| **Heron (Israel)** | Air Force | Germany, Greece | **Patroller (France)** | Army | France |
| **Harfang (France)** | Air Force | France | **Skeldar (Sweden, Switzerland)** | Navy | Germany |
| **Triton (US)** | Air Force | Germany (in progress) | **Luna (Germany)** | Army | Germany |
| **HammerHead (Italy)** | Air Force | Italy | **Searcher (Israel)** | Army | Spain |
| **Hermes 900 (Israel)** | Air Force | Switzerland | **Shadow (US)** | Air Force | Sweden |
| **Global Hawk (US)** | Air Force | NATO | **Hermes 450 (Israel)/ Watchkeeper (UK)** | Army | United Kingdom |

| Class I | | | Class I | | |
|---|---|---|---|---|---|
| **Platform (origin)** | **Service** | **Country** | **Platform (origin)** | **Service** | **Country** |
| **Raven (US)** | Rapid Reaction Forces<br>Army<br>Army, Navy | Belgium<br>Czech Republic, Italy, the Netherlands, Portugal, Spain, Sweden<br>Denmark | **Skylark (Israel)** | Army<br>SOF | Czech Republic<br>France, Sweden |
| **Puma (US)** | Army<br>Army, Navy | Czech Republic, Estonia, Germany, the Netherlands, Spain, Sweden<br>Denmark | **SpyRanger (France)** | SOF, Army | France |
| **Wasp (US)** | SOF<br>Army | France<br>Spain, Sweden | **Black Hornet (Norway/US)** | Army, SOF | France, Spain, United Kingdom |
| **Scan Eagle (US)**<br>**BlackJack** | Army<br>Army, Navy<br>Army | Czech Republic, Poland<br>Spain<br>The Netherlands, Poland | **Huginn (Denmark)** | Army, Navy | Spain |
| **Orbiter (Israel)** | Army | Finland, Poland, Switzerland | **Fulmar (Spain)** | Army, Navy | Spain |

Overall, UAVs can perform various functions in military operations. They offer numerous advantages compared to manned aircraft, since without a human element on board, only physical-material constraints can limit their maneuverability and performance. Drones have greater endurance in permissive environments, which is ideal for surveillance missions. They can collect an unparalleled amount of data and provide vast array of intelligence that contribute to greater real-time situational awareness (better than satellites do). A drone can provide communications relays and electronic support. Their greater precision minimizes civilian casualties (compared to missiles) and their acquisition costs make them less expensive than fighter jet or Airborne Warning and Control System (AWACS) aircraft. However, the hidden truth about drones is that they are far from being unmanned – they create substantial manpower burdens in terms of the supply of skilled teams to manage and operate drone missions.[20] For instance, French air force projects training of some 80-100 crews to operate its 20+ MALE drones.[21] Operating large drones requires also ground stations, bandwidth (satellite time to transfer data), and a trained imagery analysis team.

To conceptualize the developments on the European defense market with respect to military UAVs, this report uses diverse open-sourced data: 1) official publications by ministries of defense, such as national defense and security strategy, future procurement plans, and official press releases, and NATO and the EU public materials; 2) information collected during interviews with NATO and EU officials, as well as with national representatives from several member countries; and 3) the secondary sources: newspaper articles (such as Jane's, Defense News), reports and research papers by NGOs, institutes, and think tanks. The findings are based on the analysis of the following countries: Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. Annex 1 summarizes the current inventories of European military UAVs and the future investments into unmanned technologies per country. In addition to scanning for recent news releases, this report combined data from five different databases: 1) Fuhrman and Horowitz (2017) – drones per country between 2014-2016; 2) Center for a New American Security's Proliferated Drones – drone manufacturers per country; 3) International Institute for Strategic Studies' Military Balance (2018, 2019) – drones per country in 2017 and 2018; 4) Boosting Defence Cooperation in Europe (2018) – future investments into UAS; and 5) European Forum on Armed Drones – in-service drones per country.[22] Despite several divergences, these data helped create a solid picture of the current state of affairs on the European military drone landscape.

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**9** Keith Hayward, Unmanned Aerial Vehicles: A New Industrial System? (London: Royal Aeronautical Society, November, 2013), 3, https://www.aerosociety.com/Assets/Docs/Publications/DiscussionPapers/UASDiscussionPaper.pdf.

**10** Interestingly, the world-wide monopoly on the commercial drone market belongs to a Chinese private company DJI and their successful Phantom Drone platform (80% of all sold commercial drones).

**11** Elisa Catalano Ewers, Lauren Fish, Michael C. Horowitz, Alexandra Sander, and Paul Scharre, Drone Proliferation: Policy Choices for the Trump Administration (Washington: Center for New American Security, June 2017), 2, http://drones.cnas.org/wp-content/uploads/2017/06/CNASReport-DroneProliferation-Final.pdf.

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**13** NATO, STANAG 4671 - Unmanned Aircraft Systems Airworthiness Requirements, Annex A (Brussels: NATO, February 2017), A-5. In addition, Unmanned Aircraft System a) is capable of sustained flight by aerodynamic means; b) is remotely piloted or automatically flies a pre-programmed flight profile; c) is reusable; and d) is not classified as a guided weapon or similar one-shot device designed for the delivery of munitions.

**14** Council of the European Union, Common Military List of the European Union (Brussels: EU, 2017), https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1521098021619&uri=OJ:JOC_2018_098_R_0001.

**15** SESAR JU, European Drones Outlook Study: Unlocking the Value for Europe (Brussels: SESAR JU, November, 2016), 2, https://www.sesarju.eu/sites/default/files/documents/reports/European_Drones_Outlook_Study_2016.pdf.

**16** Advanced drones "can remain in the air for at least twenty hours, operate at an altitude of at least 16,000 feet, and have a maximum takeoff weight of at least 1,320 pounds". Matthew Fuhrmann and Michael C. Horowitz, "Droning On: Explaining the Proliferation of Unmanned Aerial Vehicles", International Organization 71 (Spring 2017): 401-2.

**17** Strike and combat drones are further developed MALE platforms with added stealth technology and armed payload. For instance, Predator is considered a MALE drone, while its spin-off Reaper is considered a strike UAV. This report refers to strike/combat drones in the discussion about MALE UAS for the sake of brevity.

**18** As defined in NATO, NATO Standard AJP-3.3 Allied Joint Doctrine for Air and Space Operations, Edition B, Version 1 (Brussels: NATO, April 8, 2016), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/624137/doctrine_nato_air_space_ops_ajp_3_3.pdf. The EU has developed its own risk and performance-based classification of civilian drones: open, specific, and certified category (see Section Three).

**19** Sensor packages usually represent at least one quarter of the UAV price per unit. See Hayward, Unmanned Aerial Vehicles, 6.

**20** Werner Dahm, "Drones Now and What to Expect Over the Next Ten Years," in Drone Wars: Transforming Conflict, Law, and Policy, ed. Peter Bergen and Daniel Rothenberg (Cambridge: Cambridge University Press, 2014), 348, 356.

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### Section Two:

# European Military Drone Landscape

This section provides a fine-grained qualitative analysis of the diffusion of military UAV technology in Europe. Using the open-source data about seventeen European countries, it examines procurement practices and future investment plans with respect to all main military UAV categories (advanced, tactical, small). The report's findings indicate that most European countries have already used and are interested in acquiring more military drones in the short to mid-term. However, there are significant differences in drone capabilities among European countries. While most of them have operational experience with small and tactical drones and some have industrial capacity for their production, only a handful of countries have acquired large advanced drones. While American (General Atomics Aeronautical Systems Inc, AeroVironment, Northrop Grumman Corporation) and Israeli (Elbit Systems, Israel Aerospace Industries) companies remain the key and largest international vendors of military drones, the European companies Airbus Defence and Space, BAE Systems, Dassault Aviation, Leonardo, Thales, and to a lesser extent Schiebel, ETM Penzberg, Safran, and WB Electronics, are the main industrial players in the region.

Most European countries cannot afford buying and operating advanced drones due to lacking expertise and infrastructure, let alone developing their own platform. Although the United Kingdom, France, Germany, Italy, and Spain (and to some extent Poland) have the industrial base and expertise to produce the full spectrum of military drone capabilities, even today they have to be team players when it comes to large drones, mainly due to economic reasons. Although the primary function of UAVs for European countries has been to provide surveillance and reconnaissance,[23] several countries are now looking into armable MALE drones or arming tactical UAVs.

These differing ambitions and resource limitations pushed some European countries to form various drone clubs (see TABLE 3). These mostly informal groupings offer numerous advantages to their participants, including but not limited to sharing of best practices, pooling resources, and discussing capability requirements. They facilitate knowledge sharing and mentoring relations between the have and the have-nots and enhance multinational solutions; some of them exist within either NATO or the EU frameworks.

## TABLE 4 Drone clubs in Europe

| Drone Club | Members |
|---|---|
| **Strategic enablers** | **NATO Alliance Ground Surveillance**<br>15 countries acquiring the AGS system: Bulgaria, Czech Republic, Denmark, Estonia, Italy, Latvia, Lithuania, Luxembourg, Norway, Poland, Romania, Slovakia, Slovenia, and the United States |
| **EDA drone clubbers** | **France, Germany, Greece, Italy, the Netherlands, Poland and Spain**<br>(officially known as the European MALE RPAS Community at the EDA) |
| **Eurodrone developers** | **France, Germany, Italy, Spain, Czech Republic** (since 2018); **Belgium** (observer since 2017) |
| **Future Combat Drone Visionaries** | **France, Germany, Italy, Sweden, Spain, Greece, Switzerland, United Kingdom**<br><br>Cooperative projects:<br>• nEUROn: France, Italy, Sweden, Spain, Greece, Switzerland<br>• Future Combat Air System (FCAS): France, United Kingdom<br>• Système de Combat Aérien du Futur (SCAF): France, Germany, Spain<br>• Tempest: United Kingdom, Sweden<br><br>Solo project:<br>• Taranis: United Kingdom |
| **MUCs** | **France, Italy, United Kingdom; observers: Netherlands, Spain, Belgium** |
| **MALE Weaponizers** | **United Kingdom, France (Italy?)** |
| **Third way goers** | **Germany, Greece** (lease instead of purchase) |
| **NSPA clubbers** | **Spain, Poland, Luxembourg, Italy, Belgium, Czech Republic, Greece**<br>(members of the NSPA UAS Support Partnership) |

## High Altitude Long Endurance UAVs

Only a handful of countries in the world have developed HALE UAV technology – namely, the United States with its Northrop Grumman RQ-4 Global Hawk, which was the first HALE developed in 2001, and Northrop Grumman MQ-4C Triton as the naval equivalent of the land-based Global Hawk; Israeli upgraded Eitan UAV, and China, who has several platforms of this category in development (Soaring Dragon and Cloud Shadow; CASC CH-7, expected in 2019; and Shenyang Divine Eagle, expected in 2020[24]). Russia is not there yet. American platforms continue to dominate this category of the largest drones. Opportunities to procure HALE drones and resources required to operate them are very limited. Notably, at the moment no European country possess, operates, or develops HALE drone on its own. This strategic capability remains beyond the resources and operational needs of a single European country. There were few attempts at developing this strategic UAV capability in the past. For instance in the 2000s, Thales made some HALE trials in the form of optionally piloted aircraft (OPA).[25] The infamous German EuroHawk program tried to adapt the American RQ-4E Global Hawk drone to European requirements, but it was eventually cancelled in 2013 due to problems with flight certification, without which the German HALE drones could not fly in Europe.[26] Recently Canada has shown interest in buying the German EuroHawk to explore the High North and monitor icebergs in the Arctic.[27]

European NATO member countries will soon acquire this strategic ISR UAV capability thanks to the NATO Alliance Ground Surveillance (AGS) program. The fleet of five NATO RQ-4D is based on the United States Air Force Block 40 Global Hawk adapted to NATO requirements for intelligence, surveillance, and reconnaissance capability to protect ground troops and civilians, control borders, provide maritime safety, contribute to the fight against terrorism and crisis management, and assist in humanitarian missions. These assets will be owned by all 29 NATO countries and operated by the Supreme Headquarters Allied Powers Europe (SHAPE).

Due to political and economic reasons there are fifteen acquisition nations (Bulgaria, Czech Republic, Denmark, Estonia, Germany, Italy, Latvia, Lithuania, Luxembourg, Norway, Poland, Romania, Slovakia, Slovenia and the

United States) and two provide in-kind contributions (France and the United Kingdom).[28] However, all NATO members contribute to the enabling infrastructure – AGS Main Operating Base, communications, and life-cycle support of the AGS fleet. NATO should have this system delivered in 2019, which will be followed by a system-level performance verification phase in 2020.

Although Global Hawk/ NATO AGS is presently the only HALE platform flying in Europe, this situation might change soon. Germany has announced that it would acquire four MQ-4C Triton, a Northrop Grumman's broad area maritime surveillance HALE drone,[29] probably to replace its maritime patrol aircraft performing ISR operations (not ASW missions since Triton will not be armed). The agreement with the United States is expected to be signed at the end of 2019. Triton would then become the core of the German project Pegasus, or Persistent German Airborne Surveillance System, with Airbus developing signal intelligence (SIGINT) sensors.[30] If the final contract is concluded in 2019, Germany would receive its first Pegasus drone in 2025.[31] Triton is the most developed version of Global Hawk and is used by the United States Navy; it will achieve its initial operational capability in 2021.[32] Several other countries had already showed interest in ordering it, among others the United Kingdom, Australia, and Norway. The British Royal Air Force intents to procure Triton as part of their ongoing replacement of the cancelled Nimrod maritime patrol aircraft for maritime surveillance.

While developing European-made HALE drones is less probable and less urgent from the perspective of military operational needs, companies like BAE Systems and Airbus have ongoing capability development projects for a solar-powered UAV, also called a stratospheric UAV or HAPS (High Altitude Pseudo Satellite) in the form of PHASA-35 and Zephyr programs respectively.[33] In a similar vein, the Thales Alenia Space (a joint venture between Thales and Leonardo) has been developing a stratospheric balloon demonstrator together with the Spanish satellite communication company Hispasat.[34] These UAVs can stay airborne for a year to deliver services like surveillance and communications relay. The British Ministry of Defence has already ordered three Zephyr S vehicles.[35]

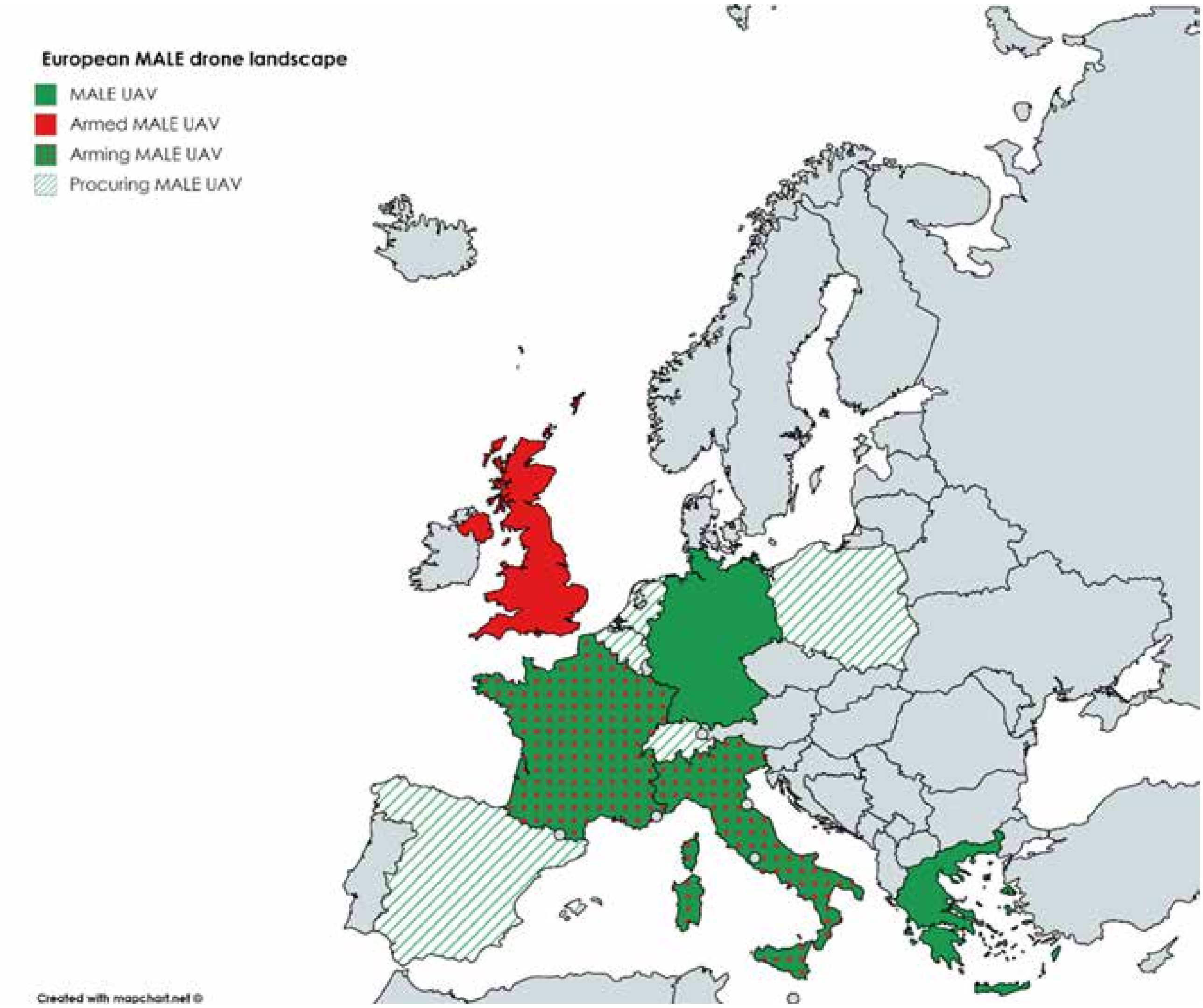
## Medium Altitude Long Endurance UAVs

In the MALE category of drones the main division line in Europe runs between the have (and aspiring) and the have-nots, as Figure I illustrates. There are currently five European states – France, Germany, Greece, Italy, and the United Kingdom – operating MALE drones. Four other countries – Belgium, the Netherlands, Spain, and Switzerland – are at various stages of the procurement process. Despite general expectations, Poland has not taken an official decision on getting MALE drones yet, but Poland's acquisition plans include a ZEFIR program for procuring this platform by 2022.[36] While only three countries prefer Israeli drones (Germany and Greece have Heron while Switzerland is acquiring Hermes 900), the rest operates (the United Kingdom, Italy, France) or is about to acquire (Belgium, the Netherlands, Spain) various versions of American MQ-9 made by General Atomics.

Most of European countries remain reluctant towards arming these drones and use them uniquely for ISR purposes. As of today, the United Kingdom is the only European country that flies the armed version of Reaper Syria deployed from Kuwait). However, in March 2019 (in Afghanistan, strike missions against ISIS in Iraq and France decided to arm its Reapers too in the context of its ongoing operation in Mali.[37] Paris has pledged to use it only in the context of armed conflicts where France is engaged and in a way that respects international law.[38]

Although Italy was the first European country to buy the American Predator, it has been waiting for the munition to arm its Reapers since 2015.

## FIGURE I European MALE drone landscape




Importantly, no flyable "made in Europe" advanced drone has been developed yet. In the meantime, apart from the usual suspects like the United States and Israel, these drones proliferated to China, Turkey, India, Iran, Pakistan, the United Arab Emirates, Saudi Arabia, Nigeria, or Russia, and many more are making serious efforts to develop or purchase MALE platforms. Although several R&D projects on a MALE UAV have started more than a decade ago, even major European powers have been laggards in the advanced drone technology. Put plainly, even if the Organization for Joint Armament Cooperation (OCCAR) manages to produce the first operational European MALE UAV in 2025, a European equivalent of American Reaper (see below), this would already be thirty years after the United States deployed a Predator for a surveillance mission in Bosnia.[39] However, European countries would have needed to operate large drones long before that. To overcome this capability shortfall, European countries have developed various procurement strategies to acquire large MALE drones in short to mid-term.

**Procurement strategies and future acquisitions of MALE platforms in Europe**

Several European countries decided to import foreign MALE UAVs mainly due to their pressing military requirements for a full spectrum of capabilities to perform ISR and ISTAR missions in Mali (France, Germany), in the Mediterranean area (Italy), and in the Middle East (the United Kingdom). The American MQ-9 Reaper has been the only ready-to-use interoperable MALE platform on the market. For instance, the French MALE UAV Harfang (based on Israeli Heron) took a long time to develop and had not been very successful as the four remaining Harfangs are now used only for training purposes. France is further strengthening its fleet of Reapers with six new MQ-9s by the end of 2019 and aims at having 24 MALE drones operational by 2030.[40] The French Reapers also support the permanent surveillance of the French territory for national security purposes.[41]

Belgium is procuring four unarmed SkyGuardian drones by 2025 to conduct persistent surveillance missions over the North Sea and the English Channel, to provide ISTAR contribution to national, NATO, and coalition operations.[42] This purchase was approved as foreign military sale (FMS) by the United States' State Department in March 2019.[43] SkyGuardian is a new version of MQ-9 Reaper, certified by General Atomics to fly in European airspace. Spain and the Netherlands will have their unarmed MQ-9 Reaper drones delivered by 2020 for homeland security, peacekeeping/enforcement and counterterrorism operations[44] and to contribute to NATO missions with this ISR capability.[45] Switzerland expects six unarmed Hermes 900 from Israel by 2020.

Having operated American MALE drones since 2007, the United Kingdom now aims to double the number of its MALE drones by 2025. Through the Protector program the United Kingdom has adapted the American Reaper to European standards (in essence, it is an armed version of SkyGuardian) and aims to acquire 16 certified Protectors for its Royal Air Force by 2024 and armed them with British Brimstone 2 missiles.[46] The British Tornado pilots from the 31st squadron are being retrained to operate Protector RG1 UAVs, since London has decided to eliminate Tornado jets from its air forces inventory.

However, fulfilling these urgent operational needs resulted in a political trade-off situation – the acquisition of an American platform often goes against national strategic and industrial interests. The limitations of relying on United States technology are especially visible in terms of the eroded sovereignty as sensor packages, maintenance, and training are dependent upon American industry, which results in significant operating costs and the loss of skills and jobs for European industry, not mentioning the loss of sovereignty as the United States Government retains some control over their deployment.[47] These arrangements, disadvantageous to European customers, could further strain the current poor status of transatlantic relations.

The German and Greek cases are different as they have decided to lease large drones, instead of buying them. For instance, Germany has leased five Israeli Heron TP until 2027. This more cost-effective alternative fulfils its operational needs for lesser money, until the Eurodrone project, with Germany in lead (see below), is completed.[48] The Italian case is also particular. Apart from operating a fleet of American Reapers, the Italian government has recently decided to procure eight P.1HH "HammerHead" MALE drones from the Italy-based company Piaggio Aerospace, even though the Italian Air Force is not interested in the HammerHead platform.[49] This constitutes a politically motivated purchase to save the company, as this only commercial manufacturer of military drones in Europe announced insolvency in November 2018 after the United Arab Emirates canceled the order of 8 P1HH (and bought Chinese drones instead), as well as after Italy's Ministry of Defence cancelled its request for 20 P.2HH.[50] The company might also be bought by the largest Italian defense firm Leonardo, though Leonardo is no longer interested in Piaggio's work on drones.[51]

Given the numerous acquisition plans in several European countries, the number of MALE drone operators is about to increase in Europe – the existing drone clubs should expect some newcomers. These drone clubs are informal groupings of countries who want to share best practices, enhance interoperability, pool resources regarding training and maintenance of UAV platforms, and mentor the future operators of MALE UAVs.

First, the MQ-9 Users Community, also called MUC, is formed by members from Italy, France, and the United Kingdom; and observers from Belgium, the Netherlands and Spain. Although the formation of a Reaper Users Group was first announced at the NATO Wales Summit in 2014, the countries decided to keep this group format at a national level (on the French and American insistence). The MUC working group meets twice a year to share best practices, while its steering committee of senior officers and program directors meets once a year. Their objective is to focus on existing synergies and capabilities to enhance interoperability and reduce overall costs. This informal community also serves as a tool of defense diplomacy for the Europeans vis-à-vis the United States and in negotiations with General Atomics. However, since each country has a separate bilateral FMS agreement with Washington, these European countries are contractually blocked from pooling the costs among themselves, though they do not need the US approval before the deployment in operations and their respective MALE drones can operate together while on mission.


Photo from www.p1hh.piaggioaerospace.it

Second, the so-called European MALE RPAS User Community was created in 2013 by France, Germany, Greece, Spain, Italy, the Netherlands and Poland.[52] In its function as a custodian of this European drone club, the European Defence Agency (EDA) provides a platform for European countries to share their operational experience with MALE drones (doctrines, procedures), exchange information and best practices on such systems, and identify options for pooling and sharing such as training, logistics, or maintenance. The EDA supports this community through the work on safety, regulation, and air traffic integration (ATI) into non-segregated space, detect and avoid sensors projects, and the study on joint production of MALE drones.

**Eurodrone project**

The long-term procurement strategy of France, Germany, Spain, and Italy, at least, is to develop a European indigenous MALE drone. Yet, there is a significant difference between developing design concepts and demonstrators (research and experimentation) and manufacturing operational platforms. While prototypes are easily built, turning them into products is much more complicated as it takes both resources and political capital.[53] At the same time, the attempts of these European countries were plagued by competing national interests, differing capability requirements, and industrial rivalry, especially between France, the United Kingdom, and Germany during the 2000s and 2010s.[54] The major unsuccessful

MALE UAV projects include Euromale (EADS, later renamed to the Advanced UAV initiative, 2004-2009),[55] Mantis (BAE Systems, 2007-2010),[56] Barracuda (EADS Germany and Spain, 2006-?),[57] Talarion (EADS France, Germany, Spain, 2010-2012),[58] Telemos (BAE Systems and Dassault Aviation, 2010-2012),[59] or HammerHead (Piaggio Aerospace, no commercial success). This points to the oligopoly of established defense aerospace centers on the European defense market.

**Major European industrial players in the military drone business**

- Airbus Defence and Space
- BAE Systems
- Dassault Aviation
- Leonardo
- Thales

Although France suggested that Europe should have its own version of American Predator already in 1995,[60] the breaking point in this long development process of European indigenously produced advanced drone arrived in December 2013 when the European Council approved a European MALE UAV project with an intention to have this new MALE drone operational by 2025. Back in 2014 called "Future European MALE project" or FEMALE,[61] this project became one of the military capability priorities, since the European Council considered advanced drones an urgent capability that would increase the EU strategic autonomy. Consequently, in May 2015, Germany, France, and Italy signed a letter of intent to jointly develop a European MALE drone. After Spain joined the project in 2016 and all participants agreed on their respective industrial shares, they launched a two-year definition study within the OCCAR framework and with the EDA supporting the work on ATI and certification. The main industry participants are Airbus (Germany, in lead), Dassault (France), and Leonardo (Italy).

This Eurodrone project aims to develop an advanced armable drone, a European equivalent to the American Predator/Reaper, mainly for ISR purposes and to support ISTAR missions. It should be fully certified to fly in non-segregated airspace [62] and be able to operate worldwide and independently from foreign technology. For instance, this platform will be supported by the European navigation system Galileo, since "UAVs are only as autonomous as the satellite navigation links they use".[63] Having completed the definition phase, the Eurodrone project is entering the development phase and since November 2018, it has also a status of a Permanent Structured Cooperation (PESCO) project. With Belgium as observer since 2017, this multinational project gained another member – the Czech Republic.[64] This is rather unusual, since Czechia does not have clear operational needs for this type of drones; its motives probably combine industrial interests, experience in cooperating on electronic warfare (EW) with Germany, and to certain extent, "drone envy".[65]

The first prototype flight of Eurodrone is planned for 2023. The operational Eurodrone in 2025 is expected to represent a counter-weight to American platforms and introduce more competition on the MALE UAV market. However, even though the program symbolizes the EU strategic autonomy, the future of Eurodrone could become uncertain due to potential cost overruns that might imperil the competitiveness of this platform – French Armed Forces Minister Parly even warned that "the program will not be pursued unless they [OCCAR] reduce their financial ambitions".[66]

The United Kingdom leaving the EU in 2019 will have negative consequences for the development of a stronger and integrated EDTIB and will undermine achieving greater strategic autonomy for the EU.[67] Yet, when it comes to UAVs, the United Kingdom has not been the leader in multinational R&D. It does not participate in either the Eurodrone project or any of the EDA studies on enabling capabilities for MALE UAVs. This is mostly because the British armed forces have a high degree of interoperability with the American systems and have been using American drone platforms, for which the United Kingdom managed to secure the transfers of key technologies from the United States in the late 1990s.[68]

**Developing European combat drones**

Apart from procuring American or Israeli drones and developing (in a more or less cooperative way) the first European MALE surveillance drone, some countries also work on unmanned combat air vehicle (UCAVs). These bi- and multinational projects are kept secret and mostly outside NATO and EU frameworks. Since their main features include stealth and autonomy, not the ability to fly in non-segregated airspace, the EDA's mandate in the ATI field does not cover the development of UCAVs. These projects also aim to enhance both technological and industrial independence from the United States.

First, in 2003 France launched the nEUROn project, which was later joined by Greece, Italy, Spain, Sweden and Switzerland and their contractors (Dassault Aviation, Alenia Aermacchi, Saab, Airbus Defence and Space – Spain, RUAG, and Hellenic Aerospace Industry). This project aims to develop a European technological demonstrator of a future combat drone.[69]

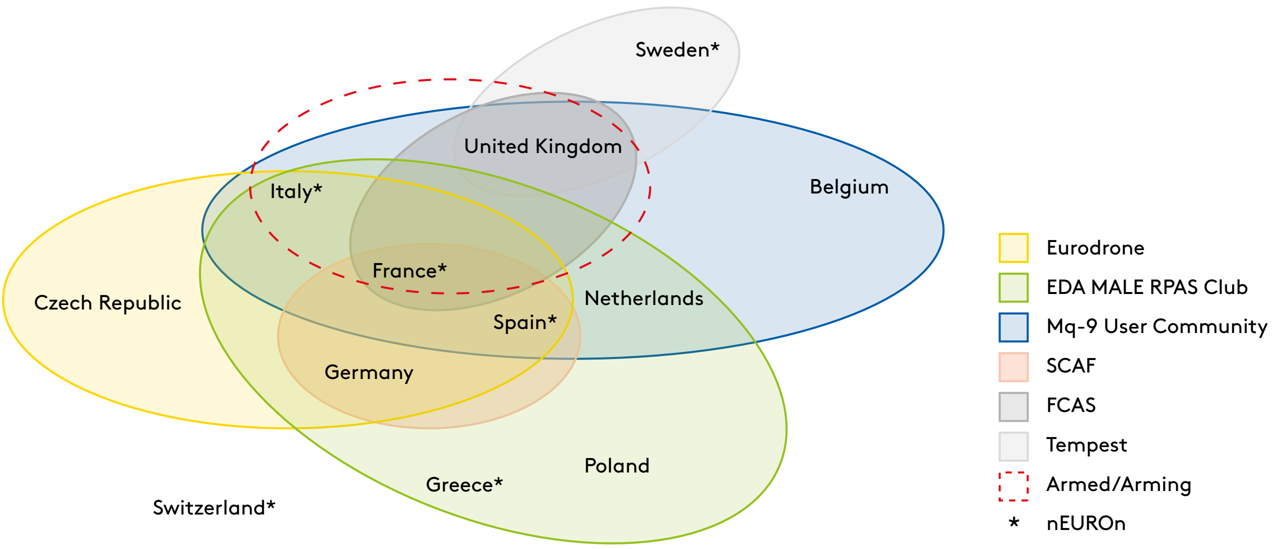
Second, the joint Anglo-French Future Combat Air System (FCAS) project launched in 2014 with the two main contractors BAE Systems and Dassault Aviation aimed to develop a joint combat drone demonstrator as part of the sixth-generation technology. The United Kingdom had previously worked on its own UCAV demonstrator prototype Taranis, developed by BAE Systems, which was meant to contribute to the advancement of the FCAS project, similarly as Dassault nEURON demonstrator (though the position of other countries participating in the nEUROn project is not known). While both governments were supposed to invest around 2 billion EUR in the next development phase,[70] due to the Brexit crisis, this project has been recently "downgraded to a technological demonstration".[71]

Third, in April 2018 France (Dassault) turned to Germany (Airbus) with the intention to collaborate on a new Système de Combat Aérien du Futur (SCAF, or Future Combat Air System, also abbreviated as FCAS). This program aims to develop strategic capability by 2040 by combining a sixth-generation manned fighter aircraft and unmanned vehicles. While France leads SCAF, Germany remains in lead of the European MALE drone project. Spain has joined this program in February 2019.[72] In turn, the SCAF framework agreement that includes the legal commitment of three participating countries and their industrial counterparts Airbus and Dassault was signed in June 2019.[73] SCAF will eventually replace German Eurofighter, French Rafale, and Spanish F-18 Hornet. Despite the initial enthusiasm, the program has been delayed due to disagreements over licensing and arms export policies of participating countries and national defense industrial grabbing.[74]

At the same time, after negotiations with France and Germany to join SCAF broke down, the United Kingdom launched a "Tempest" sixth-generation fighter program to replace its Typhoons with the new fighter jets by 2040.[75] Tempest's technology includes optional manning, i.e. the ability to fly unmanned if required, and the capacity to direct swarms of drones.[76] According to the latest developments, in July 2019 Sweden joined Tempest, thus partnering BAE Systems and Saab.

To summarize, the core development efforts in the MALE drone category in Europe is formed by France, Germany, Italy, and Spain (see Figure 2). Furthermore, the current projects developing fighter aircraft of the future, FCAS, SCAF, and Tempest point to the trend of optional manning and/or manned-unmanned teaming: unmanned technology is becoming an integral part of the next generation combat capabilities.

## FIGURE 2 European MALE drone clubs




## Tactical and Small UAVs

While large surveillance HALE and MALE platforms are used by Air Forces, European armies and navies mostly operate Class I and II (tactical and small) drones. In contrast to the situation in the advanced drone category, a larger number of countries in Europe possess domestic industrial base to produce TUAVs and SUAVs. Yet the American and Israeli platforms remain popular in Europe (Table 4).

## TABLE 5 The most popular foreign TUAV and SUAV platforms in Europe

| | |
|---|---|
| United States | RQ-11 Raven, RQ-20 Puma, RQ-21 Blackjack (former ScanEagle), RQ-7 Shadow |
| Israel | Skylark, Searcher, Hunter, Ranger, Hermes 450 |

The reason for this can vary, but most often the preference for the American technology has been related to countries' operational experience in Afghanistan. For instance, the United States command would donate small UAVs to several countries through the Foreign military aid (for instance the case of ScanEagles for Czechia in 2015).[77] Apart from financial and time-related reasons, European countries might purchase drone technology outside the EU to by-pass EU defense procurement regulation and get better off-set deals, which the EU regulation prohibits to eliminate distortion on the EU market.

Apart from operational needs, the other main factor in deciding on what kind of UAV to procure and from which country is whether 1) the technology is verified and proven, and 2) it can be quickly integrated into the existing systems and connected through datalinks, i.e. it has a high level of interoperability with the already built infrastructure and interface. This is what the American drones usually do have in contrast to Israeli drones. Lastly, countries make their procurement decision considering the overall costs of the unmanned system in view to find a cost-saving solution. For instance, Raven and Wasp UAV platforms use the same GCS, both manufactured by the American company AeroVironment.

TUAVs developed and produced in Europe are not rare, since this category of drones does not necessitate complex intelligence management and integration systems (in contrast to advanced MALE UAVs). Nevertheless, there are still only few indigenous European military tactical drones (see TABLE 5).

## TABLE 6 Selected TUAV platforms developed in Europe

| | Country | Platform | Company |
|---|---|---|---|
| **Tactical drones (Class II)** | Austria | Camcopter S-100 | Schiebel |
| | France | Patroller | Sagem |
| | Germany | LUNA | EMT Penzberg |
| | Greece | HAI Pegasus II | Hellenic Aerospace Industry |
| | Italy | Falco; AWHERO | Leonardo |
| | Spain | Atlante | Airbus |
| | Sweden | Skeldar V-200 | Saab (together with Swiss UMS) |
| | United Kingdom | Herti<br>Watchkeeper[78] | BAE Systems<br>Thales |

There are currently no politically visible multinational capability development projects in these smaller UAV categories. Rare examples of cooperation include binational production, such as UMS Skeldar (a joint venture between UMS Aero Group and Saab) and Ranger (a Swiss-Israeli joint venture between RUAG Aviation and Israel Aerospace Industries), or joint procurement through NSPA (see Section Three). Belgium, the Netherlands, and Luxembourg cooperated closely to purchase RQ-11 Raven together in 2016, and in 2018 Belgium and the Netherlands declared their interest in cooperative development of tactical unmanned capabilities.[79] In other cases, countries missed the opportunity to act jointly, such as when the Netherlands and Poland each procured separately RQ-21 Blackjack without coordinating their respective purchases, or when Denmark bought Puma drone shortly after Sweden purchased the same system.[80] However, there might be further tactical opportunities for multinational cooperation on the European level, especially in training. Indeed, the EU's first Coordinated Annual Review on Defence (CARD) trial showed that almost half of EU member states were interested in working together on tactical and small drones.[81]

The current lack of cooperative initiatives in multinational capability development projects could be related to the lack of clarity about the utility of tactical drones. Although countries remain interested in TUAVs, their thinking is not matured enough. While the demand in the 2000s was concentrated on TUAV and MALE drones, in the past years there has been less operational need for TUAVs. The military deem them as flying either too high or too close (and are thus large and visible) and because of their requirements for take-off and landing. Some national projects of TUAV development were cancelled because these UAVs were considered just too big (such as the program Sojka in Czechia). Nowadays they are mostly used for training. However, one of their main advantage in comparison to SUAVs is that since they are bigger, they can carry larger payloads and thus can be armed. Countries like Poland and Czechia are already looking into this option.[82]

The military wants to find a more effective role for TUAV platforms. The recent trend points to the rising popularity of tactical drones in the maritime domain. Popular maritime platforms include ScanEagle, BlackJack and, Skylark-C (fixed wing) and Camcopter S-100, Skeldar, and MQ-8C FireScout (rotary wing/ unmanned helicopter). For instance, France's Safran has been developing its own Patroller tactical drone for maritime surveillance.[83] Safran also cooperates with Airbus Helicopter and the Naval Group to develop a naval drone system that could be used for coastal border surveillance, policing, and infrastructure protection. This is part of France's larger plan to equip its Navy with unmanned systems, the Système de Drones Aériens de la Marine, or SDAM, program.[84] This increasing interest in tactical vertical take-off and landing (VTOL) drones may result in a new category of drones in making: Rotary Unmanned Air System (RUAS), such as Leonardo's AWHERO unmanned helicopter for both land and naval operations,[85] as they are more easily operated from a ship deck. Both Leonardo and Safran are involved in the OCEAN2020 program financed by the EU. The EU already uses these tactical VTOL drones for border control. In addition, VTOL drones with their speed and endurance could also be interesting for the army. TUAVs usually need catapult and landing runway, while VTOL-capable drones are not limited by requirements for conventional take-off and landing. Despite the growing utility of tactical

VTOL drones, endurance and payload remain the most important features. These also determine the trade-off between size and noise: smaller the payload, smaller the size, smaller the noise. And smaller is getting popular.

In 2018, out of more than existing 200 drone projects in Europe, more than 60% focus on SUAVs.[86] The use of SUAVs is growing among the European armed forces. While some European countries continue to buy American systems, aerospace companies across Europe, especially in cooperation with small and medium-sized enterprise (SMEs), have produced different types of SUAVs in the recent years (see TABLE 6). In contrast to advanced and tactical drones, the developments and spread of Class I UAVs, small, mini, and micro/nano drones, have been driven by the commercial entities. These dynamics are characterized by the highest diversity of users and services as the barriers to entry on the small drone market are significantly lower than in case of larger UAVs. This has been facilitated through the development of dual-use drone technology, economic opportunities, and opening of regulation on the emerging common European drone market. SUAVs have become ubiquitous since technologies with more than just military purpose tend to spread more quickly.[87]

## Table 7 Selected SUAV platforms developed in Europe

| | Country | Platform | Company |
|---|---|---|---|
| **Small drones (Class I)** | Denmark | Heidrun; Huginn | SkyWatch |
| | France | SpyRanger | Thales |
| | Germany | Aladin | EMT Penzberg |
| | the Netherlands | HEF32 | High Eye |
| | Poland | FlyEye | WB Electronics |
| | Portugal | AR4 | Tekever Autonomous Systems |
| | Spain | Fulmar<br>Atlantic; Tucan | Wake Engineering<br>SRC Everis |
| | Switzerland | eXom; eBee | SenseFly |

This has resulted into an important change in how and where the military procures its equipment. Although UAVs come originally from the military, today it is the civilian sector which sets the trends in unmanned technology. In the past, the military usually defined requirements and industry in turn delivered prototypes. The situation in the Class I drones has reversed: drones are produced commercially, the unit cost is reducing, and the pace of innovation is very high. The military is being surpassed by a private sector that is faster, cheaper, more innovative, and stronger in nano-technologies. This is not surprising since innovation and research in the military is slow, expensive and requires higher sophistication and a greater range of functions, not to mention the process of testing, validation, and verification against cyber threats. The import of commercial technology into the military is usually done through militarization of drones by the private companies themselves who produce drones. However, very often private commercial industry is reluctant to directly cooperate with defense ministries on R&D of military technology due to ethical concerns and security restrictions. There is a large room for improvement on the defense market when it comes to the coordination between national governments and competitive manufacturers.

Although SUAVs are not armed and can carry minimum payload, the current trend points towards the development of even smaller UAS with higher performance. They remain extremely useful in providing situational awareness and thus reducing risks to troops. The American Puma and Blackjack platforms are extensively used in expeditionary missions among SOF, paratroopers, and rapid reaction forces. Currently, more militaries are equipping their troops with "spy drones", the smallest SUAVs, which are operated on the platoon and squad level. To detect threats, SOF use tiny pocket-sized helicopter drones with Beyond Visual Line of Sight (BVLOS) capability that are also called personal reconnaissance system (PRS).[88] Nano-UAV Black Hornet, produced by American company FLIR (originally manufactured by a Norwegian company Prox Dynamics, which was acquired by FLIR in 2016), is the only military-grade and military-certified drone in this category and its use has spread to already 30 countries, including France, Norway, Spain, the United Kingdom[89] or the United States army who is currently procuring 9,000 of Black Hornets.[90]

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**Section Three:**

# NATO vs the EU – Defense vs Economy

The two most important security institutions in Europe – NATO and the EU – can qualitatively shape the European military drone landscape and help their member countries close their capability gaps. Each of the two institutions has a specific set of strengths that derives from a distinctive institutional logic (see Table 7): while NATO is driven by defense interests and military operational logic, the EU follows economic interests and market logic. On the one hand, NATO works on military standards for all types of military UAVs, builds expert communities, provides procurement support, and acquires a fleet of HALE UAVs. On the other hand, the EU finances drone-related R&D projects, focuses on air traffic integration of drones into European airspace, supports countries using MALE UAVs, and facilitates contacts between civilian and military experts.

In this context, NATO's core function is to improve interoperability of the allied armed forces. Its advantage lies in the detailed, systematically performed strategic defense planning – NATO Defence Planning Process (NDPP) – that clearly identifies military requirements that the Alliance needs from each member country. Following the military operational logic, NATO makes sure that capability development projects, either individual or multinational, are linked to the NDPP that defines capability targets required from each member country. The NDPP is the backbone of all capability development programs, including ad hoc multinational projects.

In contrast, the EU offers a range of funding opportunities to incentivize innovative R&D projects; since 2016, it has been directly targeting the defense and security domain. The EU's main goal is to strengthen the defense technological and industrial base, create common European drone market to maximize its economic potential, and decrease the EU's dependence on foreign military technology, i.e. the overall goal of strategic and industrial autonomy. To do so, the EU has been developing an EU-wide regulatory framework addressing both drone manufacturers and drone operators. In innovatively combining product legislation and aviation legislation, the EU aims to develop a common European drone market, thus ensuring product safety and ATI regulation for operating drones in European airspace. The tendency of ever-expanding Euro-competencies also plays role in the development of the EU drone policy.

Moreover, since 2016, the EU has tried to align its economic interests with the defense needs. The European Commission has made available large sums of money from the EU budget for defense related projects, ideally linked to the Capability Development Plan (CDP) and with high participation of SMEs. This represents an important alternative for European NATO member countries. However, the EU does not deal with the development of military standards. This has to do with industrial and market interests: introducing civilian and dual standards in the aviation community means to be one step ahead of the military and to create advantage for the European airspace industry. In addition, the EDA acts as a unique interface for civilian-military coordination, thanks to its research and technology (R&T) projects.

## Table 8 NATO and the EU: comparing strengths and weaknesses

| NATO<br>Defense, military operational logic | European Union<br>Economy, market logic |
|---|---|
| **Military expertise**<br>- Long tradition and trust<br>- Science and Technology Organization<br>- NATO Support and Procurement Agency<br>- Military standards<br><br>**Transatlantic links**<br>- The American intellectual leadership<br><br>**NATO Defence Planning Process**<br>- Clearly defined military requirements<br>- Hook for multinational projects<br><br>**Prestige and high political visibility**<br>- Improved mechanisms for creating ad hoc collaborative projects<br><br>**Acquisition of NATO-owned strategic UAV capability**<br>- HALE UAS for 29 countries<br>- Backbone ISR architecture | **Financial resources and institutional incentives promoting multinational cooperation**<br>- New EU defense funding to develop more European-made capabilities<br>- PESCO as politically attractive and legally binding multinational cooperative framework<br><br>**Regulatory tools**<br>- European market consolidation to build a competitive European industrial base<br>- macroeconomic benefits<br>- one regulatory framework for civilian drone manufacturers and service providers<br><br>**Civil-military interface**<br>- dialogue on standards, and ATI and UTM/ATM regulation<br><br>**Custodian of the MALE drone community**<br>- EDA supports information exchange among MALE-operating countries, works on ATI of drones |
| **Weaknesses:** | |
| **Lack of resources**<br>- NATO does not fund multinational projects<br>- Understaffed capability development personnel<br><br>**Culture of secrecy**<br>- over-classification causes limited sharing with non-NATO countries and the EU<br><br>**Perception problems**<br>- NATO is not involved only in HALE-type UAVs<br><br>**Missing interoperability mechanisms**<br>- no NATO-level verification procedure for certification and STANAG implementation | **Lack of military expertise and experience**<br>- heavy focus on civilian and hybrid standards and R&D projects<br><br>**Transparency issues**<br>- Project selection and restrictive scope of eligible projects (PESCO and PADR,EDIDP)<br>- Follow-up procedure for tangible deliverables (PESCO)<br><br>**Institutional stovepipes**<br>- communication problems among European institutions (Council, Commission, European External Action Service, EDA) |

While the EU builds its attractiveness on financial incentives, NATO scores high with its seventy-year long tradition and experience in military cooperation and standards. This is especially important for smaller states that often lack military expertise and industrial capacity. The transatlantic link to the American technological and military know-how is another important asset that NATO provides to European countries. However, while NATO is a stable and reliable organization with integrated command structure and a clear set of military requirements, it does not have resources, time, or risk-tolerance to be innovative. On the other hand, although less active than the EU in the field of R&D activities, NATO's NSPA provides a large portfolio of procurement services. NATO itself is procuring a fleet of strategic ground surveillance drones. In contrast, the EU does not possess own military capabilities; its agencies like Frontex lease them from member states.[91]

Multinational cooperative projects further crystalize the difference between these two institutions. NATO's defense logic encourages multinational cooperative projects based on military requirements drawn from the NDPP. The incentives are therefore explicitly linked to capability shortfalls and priorities (NATO tells countries which capabilities they need). In contrast, the EU's economic logic uses financial incentives such as grants and co-financing mechanisms and then expects project proposals from consortia of states and defense companies (the EU tells countries how much money they can save).

The rest of the section further details the institutional mechanisms in both NATO and the EU that facilitate the spread of military drone technology and help member countries meet their national capability needs, see TABLE 8.

## TABLE 9 NATO and EU institutional mechanisms

| Mechanism | NATO | European Union |
|---|---|---|
| **Enabling** | STANAGs (all types of UAVs, JISR)<br>NSPA UAS Support Partnership<br>Air Traffic Integration of HALE UAV (together with EUROCONTROL) | Airspace regulation (including ATI of military drones)<br>European drone market regulation (civil UAVs) |
| **Funding** | AGS<br>NIAG Study Groups | R&D projects funded through PADR and EDIDP, EDA operational budget |
| **Networking** | STO, industry, HALE experts<br>National military experts | European MALE RPAS User Community, industry exchange platform, civil-military dialogue |

## Enabling Mechanisms

### NATO

**Military expertise**

All the work related to military capabilities in the NATO structures is geared towards improving interoperability, i.e. the ability to use national assets jointly in NATO missions. NATO produces knowledge that drives nations' own activities. It does so in various ways, such as developing military standards (both technical and operational) and doctrines, organizing exercises to validate against standards (for instance, Unified Vision), assisting with capability roadmaps (international staff members known as Capability Area Facilitators). When it comes to capability development, the central governing NATO entity is the Conference of National Armaments Directors (CNAD), where National Armaments Directors (NADs) and their representatives (NADREPs) oversee the work of the three main armament groups (air force, navy, and army).

NATO has a long tradition and experience with developing military standards; its Standardization Agreements (STANAGs) are used and widely respected by both military and industry.[92] The UAS standardization work is centered in the Joint Capability Group on Unmanned Aircraft Systems (JCGUAS), historically located under the NATO Naval Armaments Group (NNAG), one of the CNAD main armament groups. It further collaborates with Military Committee's Air Standardization Board, NATO Standardization Office, Aviation Committee that regroups both civilian and military stakeholders and its subgroup Air Operations Support Working Group.

JSGUAS is composed of technical syndicate and operational syndicates. The former deals with the standardization of platform airworthiness and command and control (C2) infrastructure, while the latter works on doctrines for employment and terminology. Both components are marked by a heavy American presence. The Maritime Tactical Joint UAS Working Group led by Canada is located in-between the syndicates. The Flight in Non-Segregated Airspace Subgroup of JCGUAS is led jointly by the United States and France. The main NATO JCGUAS/NNAG work streams include capability integration (technology development), UAS interoperability (C2, functional and technical STANAGs), operational integration (force architecture), and UAS acceptance (partner countries). For instance, the set of UAV airworthiness STANAGs is more than 600 pages long.[93]

Regarding intelligence, surveillance, and reconnaissance (ISR), NATO started to develop joint ISR architecture – aimed at developing a common situational awareness picture based on different sources – only after the 2011

Unified Protector operation in Libya. This included formulating a NATO JISR policy (doctrine development, transfer of authority) and capability development (infrastructure, standards for interoperability). NATO's work on ISR thus informs member countries on which national assets the Alliance needs and how countries can plug them into the common architecture to enable data and intelligence sharing. The acquisition of a HALE unmanned system, the Alliance Ground Surveillance program, is an important step ahead and a central part of NATO JISR as it will provide SACEUR with own ISR assets in a similar way as NATO's AWACS fleet does.

NATO creates environment and conditions for interoperability and STANAGs underpin these peacetime efforts. There are however many obstacles on both institutional and national level. First, if STANAGs are too tight, national industry might ignore them and go their own way, while countries are not incentivized to implement them. The fragmented state of European defense market also hurts the STANAG implementation. Second, if a standard is too loose, it misses its purpose as it opens the room for wide interpretation. The result of this vicious circle is that even though there is consensus on having a standard, it does not necessarily translate into maximized interoperability. NATO does not have the capacity or mandate to verify whether STANAGs are properly implemented and followed – validation and certification is a national responsibility.

Apart from standardization, NATO further promotes interoperability through enabling the creation of multinational projects. CNAD, although without decision-making power, provides a forum for policy level discussion on NDPP targets and priorities and informal meetings of specific subsets of NADs and NADREPs from interested countries. Contrary to the popular perception of CNAD being just a talk shop, high-level letters of intent and memoranda of understanding signed by defense ministers are born in CNAD during these discussions. The recently created Multinational Capability Cooperation Unit in the Defence Investment Division at the NATO HQ aims to channel the national efforts and facilitate these projects. The NDPP is a backbone and serves as an important justification for creating potential multinational capability development projects.

**Procurement support**

NATO has consolidated and centralized logistics management functions into one procurement agency. The NATO Support and Procurement Agency (NSPA) is an acquisition agent with over 60 years of experience that does not offer but provides services; it is a fully customer-funded agency, operating on a "no profit–no loss" basis. Some 1370 NATO employees with industry and military background help the Alliance, the Allies, and partner countries with acquisition and design of systems (new helicopters, air-to-air refueling), prepare procurement contracts with industry and maintenance packages on future upgrades, support training (navy and land helicopter simulators), provide operational and systems support and services,[94] and assist with decommissioning and destroying old equipment. The NSPA also function as a "military eBay" for spare parts. Over 90% of NSPA activities comes from the NATO member countries, but SHAPE tends to be the NSPA's largest customer (mainly logistics planning support to NATO military authorities). In general, smaller countries rely on the help of NSPA experts with acquisition contracts, while larger countries use the NSPA for in-service support.[95]

Over the last decade the countries' interest in NSPA services has increased considerably. In 2017 the NSPA worked on contracts of an overall value of 4.8 Bn EUR and supported more than 90 different weapon systems.[96] This is due to several factors. First, since the adoption of the NATO Defence Investment Pledge, the governments have been putting more money into the defense budgets. Yet, spending defense money effectively is not easy, it is usually logistics-heavy and time-consuming. Second, buying sophisticated military technology requires complex acquisition process; since the post-Cold War downsizing included also personnel at ministries of defense, countries suffer from the lacking expertise. Third, the NSPA has become very useful for the growing number of multinational contracts as it achieves lower per unit cost, simplifies the multinational acquisition process and the communication between the participants, and facilitates the transfer of technological knowledge to the whole user group of countries. Fourth, the NSPA assists with foreign military sales from the United States. In this context, the NSPA also facilitates sharing of weapons among allies. In the case of the precision guided munitions multinational project led by Denmark, the NSPA acts as a lead buyer for twelve participating countries.[97] And fifth, the NSPA protects its customers from unreliable companies on the market, secures a good price, and help them avoid costly mistakes in procurement.

The growth in the popularity of the UAV led to the creation of the Unmanned Aerial Systems Support Partnership in 2012. Support Partnerships are groups of countries paying for a pool of NSPA experts chosen to work on a specific project (support partnerships are not a common funded project). They can be open also to partner countries. The NSPA provides these countries with services that can cover most of their logistical and operational needs: system acquisition, equipment and spare parts procurement, repairs, maintenance and overhauls, on demand services (engineering services, modifications/ upgrades), on-site technical assistance, training and manuals, and transportation.

At the very beginning the NSPA helped Germany and Turkey with the acquisition of Heron in 2012. Over the time this UAS Partnership has grown to include the support of smaller drones like Raven UAV (for Spain, Belgium, Luxembourg, Italy, Czech Republic), Orbiter UAV (for Poland), and even the Joint Tactical Intelligence Systems. Currently, the NSPA through this Support Partnership provides services to at least eight NATO member countries on drones like Raven, Orbiter, Sperwer, FlyEye, PASI Searcher Mark III, Huginn, Wasp, ScanEagle, Black Hornet, and AR 180. For instance, the Portuguese Army has recently ordered Raven B drones for their ISTAR systems through NSPA.[98] When the Spanish Army procured Israeli Searchers for ISR missions, delivered in July 2018, the NSPA managed the upgrade of those systems.[99]

**Getting HALE up in European Airspace**

The military need to use European airspace for training and deployment to and from the operational theatre abroad. Operating UAVs heightens the competition for already congested European airspace; the proliferation of small drones in the lower airspace limits the availability of segregated military airspace and can affect the operation of military airbases. The military does not use much of airspace during the peacetime – military drones usually fly at high altitudes above regular civilian air traffic and SUAVs and TUAVs are usually used once they are deployed in the theatre. However, as civil aviation is looking into the possibility to fly even higher (above 30,000 feet), this can affect the deployability of HALE UAVs in Europe as well.

NATO liaises with EUROCONTROL[100] to enable its future AGS to fly in European airspace and to facilitate the military cross-border air mobility, the so-called Rapid Air Mobility initiative.[101] NATO-EUROCONTROL technical and operational collaboration dates back to the 2003 Memorandum of Cooperation. It is believed that achieving civil-military interoperability in the area of air traffic management and control, navigation, and surveillance is key to finding a balance between civil predictability and military airspace needs and thus enhancing the flexible use of airspace, based on "the idea of area modularity in airspace design".[102]

EUROCONTROL supports HALE flights accommodation in Europe. To this end it has published "EUROCONTROL Air Traffic Management Guidelines for Global Hawk in European Airspace" in 2010 that define procedures for faster accommodation through creation of the segregated space.[103] The short-term goal is to accommodate HALE (and MALE) UAVs to support the military for regular and non-regular missions (the flexible use of airspace allows for segregation). The main long-term goal aims at the full integration into the European airspace (as opposite to accommodation), because while reconnaissance missions performed by drones are temporary and more focused, surveillance requires continuous observation and persistent scanning that cannot be made possible only through short-term segregation.

The full air traffic integration means that drones need to abide a whole set of civilian flight rules. However, the detect and avoid systems, on which most of ATI-related R&D is focused, are important but not sufficient and have a poor record of success. As they are not a primary means of safety, only a safety net, communication C2 links and drones' connectivity to air traffic management (ATM) networks are the most important and effective safety measures.

## EU

**European Airspace and Market Regulation**

For more than a decade, the EU has acted as a political entrepreneur in the domain of civilian and dual-use drone technology. Most of the European Commission's activities have dealt with financing R&T and R&D projects, regulating the European drone market, and integrating drones into European airspace. The 2016 EU Global Strategy has opened the door for new roles of the European Commission in the defense and security sector, especially in terms of new financial opportunities. However, it is important to remember that military drones remain under the national control and regulation, as they fly in segregated airspace under the national authority. The EU has no direct competence in regulating military drones of any size.

To better deal with continued air traffic growth, the European Commission launched in 2010 the Single European Sky (SES) initiative that aims to reform European ATM and create a Schengen for airspace. The SESAR Joint Undertaking (SESAR JU), sponsored by European Union, EUROCONTROL, and industry partners, currently implements the SESAR 2020 Program (2016-2024) worth 1.6b EUR. With the arrival of the commercial unmanned aerial technology, the European aviation expert community introduced the drone dimension into the "Master Plan" on European Air Traffic Management in

2015,[104] which is the backbone of SES, to, among others, facilitate cross-border air mobility. Since 2016 the RPAS ATI Single European Sky Expert Community has been working on the ATI roadmap on RPAS regulation with the goal to implement integration of large RPAS into non-segregated airspace by 2025.

The European Commission with its market-oriented logic has recently broadened its competencies in the drone regulation area. Until few months ago, the EU could regulate only drones of less than 25 kg; the rest fell under the national competence, as member states were responsible for all drones lighter than 150 kg. The new Basic Regulation (EU) 2018/1139, introduced on 11 September 2018,[105] extends the scope of the European Union Aviation Safety Agency (EASA) mandate regarding civilian UAVs at the EU level – EASA can propose to the European Commission technical regulation on aviation safety to regulate drones of all sizes. It is the first EU-wide regulation for civil drones that harmonizes operational regulations in Europe. It further creates a common EU market for drone design requirements for small drones (up to 25kg), through the label "Conformité Européenne". Using a new risk and performance-based approach that is technology neutral and flexible to accommodate the rapid pace of innovation unseen in aviation, EASA has created three categories for civilian drone operations: a) open (no pre-authorization required even for BVLOS operations; CE marking for safety and security – less than 25kg and within 120m); b) specific (requires an authorization; transport of goods); and c) certified (need of specified license for the pilot and certification of UAS; human transportation – urban air mobility).[106]

Furthermore, the European Commission has been working on a so-called "U-space" – an umbrella concept for developing an institutional, regulatory, and architectural framework that would allow a new business model for drones flying below 120 meters. This is part of a Commission's wider plan to support innovative multimodal solutions integrating the third dimension into urban planning processes, called Urban air mobility Initiative of the European Innovation Partnership–Small Cities & Communities. It aims to be operational by 2025 and increase the level of drone connectivity in four stages by 2030.

At the moment, this Regulatory Framework that will regulate the operations of UAS in Europe and the registration of drone operators and of certified drones was approved by the EASA committee on 28 February 2019 and by European Commission on 12 March 2019. It has been sent to the EU Parliament and to the EU Council for the mandatory 2 months scrutiny period. If they do not have any objections, the legislation will be published before the summer of 2019. By 2022 the transitional period will be completed, and the regulation will be fully applicable.

The EU, through the work of the European Commission and EASA, aims to establish one EU-wide regulatory framework for both drone manufacturers and drone service-providers to develop European product safety standards for drones, to open a common European drone services market, and to facilitate cross-border air mobility. This EU drone policy informed by a market-oriented logic should ensure economy of scale, widen the EU market, improve employment by involving SMEs as the main driver for innovation and employment, create competitive environment for service provider, and improve the EU position on the global drone market. Finally, the EU policy also aims to improve public acceptance of drones and point to their social value. However, even though the EU decides the rules, influences standards, and creates a common regulatory framework, it is the national (even local, in case of U-Space) authorities in the member states who enforce regulatory rules. They must take the responsibility for non-compliance and pay for the damages caused by accidents.

**EDA and military aviation**

While the European Commission focuses on integration of civilian and dual-use drones, the EDA deals with aspects related to military drones. In 2010, the EDA was tasked to work on the implications of SES and SES ATM research program (SESAR) for the European air forces. In 2013, the European Council gave the EDA a mandate to facilitate ATI of military drones into European airspace.[107] To this end, an RPAS Regulatory Framework Working Group was established in the EDA in 2014. Furthermore, the Agency works towards the harmonization of national airworthiness and certification processes. The EDA is a member of a high-level Coordination Mechanism composed by EASA, European Commission (EU RPAS Steering Group, DG MOVE), and SESAR JU. On the working level, the EDA coordinates with EUROCONTROL, EUROCAE, and a world-wide group of experts from the Joint Authority for rulemaking and Unmanned Systems on airworthiness standards and ATM Concept of Operations (CONOPS) for large and smaller drones. The EDA's goal is, together with all stakeholders including the military, to a) develop common military airworthiness and certification requirements for military RPAS by 2020; and b) fully integrate large RPAS in non-segregated airspace by 2025, preceded by an accommodation phase in 2020-2025.[108]
The EDA has an important role in managing R&D projects related to drone ATI, aimed at enabling MALE drones to fly in Europe. There are three types of projects

at the Agency. First, projects fully paid from the EDA's operational budget, such as DeSIRE (Demonstration of Satellites enabling the Insertion of RPAS in Europe) that looks into the integration of drones using SATCOM Command and Control (C2) links; Remote Pilot Station Standardisation that was launched by the EDA in 2017 with a consortium of Airbus and GMV as its industrial partners[109]; or accommodation of MALE-type RPAS that was launched in 2018 to allow military RPAS to flight under civil ATC. There are currently eight projects related to RPAS R&T and training at the EDA.

Second, the EDA manages pilot projects funded and governed by the European Commission (see below). The UAV-related projects are for instance TRAWA on the Detect and Avoid Standardization.

Third, the EDA manages ad hoc projects that are funded and managed by contributing Member States representatives; the EDA only helps states with initial program and contract arrangements and provides rather technical support. There are several UAV-related projects. For instance, MIDCAS SSP (MID-Air Collision Avoidance System Standardisation Support Phase) aims to develop the sense and avoid function for drones and is funded and managed by Sweden (lead nation), France, Germany, Italy and Spain; or ERA (Enhanced RPAS Autonomy/Automation), launched in 2015, tries to establish the technological baseline for automatic take-off and landing and is funded and managed by Germany (in lead), France, Poland, Sweden and Italy.

The EDA can propose this ad hoc type of project to its members: its Collaborative Database (CODABA) is designed to support the EDA's Member States in sharing information on their defense plans and capability development programs. It contains almost 7,000 records on in-service capabilities and future plans.[110] This enables EDA to identify opportunities for multinational cooperative projects, as through CODABA each EDA member country can signal its interest in collaboration. Currently, around fifteen CODABA-based activities are related to RPAS. The access to this comprehensive overview of capability plans and programs is restricted to the EDA staff and EDA member states' government authorities.[111]

Lastly, the Agency is active also in the MALE RPAS development program run by OCCAR on behalf of Germany (in lead), France, Italy, and Spain. Under the EDA-OCCAR arrangement, EDA provides support in terms of ATI work - integration of this next-generation military MALE UAV in SES.

## Funding Mechanisms

### EU

**Reseach and Development**

The EU public research funding channeled into civilian and dual-use drone technologies goes back to the 2000s under programs such as Horizon 2020 (EU's framework program for Research and Innovation for 2014-2020) or Framework Program (FP) 5, 6 and 7. For instance, through the FP7 the European Commission invested 50m EUR for projects on the adaption of military surveillance techniques to Europe's borders, out of which at least six included the use of drones for border control. Even though many projects developing drone technology financed through the FP7 did not deliver tangible results (such as patents), there have been a substantial increase in both the number of projects and the amount of money invested into drone research in the H2020 financial framework. More than producing actual results, these investments of the European Commission into dual-use drone technology projects meant to get the defense industry community accustomed to sharing technological expertise and working in multinational setting, which resulted into a gradual spill-over from civilian to military domain.[112]

Defense has become a new industrial policy of the European Union. The European Defence Fund (EDF) is a continuation of this tendency except for this time the EU money are explicitly available for funding projects in the defense area. Through the EDF, the European Commission provides financial incentives to member states and European industry, especially SMEs, to develop collaborative cross-border projects in order to amplify national investments into defense R&D, create opportunities for multinational projects to consolidate the fragmented European market, and to strengthen EDTIB. This European Commission's initiative ultimately aims to improve the competitiveness of European defense industries and increase EU's strategic and industrial autonomy, i.e. to help the EU member states develop truly European military capabilities and enable them to conduct operations autonomously. EDF of 13b EUR will be financed out of the Multiannual Financial Framework 2021-2027. In February 2019, the European parliament, Council, and Commission reached a provisional agreement on EDF, which now needs a formal approval from the European Parliament and the Council. The discussion on the terms of reference is ongoing.

Launched in June 2017 as part of the European Commission's European Defence Action Plan, the EDF currently goes through a testing, or preparatory, phase

Photo from airbus.com

until 2020 with a budget envelope totaling 590m EUR. The EDF in its testing phase is divided into the research and capability windows. First, the research window runs under the Preparatory Action on Defence Research (PADR) program and uses a grant approach to finance defence R&T cooperative activities. Its EU budget of 90m EUR is managed and implemented by EDA until 2019 thanks to the mandate delegated from the European Commission.

The eligibility rules are strict. Applications must be submitted by consortia made up of at least three European companies from three member states and under the condition that the knowledge has to stay on the EU territory. Non-EU entities are not eligible for PADR grants. After the call for proposals in 2017 and 2018, member states and the European Commission selected several projects dealing with the use of unmanned systems in the air, maritime surface and underwater domain. For instance, in 2017 the very first PADR grant went to the research project Ocean2020 that consists of 42 entities from 15 EU states, including NATO Centre for Maritime Research and Experimentation (CMRE) and the defense ministries of five countries.[113] The project is led by Leonardo and explores maritime surveillance technology. Other PADR projects include PYTHIA, GOSSRA, VESTLIFE, and ACAMSII. In the 2019 period the European Commission has earmarked under PADR 1.5m EUR into the research on interoperability standards for military UAS.

Second, the capability window that aims to support the joint development of equipment and technology is, in this testing phase, operated by the European Defence Industrial Development Program (EDIDP). It uses the system of co-financing and the public-private partnership approach, meaning that the available budget of 500m EUR (until 2020) from the European Commission is supplemented by national investment of the member states participating in a given project. This window is open also to companies controlled by non-EU states. The first set of nine calls for proposals was published in 2019 and the second set of 12 calls is expected in 2020. The first projects will be known at the end of 2019.[114] These calls look for projects in the domain of Counter-Unmanned Air Systems capabilities and unmanned ground systems (13.5m and 30.6m EUR respectively), sensor suite for integration of tactical drones into air-traffic management (43.7m EUR), and maritime surveillance capabilities (20m EUR).

As to the rules and eligibility, research projects should receive 100% funding from EDF, while capability and prototype development projects will be co-funded to 20% and testing and certification projects up to 80%; additional amount of money will be awarded to projects with SMEs' participation. The collaborative projects must include at least three eligible entities from at least three Member States or associated countries and entities not controlled by third countries. The applicants who are not based in the EU will not receive any EU funding, though they can be member of the applying consortia. As it stands now, the European Commission would not object funding the development of lethal drone capability if in conformity with international law.

The multinational projects created through the PESCO mechanism, a treaty-based legally binding framework that enhanced multinational cooperation between participating EU member states, are eligible for the EU funding: PESCO projects can received a financial bonus of 10%. As to the UAV capability, the second batch of PESCO projects released in November 2018 includes the development phase of the Eurodrone project that will address a common use of system of the European next generation MALE UAV, including training, exercises, and logistics. It is already planned that the Eurodrone project would receive 100m EUR from EDIDP.

The EU member states with large national industry mainly push against the inclusion of third states. However, both military and industry consider it important to keep the door open to non-EU entities. For the military, it is necessary from an interoperability point of view; for instance, the EU needs the industrial R&D base of the United Kingdom (after Brexit) and Norway. Keeping the EU market closed is not in the industry's interests as companies compete on the global market. For the industry it is also important to keep access to the American companies – there is a fear that the EDF could impede the transatlantic link. Furthermore, the current EDF regulation is too restrictive, top-down, and member-states driven in terms of the scope of eligible projects. In addition, since the capability window does not fund 100% of the project costs, a company interested in EDIDP needs first to consult its national authorities to gain national co-investment before it could benefit from the EU money. This can turn to be problematic for states with smaller R&D budgets.

## NATO

**Procuring strategic assets**

In 2009 NATO Allies agreed to collectively procure five RQ-4D Global Hawk Block 40 aircraft. Procuring this most advanced ISR HALE UAV platform is a project of a political-level and strategic importance and a result of military requirements identified by commanders from NATO countries.

The idea of the AGS program was born at NATO already during the Persian Gulf War in 1991 when the United States demonstrated the abilities of its Joint Surveillance

Photo by NATO

and Target Attack Radar System (JSTARS) that provided the United States-led coalition with ground situation information through communication via secure data links.[115] In this context, HALE is the continuation of this Revolution in Military Affairs. Building the whole program on American Global Hawk was a natural choice for the Alliance, since at that time there was no other HALE UAV available out there and the concept development of a new platform would be both time and resource consuming. AGS is meant to enable the Alliance to monitor the wide North Atlantic territory and to give NATO more flexibility (AGS is easier to deploy, less costly, and requires less personnel than JSTARS). AGS will be NATO's prime JISR capability.

The framework of the AGS program is flexible: although there are only fifteen countries that are contributing directly to the acquisition of the core system (a fund of 1.5b USD), all 29 member countries finance the infrastructure on the ground in Sigonella airbase through the NATO Security Investment Programme. Furthermore, annual costs for operating system are covered by the NATO military budget, and the United Kingdom and France will provide in-kind contributions (contribute comparable national assets, still under negotiations). AGS main industrial participants are Airbus Defence and Space (Germany), Leonardo (Italy) and Kongsberg (Norway). Participation in the AGS program offers countries numerous benefits; for instance, training of national experts who then bring back home knowledge, industrial benefits to national subcontractors, access to information without owning the asset, and technology transfer.

These five Global Hawks should be delivered to Sigonella in 2019 and then undergo a six-month testing phase.[116] The permanent facilities for the AGS Main Operating Base should be put in place by 2021. Once completed, the unmanned aircraft will be owned by the Alliance and operated by the NATO AGS Force at the AGS

Main Operating Base in Sigonella and at the Allied Air Command in Ramstein under the responsibility of SHAPE in Mons.[117]

NATO is not interested in acquiring the MALE-type drone since several of its member countries already have them.[118] The principle for acquiring common capabilities owned by NATO says that only a capability that is "over and above" one nation can be provided by NATO (like AWACS). Also, during peacetime, NATO asks its members for situational awareness information that is collected nationally with MALE drones already in their possession. Since AGS sensors package cannot cover all types of intelligence data collection, the rest is expected to be provided by national MALE drones.

**Industrial expertise**

NATO directly invests money from its civilian budget (approx. €2,25 million) into defense research. The NATO Industrial Advisory Group (NIAG) is NATO's tool to engage with industry in view to obtain industrial advice. NIAG representatives are national as they represent the voice of industry in their respective countries, rather than the interest of a single company. Since NIAG operates on a pre-competitive basis, the advice sought from the industry does not always have to be the best available: while not selling anything to NATO, industry might fear revealing commercially sensitive information. Despite certain disadvantages of this model, thanks to its 50 years of experience, NIAG has built a network of 5000 companies, 80% of which are SMEs that collaborate on future capabilities. Industry is interested in knowing what NATO needs and what the military thinks in terms of capabilities. In case of drones, NIAG studies have in general focused more on concept development, such as autonomy, and more concrete technical work has been done on low, small and slow UAS. Many NIAG studies initiated by JCGUAS/NNAG have resulted in STANAGs.

## Networking Mechanisms

### NATO

The networking function of international organizations has been often undervalued. Yet NATO has helped form an unprecedented community of scientific experts and the network of industry representatives. Moreover, it hosts 29 delegations under one roof. Most of those entities date back to the 1950s and 1960s; these long-lasting fora for informal meetings and socializing have contributed to the development of close relations, the creation of trust, and their understanding of the Alliance's tasks and systems.

Thanks to the AGS program, NATO has brought together the community of HALE and ISR experts. The core, around 60 staff, works in the NATO Alliance Ground Surveillance Management Agency and Organization (representing 15 AGS acquisition countries), but in total more than 600 people are involved in the AGS program. The base in Sigonella will host 550 personnel, in addition to smaller staff in Mons and Ramstein. Furthermore, the NATO Training Center in Sigonella will train around 80 AGS pilots, Joint ISR analysts, sensor operators and maintainers per year.

NIAG study groups bring together national industrial experts and together with the high-level NATO-Industry Forum, hosted by the Commander Supreme Allied Command Transformation and the Assistant Secretary General Defence Investment, and the NATO Communications and Information Agency's annual industry conference NITEC, are the NATO's tools to improve NATO-industry collaboration.

The NATO's Science and Technology Organization (STO) maintains a community of more than 5,000 scientists. The STO has created a network of subject-matter experts from academia and industry that pool knowledge. These experts are not paid by NATO, but they come either directly from national Science and Technology units at ministries of defense. In this context, NATO's transatlantic character gains on importance since thanks to the STO it provides its member countries the access to the United States' expertise and know-how (approx. 25% of experts are from the United States). There are around 250 projects at any time in different phases of development within STO. They usually reflect national priority projects, but NATO offers them the opportunity to collaborate internationally (there must be at least four countries per project). In addition, the STO Staff prepares own research priorities derived from the NDPP – they are of a particular interest to smaller nations with no science and technology base. Projects are nation-driven; the participating nations decide which projects to fund and with whom to share the results. Usually, 70% of the projects are open to the Partnership for Peace nations, Australia, Finland, and Sweden. No STO expert panel focuses exclusively on drones or ISR. UAVs can be discussed in six out of STO's seven technical teams (the Applied Vehicles panel is probably the most relevant), which makes it a challenging platform as UAVs aggregate more priority areas. In 2018, top 5 countries participating in STO studies were the United States, the United Kingdom, Germany, the Netherlands, Canada, France, Turkey, Italy, and Norway; the projects included also a study on swarm systems for ISR.[119]

Furthermore, NATO represents the military community in its advocacy role with other stakeholders. It has succeeded in establishing working links with the SES representatives to communicate the military view on airspace regulation, although the regulation of the airspace for military operations and training is formally outside of the SES mandate. This has also led to the promotion of military regulation for non-EU nations. In addition, the NATO Aviation Committee brings civilians on board with similar objectives. NATO also represents military in the meetings with EUROCONTROL, EASA, and International Civil Aviation Organization (ICAO). On behalf of the military drone community, it facilitates negotiating over-flight permissions or liability issues, since NATO requirements for airspace is a collective policy.

## EU

On the EU side, the EDA serves as an interface for civil-military relations. Since 2010, the EDA has developed ways to engage the military in the SES initiative and to connect them with the European institutions, thanks to EU funds for military projects on SES/SESAR related technology and RPAS ATI activities. Among others, the EDA is supporting the EU Member States in identifying military projects and in preparing bids to obtain EU co-funding. It has mechanisms for bringing military perspective into the work on reforming the ATM in the European airspace; for instance, the EDA's Military Airworthiness Authorities, or MAWA, translates civilian regulations from EASA into the military world. EDA also liaises with civilian stakeholders in other units and organizations: the European Commission (DG MOVE), EUROCONTROL, EASA, the SESAR Joint Undertaking, and EUROCAE (responsible for the development of worldwide recognized industry standards for aviation).

The EDA and NATO have been improving their staff-to-staff coordination. Especially after signing the EU-NATO Joint Declaration, NATO and EDA experts worked closer on problems related to military aviation. Although the military and the civilians share the same airspace, the SES regulation does not apply to military operations and training. This civil-military cooperation has been key to developing the overarching document "The Military Aviation Strategy in the context of SES", approved by both the EDA Steering Board and the North Atlantic Council in 2017, which provides guidelines to some 11,000 military aircraft stationed in Europe where military flights represent 25% of all flights across European airspace.[120]
The EDA also serves as an information hub or a gateway for industry. The Agency has tools to navigate companies through various funding opportunities offered by EU institutions. The EDA has also established an industrial exchange platform to coordinate industry efforts to fill the gaps in R&D, and a specific "EDA Industry Exchange Platform on RPAS Air Traffic Insertion" in 2017 to strengthen and formalize a dialogue with European industry and a community of military users.

Last but not least, since 2013, the EDA has been facilitating cooperation and networking among countries that currently operate large MALE drones or are interested in acquiring this capability in the near future – the so-called European MALE RPAS User Community (see Section Two). Although this community was not very active the first three years, one of its recent milestones includes the development of the MALE RPAS desktop training simulator for European military RPAS schools.[121]
The EDA Staff and EDA's MALE Community liaise regularly with the European Air Group (EAG),[122] whose members also include Belgium and the United Kingdom, to assure interoperability of future MALE drone capabilities. This EDA platform contributes to building a shared operational culture among MALE drone capable countries.

## Endnotes Section Three

**91** For instance, Frontex uses Italian UAS platform Falco produced by Leonardo to monitor migration within the EU Border Surveillance System (a framework for the exchange of information to improve situational awareness). Tom Kington, "Leonardo launches new drone ahead of Paris Air Show," Defense News, June 10, 2019, https://www.defensenews.com/digital-show-dailies/paris-air-show/2019/06/10/leonardo-launches-new-drone-ahead-of-paris-air-show/?utm_source=Sailthru&utm_medium=email&utm_campaign=EBB%20 06.11.19&utm_term=Editorial%20-%20Early%20Bird%20Brief.

**92** Interoperability means the measures necessary to work together effectively with the different national organizations and equipment as they are; in contrast, standardization means the measures necessary to avoid the mess in the first place. Rupert Smith, The Utility of Force: The Art of War in the Modern World (London: Penguin Books, 2005), 316.

**93** John E. Mayer, State of the Art of Airworthiness Certification (NATO Science and Technology Organization, STO-MP-AVT-273, 2017), 6. The STANAGs in question are: STANAG 4671, 4702 (for rotary wing), 4703 (for light UAS) and still to be ratified 4746 (for small VTOL UAS).

**94** The NSPA has a world-wide reach. For instance, it supports 800 ports for ship docking and has its contractors in Afghanistan, Mali, and Kosovo. Because only member states can ask the NSPA to support their deployment in operations, the NSPA sometimes provides support within the framework of EU-led operations (for instance in Kosovo or in the anti-piracy mission).

**95** The NSPA and the EDA are very different in nature. The EDA does not have comparable resources and expertise to NSPA to execute the amount of procurement contracts, The EDA has only some 150 persons, small operating budget of 28m EUR, functions more like a defense think-tank. However, its board is composed of Defense Ministers gives it a political standing and allows it to see further ahead.

**96** Out of which 1.1 Bn EUR relate to the acquisition of NATO multi-role tanker transport aircraft. NSPA, Annual Report 2017 (Capellen: NSPA, 2018), 5, 16, https://www.nspa.nato.int/leaflets/Docs/AnnualReport2017.pdf.

**97** "NATO helps Allies speed up sharing of weapons," NATO, March 27, 2019, https://www.nato.int/cps/en/natohq/news_164961.htm; https://www.dsca.mil/major-arms-sales/nato-support-and-procurement-agency-precision-guided-munitions.

**98** Victor Barreira, "Portugal orders Raven B UAS," Jane's Defence Weekly, September 14, 2018, https://www.janes.com/article/82986/portugal-orders-raven-b-uas.

**99** "Two PASI Searchers Mk III Class II Tactical UAVs Delivered to Spanish Army," Defense-aerospace.com, July 9, 2018, http://www.defense-aerospace.com/articles-view/release/3/194591/nspa-delivers-pasi-searcher-uavs-to-spanish-army.html.

**100** EUROCONTROL is an intergovernmental organization that acts as a network manager – it organizes the air traffic in Europe and provide sources for route changes. It also supports EASA, who proposes regulations on ATM to the European Commission.

**101** "NATO Secretary General thanks EUROCONTROL for continued Cooperation," NATO, January 18, 2019, https://www.nato.int/cps/en/natohq/news_162475.htm.

**102** "From Start to Finish", AIRSPACE 41 no. 2 (2018): 18-19, https://issuu.com/canso/docs/airspace_41_quarter_2__2018_digital.

**103** It establishes a set of minimum ATM requirements for HALE flight in European airspace that should be used to negotiate access to national airspace within Europe. These guidelines isolating HALE drones into segregated airspace during climb-out and recover, and to cruise in non-segregated airspace at high altitudes above manned aviation. See "EUROCONTROL Air Traffic Management Guidelines for Global Hawk in European airspace," EUROCONTROL, December 1, 2010, https://www.eurocontrol.int/publication/eurocontrol-air-traffic-management-guidelines-global-hawk-european-airspace.

**104** SESAR, European ATM Master Plan: The Roadmap For Delivering High Performing Aviation For Europe (Brussels 2015), https://ec.europa.eu/transport/sites/transport/files/modes/air/sesar/doc/eu-atm-master-plan-2015.pdf.

**105** "Safe operations of drones in Europe," EASA, September 28, 2018, https://www.easa.europa.eu/newsroom-and-events/news/safe-operations-drones-europe.

**106** "Civil drones (Unmanned aircraft)," EASA, accessed April 27, 2019, https://www.easa.europa.eu/easa-and-you/civil-drones-rpas.

**107** The European Council in 2013 tasked EDA to support four capability development programs: Air-to-Air Refuelling, Governmental Satellite Communication, Cyber Defence, and Remotely Piloted Aircraft Systems. "Capability Programmes," EDA, accessed December 12, 2018, https://www.eda.europa.eu/what-we-do/our-current-priorities/capability-programmes.

**108** EDA, The Military in the Single European Sky: Partnering for Excellence in Global Aviation (Brussels: EDA, 2018), 12, https://www.eda.europa.eu/docs/default-source/brochures/eda-ses-brochure-2018-final.

**109** Yet, this project on Civil standard for RPS-RPA interface risks duplicating parts of the already existing NATO's STANAG 4586. EDA, Standardisation of Remote Pilot Stations of RPAS - an European Defence Agency project developed by Airbus and GMV (Brussels: EDA, 2019), 6, https://www.gmv.com/export/sites/gmv/DocumentosPDF/Folletos/Brochure_Remote_Pilot_Stations_of_RPAS.pdf.

**110** Data come from four types of sources: input directly from member states, open-source information compiled by the EDA staff, the NATO's NDPP, and official governmental documents.

**111** For instance, the NATO Staff does not have access to EDA's CODABA, nor do the EU member states that are not members of EDA, such as Denmark. "Collaborative Database," EDA, June 12, 2017, https://www.eda.europa.eu/what-we-do/activities/activities-search/collaborative-database.

**112** Oliveira Martins and Küsters, "Hidden Security," 17.

**113** "Pilot Project and Preparatory Action on Defence Research," EDA, July 8, 2019, https://www.eda.europa.eu/what-we-do/activities/activities-search/preparatory-action-for-defence-research

**114** European Commission, EDIDP and PADR – factsheet, March 19, 2019, https://ec.europa.eu/docsroom/documents/34510.

**115** The Persian Gulf War represented a "critical point in the development of UAV industry" – in this sense, drones represent the further continuation of revolution in military affairs in airpower. Søby Kristensen et al, Unmanned and Unarmed, 3.

**116** Allies signed the core acquisition contract in May 2018. "Alliance Ground Surveillance (AGS)," NATO, last modified June 21, 2019, https://www.nato.int/cps/en/natolive/topics_48892.htm.

**117** NATO, The Secretary General's Annual Report 2018 (Brussels: NATO, March 2019), 48, https://www.nato.int/nato_static_fl2014/assets/pdf/pdf_publications/20190315_sgar2018-en.pdf.

**118** NATO cannot acquire an armed drone like Reaper or Predator. The general consensus maintains that lethal force must be controlled by the member countries, not international organizations due to liability reasons.

**119** NATO, The Secretary General's Annual Report 2018, 44-45.

**120** EDA, The Military in the Single European Sky, 3, 11.

**121** "Latest News: EDA sets-up collaborative RPAS training," EDA, January 18, 2018, https://www.eda.europa.eu/info-hub/press-centre/latest-news/2018/01/18/eda-sets-up-collaborative-rpas-training.

**122** Formally created in 1998, EAG currently includes member countries: Belgium, Germany, Spain, France, Italy, the Netherlands, the UK; partner countries: Norway, Sweden; associate countries: Canada, Poland, the US, Australia. "Organization," European Air Group, accessed May 3, 2019, http://www.euroairgroup.org/about-eag/organisation/.

**Section Four:**

# UAVs, Future Warfare, and Multinational Defense Cooperation

Most European defense ministries have included at least one type of UAVs in their future acquisition plans, which unequivocally indicates a continuing drone proliferation in Europe. The UAV inventories of European countries will include more large advanced drones, especially to counter threats from the East and South and out of the fear of "not falling behind" – some countries will acquire drones to improve their status and become members of drone clubs.[123] This concluding section outlines major future trends in the development of UAV technology and drone warfare and draws implications for the European defense market and its main stakeholders (national governments, industry, and military) in terms of the technological innovation and the transatlantic framework of cooperation. It aims to inform smart choices leading to the development of the right UAV capabilities for the future requirements of European armed forces.

## Future Unmanned Technology

Drones do not win wars today – they are too vulnerable and cannot achieve a decisive victory.[124] The current-generation drones still face numerous problems and limitations.[125] In general, they are not useful in contested environment without air superiority, i.e. when it is likely they will be shot down, as the recent cases of downed MQ-9 Reaper in Yemen[126] and Global Hawk in the Strait of Hormuz[127] have shown. The probability that a drone crashes is high because UAVs do not have air defense capabilities, their maneuverability and stealth capability remain poor, and they usually fly at low altitudes and slow speeds. They are also prone to accidents due to technical failures and severe weather, affecting the operational range of data links between the UAV and the control station. If the information and cyber security of drone-related C4ISR systems is insufficient, drones run the risk of jamming, hacking, and spoofing.

Drones are flying dull (long surveillance), dirty (CBRN detection), and dangerous (high risk for manned aircraft) missions. The existing practice of deploying drones in low cost, low-risk conflict engagement and with an objective to minimize the number of boots on the ground will continue. While today's drones are predominantly conceived for counterterrorism missions, the next generation will have better capabilities especially with respect to the last of the three Ds – dangerous mission in hostile environment without air superiority. This will require improving i) survivability of UAVs in high-threat environment and extreme weather conditions; ii) self-protection measures and resilience to cyber threats; and iii) information gathering and data processing capabilities.[128]

The overall trend shows that drones are getting "stealthier, speedier, and smaller".[129] They are increasingly lethal, quieter, and multi-capability-based by design, will fly longer and soon in cooperation with manned aircraft (manned-unmanned teaming) or other drones (swarming). Their improved flexibility and adaptation will allow the armed forces to employ a single drone for multiple tasks, especially in the niche area where manned aircrafts face limitations.

The advancements in autonomy will be determinant for the shape of the next-generation drones. While automation and/or autonomy already exists in auto-pilot functions, anti-collision systems, real-time flight plan adjustment systems, or take-off and landing in emergency situations,[130] autonomy of future UAVs will be enhanced for instance in the situation with no modern communication infrastructure, such as Global Positioning System (GPS) signal.[131] Yet, as the level of autonomy is function-specific, the most important improvements are expected in the area of data collection and processing, pushing forward the data-driven warfare. In this sense, drones may "symbolize a shift in the nature of warfare".[132] As much more data is being collected than can be effectively processed, UAV operators will need more comprehensive data analysis software to make sense of what is actually being collected, increasing, among others, the "reliance on automated methods as guidance for attacks".[133] The second related problem with the data surge is the question of access to information and preservation of military effectiveness. In situations when drones are collecting vast amount of information from the battalion level down to the squad, it might be prudent to ask who should get the information and how little information is enough to accomplish the given task. Finally, in contrast to mainly improving effectiveness on the tactical and sub-tactical level in case of the current armed drones, the development of new-generation UAVs such as advanced supersonic drones, swarm-based air defense systems, or autonomous combat drones could alter the strategic balance of military capabilities. On the other hand, while innovation in unmanned technology will leverage advancements in artificial intelligence, machine learning, and big data, the next generation drones will also include drones with lower production and acquisition cost and simplified operating C2 systems (including the possibility of developing one platform for army, navy, and air force). Yet the growing reliance on unmanned systems (not only by the military) runs the risk of falling into the technological determinism trap. Prudent assessment is required as to which functions could be safely and efficiently delegated to unmanned machines.[134]

**Drone as Force Multiplier**

The most important function of drones continues to be that of a force multiplier, especially as the capability delivered by fewer personnel decreases the risk of human cost.[135] Military drones of all three main classes have been predominantly used in the ISR domain, where they are becoming one of the most popular equipment, providing information superiority thanks to, among others, real-time imagery of higher resolution than satellites, supplying mobile communication relays, and improving the observe, orient, decide, act loop. UAV deployments that combine ISR and strike missions help shorten the kill chain and reduce collateral damage. From large surveillance HALE drones to pocket-sized undetectable drones with powerful sensors, the proportion of unmanned technology operated by armed forces will steadily increase. This will prove challenging in terms of the availability of bandwidth due to high number of drones flying in a constrained airspace.[136] Lastly, the HAPS technology using renewable solar energy may foster further innovation in unmanned autonomous surveillance platforms.

Airborne electronic warfare is another domain with a potential for a greater use of UAVs, mainly as electronic support measures. For instance, the Pegasus program aims to meet Germany's SIGINT aircraft requirement, the UK will equip its MQ-9 Protector with electronic support measure in the form of an advanced radar detection system that turns Protector into an electronic signals intelligence (ELINT) capability. With the advances in adversary's air defense systems in the future, drones with multifunction sensors could provide important EW countermeasures to suppress/disable enemy air defenses by blinding air defense radars., such as the United States Navy's Remedy Project that develops unmanned electronic warfare platforms for radar detection and electronic attack by jamming.[137]

Logistics is the next area that will experience further increase in the use of UAVs, such as cheap unmanned cargo gliders or unmanned refueling tankers like the American MQ-25 Stingray.[138]

Apart from the domain-specific trends, two prominent concepts have started to guide innovation that aims to enhance the force-multiplier effect of drones: manned-unmanned teaming (MUT) and swarming. MUT conceptualizes drones as loyal wingmen where a piloted aircraft commands one or more drones that perform functions transferred from its manned counterpart. This force-multiplier role of UAVs will be one of the central features in the future air combat systems, mainly in the form of UCAVs. The main defense players in Europe understood this as Tempest, SCAF, and FCAS projects will include an important unmanned element. Other example includes Boeing's Airpower Teaming System that will manufacture a loyal drone wingman for the manned fighters in the Australian air forces and other "Five Eyes" countries.[139] Similarly, Russian Aircraft Corporation MiG is trying to develop drones for its future combat aircraft.[140] Unmanned combat drones will not be advanced enough yet in the near future to replace manned strike aircraft or fighters,[141] but they will be able to expand the capabilities by carrying additional payloads; for instance they can operate as "flying missile magazine" to boost the combined firepower with long-range weapons for direct engagement or carry crucial ISR/ISTAR sensors.[142] In the similar vein, the future strategy of light attack might well combine "fixed wing, rotary wing, manned and unmanned aircraft, drones and helicopters."[143] Another scenario is the pilot commanding swarms of smaller drones that fly ahead of the manned aircraft and perform reconnaissance over vast areas, resembling to an airborne aircraft carrier concept.

While today's standard is still one pilot per drone, the swarming technology opens the possibility of a multivehicle control: deploying multiple drones to perform tasks with a high degree of autonomy. Inspired by swarms of insects, the swarm of drones consists of many low-cost, expendable machines working together. Its key feature is self-organization and the machines' ability to decide among themselves. [144] While still at an experimental stage, swarming can have significant implications for the weapon delivery, including nuclear, chemical, and biological, and for air and missile defenses (for instance drone swarms acting as air mines or decoys).[145] The swarming technology, once it achieves reliable operational capacity, could become also very useful for medical assistance or logistics resupply in natural disaster and humanitarian missions.

The United States leads the development of swarm technology. For instance, Pentagon's Perdix experiment using micro-drones for aerial surveillance that have already been successfully dropped out of F/A-18 Super Hornets, or the United States Navy's LOCUST project developing drone swarms since 2016.[146] Most interestingly, the Defense Advanced Research Projects Agency has been working on ways to launch and recover drone swarms with autonomous docking system from C-130 military transporter, the Gremlins program.[147] Gremlins will be able to carry electro-optical sensors for ISR/ISTAR missions, perform electronic attack, and even engage targets with small warheads.[148]

In Europe, the Airbus Group has been testing a "drone escort system" for combat aircraft over the Baltic Sea with the objective to overwhelm enemy radar and communication systems.[149] The EDA's pilot research project EuroSWARM, completed in 2018, aimed to demonstrate the transformative effect of the swarm technology on warfare, such as deploying swarms instead of lethal capability can produce the same results. Out of European countries, the United Kingdom is the most vocal about acquiring swarms of drones – already by 2022.[150] London plans to invest 2.5m GBP (some say even 7m GBP) from the new Transformation Fund into developing a "swarm squadron of drones" that would accompany the British F-35s and that would be capable of "confusing" enemy air defense.[151]

**Drone as Weapon**

Improving Anti-Access/Area Denial (A2/AD) systems and surface-to-air missiles with ever longer range and higher speed are challenging Western air superiority. The large surveillance drones were considered invulnerable

Photo from flir.eu

until Iran shot down American Global Hawk in June 2019. Even the leading strike UAVs – GA MQ-1 Predator and MQ-9 Reaper – are designed to counter terrorists in the non-contested airspace over Afghanistan and Iraq. The current-generation drone technology is not ready for high intensity combat air missions in contested airspace. To survive those conditions, drones would need more stealth, higher speed, and better maneuverability. Armed forces will need drones able to operate in hostile environment where the threat of being shot down is extremely high. Not technically limited to human performance or physiological characteristics, future UCAVs with deep strike capabilities would be capable of penetrating adversary's EW and delivering weapons in A2/AD environment. However, as no autonomous UCAV is close to becoming operational yet, these UCAVs will assume the role of a loyal wingman (see above) within an air combat cloud or a network of integrated manned and unmanned systems.

The trend points to the development of cheaper, simpler, and attritable (replaceable and even expendable) combat drones that could serve as air-to-air dogfighters as well as bomb carriers.[152] The XQ-58A Valkyrie developed by Kratos Defense is the first a low-cost combat drone demonstrator. The project is financed through the United States Air Force Research Laboratory's Low Cost Attritable Aircraft Technology program that looks into the ways to decrease the development, procurement, and operating cost by using advanced commercial techniques.[153] The United States Air Force is already considering buying 20-30 aircraft for 2m USD per vehicle for further experimentation.[154] In contrast to MQ-9 Reaper, Valkyrie is jet-powered and can fly at (near) supersonic speeds, which enables it to become a loyal drone wingman to F-15EX or F-35 fighter jets, carrying either precision-guided munition or surveillance sensors. The most important programs developing combat drone capability in Europe are nEUROn and Taranis, both above all demonstrators for stealth (low observability) and for technical solutions for future military requirements.

Furthermore, with respect to the future operations in A2/AD environment, the United States, China, France, Russia, Turkey, and the UK have been working, or have plans to work, on hypersonic drones for strike operations. For instance, the French V-MaX project aims to develop an autonomous, remotely operated hypersonic glider,[155] while the Turkish Aerospace Industries are developing a supersonic drone Goksungur.[156]

The improving performance of smaller drones makes them a suitable means for carrying munition, such as firearms, explosives or even grenade launchers.[157] Armed tactical drones in the form of loitering munition, known as suicide drones, have already been deployed in Iraq and Syria. Apart from the most famous Israeli Harop (also operated by Germany) or Harpy drones, the United States Army has been using for some years Lethal Miniature Aerial Missile System that offers a low-cost "soldier-carried, soldier-launched" munition, which can loiter for 15 minutes and engage BVLOS targets.[158]

Swarming has becoming a technique to enhance the lethality of UAVs. Drones in large numbers can simply swarm enemy defenses. For instance, the United States Marine Corps aims to develop a swarm of suicide drones carrying different payloads for close air support (warheads) and electronic attack (counter-radar capability), with as much as 15 drones per operator.[159] Russia's company Kalashnikov has been looking into Kub-bla, a suicide drone, which, although less performing than Israeli Harpy, can serve as a weapon to suppress enemy air defenses if deployed in swarms.[160] On the other side of the spectrum, non-lethal drones armed with laser weapons causing only temporary damage might turn to be an alternative for those countries reluctant to acquire conventional armed drones.[161]

The last and most controversial trend concerns the technological advancements in ever-increasing degree of autonomy that have gained the label "killer robots". These lethal autonomous weapon systems (LAWS) are "weapons that can select, detect and engage targets with little to no human intervention."[162] On the one hand, defenders of LAWS argue that autonomous weapons can improve countries' compliance with international humanitarian law thanks to LAWS higher degree of precision and effectiveness. On the other (and bigger) hand, critics call for a ban on LAWS (particularly the fully autonomous ones) because of the danger of misuse and the absence of human judgment. In addition, as former chief scientist of the United States Air Force put it, there is no expectation that "fully autonomous systems would improve the strategic deployment of force".[163]

The European Parliament belongs to the latter group and has recently managed to adopt a joint position that calls for an international ban on LAWS.[164] Furthermore, for several years the European Parliament, concerned about the increase in targeted killing and questionable compliance with international law, has been consistently urging the European Council to adopt a common position on the use of armed drones in order to address the issues transparency and accountability. Although the European Parliament passed a resolution in 2014, the Council has not decided yet on any common EU position or developed a policy response that would better regulate and restrict the proliferation and development of armed drones and their use outside declared war zones.[165]

Several international agreements, both binding and declaratory, already exist to control armed unmanned aerial technology: the Wassenaar Arrangement, the Missile Technology Control Regime, the Joint Declaration for the Export and Subsequent Use of Armed or Strike-Enabled Unmanned Aerial Vehicles,[166] and Arms Trade Treaty.[167] The expectation is that more countries will be developing and acquiring armed UAVs, as in the next ten years, “over 40% of the UAV market value will be armed, with some 90% of these armed UAVs falling in the Class III category”. [168] However, because i) several main armed drones exporters are not members to the Missile Technology Control Regime (China, Israel), ii) there are different interpretations as to whether armed drones fall under the Arms Trade Treaty, and iii) the United States intention behind initiating the Joint Declaration for the Export and Subsequent Use of Armed or Strike-Enabled Unmanned Aerial Vehicles was actually to loosen the export control to compete with China, new and/or improved mechanisms would be needed to ensure effective arms control of weaponized drones. This is where the EU can act as norm entrepreneur to advance the international dialogue on legal and ethical questions surrounding the use of drones for lethal purposes.

**Drone as Threat**

The recent incidents at major European airports (Gatwick, Heathrow, Frankfurt), the failed drone strike in an assassination attempt on the Venezuelan president,[169] and the current conflicts in the Middle East (civil wars in Yemen and Syria, activities of the Islamic State) show that unmanned systems in the hands of hostile actors pose threat to both civilian and military installations and personnel.[170]

Drone threats can take the form of the adversarial use of UAVs as airborne improvised explosive devices delivery platform or as hostile spy drones stealing sensitive data (such as the position of armed forces).[171] Militant groups weaponizing cheap commercial drones for suicide and strike missions that affect effectiveness of coalition troops in Syria and Iraq has become an acute problem.[172] Modifying commercial drone technology into flying weapons has become a serious concern also for intelligence services in European countries.[173]

Until recently, there were no defense requirements for counter-drone technology (C-UAS) in the military. Given the rapid pace of change in this sector and the speed with which non-state adversaries exploit commercial drones, the military has found itself countering tomorrow’s technology with yesterday’s means: NATO and coalition forces “are struggling to stay ahead of the malicious use of small unmanned aerial vehicles by terrorist groups, rogue states, and other actors”, mounting specialized squadrons of ground troops to defend bases against drones.[174] The effective C-UAS measures require technology that is able to detect, disable, and intercept hostile drones, and even enforce no-fly zones for UAVs. Although current commercial technologies are “easily vulnerable to even basic counter-measures as they are not designed for combat”,[175] these small drones are difficult to detect (they usually have a small profile on radars) and intercept or even destroy (one can only try to shoot a dynamic low-flying hobbyist drone with a firearm).

To detect drones, the current C-UAS technology uses radars, electro-optical, infra-red, or radio-frequency measures, while jamming is the most frequent interdiction technique.[176] In addition to protecting military bases, soldiers can also use portable drone detection gadgets to increase their individual protection.[177]

The recent trend points to the use of directed energy weapons, lasers and radio-guided weapons to engage and disable the enemy drone. For instance, Spain has a Rapaz program that includes C-UAS R&D projects and Italy has created a Joint C-UAS Center of excellence in Latina. The German Army plan to counter hostile drones with electronic signals, small grenades, and shoulder-mounted jammers.[178] The United Kingdom has been developing a laser prototype to counter drones, the Dutch Government is looking into lasers to destroy drones endangering public safety, while the United States Marines have their first ground-based Compact Laser Weapons System prototype approved by the Defense Department.[179] In addition, since 2015 the United States Marines have been building their own counter-drone defense system – Marine Air Defense Integrated System – that will be installed on their new Joint Light Tactical Vehicles to detect and neutralize hostile UAVs by non-kinetic measures (radars, sensors, optics, jammers) while its upgraded version should also include a kinetic lethal countermeasure in the form of another drone able to intercept large MALE UAVs.[180] At the same time, the United States Army has been testing a non-lethal drone countermeasure: a grenade launcher to counter drones with a net.[181] Russia also plans to counter drones with another drone: an unmanned interceptor built around a rifle.[182]

It has been already mentioned above that swarming can enhance lethality especially by overwhelming kinetic countermeasures. Countering swarms of drones therefore must take the form of electronic and cyber measures, jamming radio frequency and GPS signals. Tracking drone swarms also requires a dedicated detection software.[183] However, drones in swarms could operate on different frequency, making it very difficult to neutralize the whole swarm with individualized soft kills (disabling the drone without destroying it). Furthermore, soon these drones could be able to fly without a control link or GPS navigation. Countering drones with another combat drone probably seems like the most sensible option for the future.[184] Lastly, the saturation of airspace by drones makes it difficult to distinguish between friendly, neutral, and potentially hostile drones. The current C-UAS technology is not able to produce a single local air picture yet.

Although the global market with C-UAS technology is rapidly growing,[185] it remains underdeveloped. Already yesterday both military and civilian authorities needed integrated C-UAS sensors able to effectively detect, tract, and identify non-cooperative drones. In addition, the C-UAS market is also lacking standards, which will complicate the upcoming counter-drone technology race. The emerging C-UAS market in the EU would necessitate a regulatory framework for counter-drone technology that would address practical, legal, and policy challenges and set standards, especially if counter-drone systems would protect critical infrastructure, governmental buildings, or large public events and to be integrated into local ATM networks. The possible side effect might be that the improvements in the counter-drone technology would make the military UAVs more complex and their unit cost will rise.[186]

At the same time, the civil sector (government and commercial use) will generate the majority of the drone market. According to the SESAR study, the European drone market will grow by €10 billion by 2035 and then by €15 billion through the 2050s with almost twenty per cent of all flights to be remotely or optionally piloted.[187] It is also expected that civil commercial users would enter the MALE category soon. Given the growth and technological innovation opening multiple possibilities for using unmanned aerial technology, the European Commission should look not only into the development of regulation and standards, but also the adaptation of physical airspace infrastructure.[188]

**Unmanned Technology Spill-Over**

Building on the experience with aerial vehicles, unmanned technology has been spreading to other operational environments. This spill-over effect concerns above all the maritime domain, and to a lesser extent, land and space[189] domains, like surface, underwater and ground unmanned systems. Yet, interoperability and standards lag behind those in the air domain. Another pressing challenge is the problematic communication between land/urban and maritime environments. The future unmanned systems need to contain technological solutions for hybrid communication navigation network. The maritime unmanned autonomous systems are expected to be employed in anti-submarine warfare, mine-countermeasures, underwater communications, and undersea surveillance, in addition to already existing efforts in incorporating UAVs for maritime surveillance as the ships built today are designed to accommodate UAVs on their deck. For instance, France has refurbished its aircraft carrier to be able to carry armed drones and developed a maritime version of its tactical drone Patroller to locate and track ships.[190]

Future maritime unmanned technology could include large unmanned robot ship/surface vessels, unmanned warships, or submarine drones for autonomous operations on the deep ocean seafloor.[191] The United States Navy is even preparing to create an unmanned "Ghost Fleet", already projecting to acquire two large unmanned-surface vessels in 2020 through a Sea Hunter Program.[192] In addition, Since 2011, Northrop Grumman has been developing a X-47B for the United States Navy aircraft carriers. This UCAV should enter service in 2020 to support aerial refueling, ISR, and strike missions.[193]

In Europe, France's Naval Group will deliver to Belgian and Dutch navies mine-hunting ships and autonomous underwater drones for defending their territorial waters and the English Channel.[194] In the United Kingdom, BAE Systems has been testing an autonomous boat, a Pacific 950 Rigid Inflatable Boat (RIB) demonstrator, while London's future plans contain unmanned submarine for intelligence gathering as well.[195]

As to the land domain, the recent NATO exercise Trident Juncture 18 tested, among others, the unmanned systems to improve logistics and protect expeditionary bases.[196] Other example of an increased interest into land or ground unmanned autonomous vehicles is the Estonian-led PESCO project "Integrated Unmanned Ground System" that aims to produce new autonomous transport and navigation capability. There is no indication that the two organizations would plan to collaborate on any of these unmanned systems.

## Transatlantic Framework of Cooperation

NATO and the EU act as important enablers of military technology diffusion. On the one hand, NATO focuses on military operational needs and interoperability, in addition to providing the strategic ISR drone capability


Photo from www.dassault-aviation.com

to its member countries. On the other hand, the EU concentrates on developing financial and regulatory tools to create, among others, a globally-competitive common European drone market and to improve the (autonomy of) European industrial base. These two institutional logics usually result in a competition for "customers", though often the NATO and the EU Staffs have merely difficulties to get sense of what the other side is doing, to identify compatibilities, and to act upon them.

The NATO-EU relations do not have to be competitive. Since both CDP/CARD and the NDPP are closely coordinated and synchronized, their lists of capability priorities are not that dissimilar. This could lead to more cooperation as there might be synergies in projects of common interest, furthering the joint EU-NATO declaration on enhanced cooperation. Importantly, the 2018 CDP includes integration of military air capabilities in a changing aviation sector. If the two organizations manage to keep their cooperative frameworks pragmatic, flexible, and practical (especially in case of the EU emerging role in the defense domain), there can be more potential for multinational cooperation in the future. The recent example of successful cooperation includes the Multi Role Tanker Transport project that was initiated in EDA and executed by OCCAR and NSPA (the acquisition and in-service support) with first deliveries scheduled in 2020-24.

There is a potential for complementarity between NATO and the EU in the domain of military UAVs: namely maritime unmanned systems and counter-drone technology. To implement NATO's reinforced maritime posture, fourteen NATO member countries have decided to pool their resources and collaborate on interoperable maritime unmanned systems, developing their joint requirements.[197] Launched in October 2018, the Maritime Unmanned Systems initiative explores detecting and clearing mines, finding and tracking submarines, as well as introducing UAVs for maritime surveillance and patrol. The initiative thus consists of several work streams, such as autonomy countermeasures (protect maritime assets and secure seaways and ports from lethal autonomous assets), maritime cyber, JISR, data fusion, and big data analysis.[198]

At the same time, at least three PESCO projects now involve maritime unmanned technology. For instance, within the first batch of PESCO projects chosen in March 2018, the Maritime (semi-) Autonomous Systems for Mine Countermeasures led by Belgium and with participation of Greece, Latvia, Netherlands, Poland, Portugal, Romania aims to develop (semi-) autonomous underwater, surface and aerial technologies for maritime mine countermeasures. These assets are expected to counter the threat of sea mines by protecting maritime vessels, harbors, and off-shore installation and safeguarding the freedom of navigation.

Since not all NATO allies/ EU member states participate in those respective projects, some countries might apply for the EDF capability window for one or more of NATO's maritime unmanned systems work streams. One of potential synergies between NATO and the EU could be found in the ASW capability area. Other non-participating countries do not have veto power over the participation and execution of the projects; for instance, Austria participates in one NATO multinational project because Turkey is not involved in it. The first step in the right direction, which could set a positive precedence, is the Ocean2020 project financed under the EDF's research window PARD – this project includes 42 entities, one of which is NATO's CMRE (although CMRE does not receive any EU money).

The second area for NATO-EU cooperation is the development of counter-drone measures. Indeed, C-UAS is in one of priority areas in the CDP and the joint work on counterterrorism is outcome of NATO-EU joint declaration on enhanced cooperation. Defense against drones could be conceptualized as air defense, army defense, and/ or force protection. The EU puts emphasis on force protection and protection of critical infrastructure against a drone threat. At NATO, an important strand of work concerns a Practical Framework for Countering Unmanned Aerial Systems that would provide missing policy, doctrine, and tactics, techniques, and procedures with an objective to build and offer guidance to employ capabilities to counter small Class I drones. As part of enhancing the Alliance's role in the fight against terrorism and endorsed by Defense Ministers in February 2019, the ambition of the C-UAS Practical Framework is to develop and deliver a coherent, standardized, and interoperable NATO C-UAS capability within 24 months. The Framework covers three areas (countering threat networks, protecting the force, and building partner capacity) and looks at both lethal and non-lethal countermeasures, as well as proportionality and swarm attacks. These efforts are led by the Emerging Security Challenges and Defence Investment Divisions and overseen by the Air and Missile Defence Committee. The output would influence for instance the acquisition of C-UAS for the NATO's Resolute Support Mission in Afghanistan.

Pursuing the objective of building a Counter UAS community, the NATO Staff held a workshop with the European Commission's DG HOME. The workshop included EU member states and Interpol drone expert forum to exchange knowledge on C-UAS requirements. On the EU side, one of the November 2018 batch of PESCO projects already focuses on C-UAS. The "Counter Unmanned Aerial System (C-UAS)" project, led by Italy (which already has a Joint C-UAS Center of Excellence in Latina) and with participation of Czechia, will deal with system development and C2 to counter micro and mini drones in both operational theatres and for homeland defense and security and dual use tasks.

Yet, NATO cooperation with the EU remains sensitive. Most of the obstacles to the inter-institutional cooperation are derived from the fact that their members are not identical. Namely, the Turkey-Cyprus issue prevents the creation of official communication channels between NATO staff and the EDA on the working level due to the impossibility of agreeing on a new security agreement. As a result, for instance, JCGUAS cannot share with EDA military requirements and STANAGs on UAVs. The lack of regular information exchange is particularly challenging in the context of new EU defense financial mechanisms. Existing parallel discussions on the national level represent another challenge: bureaucracy units in the capitals on NATO and the EU agendas respectively rarely talk to each other. Yet the seventy years of NATO's expertise in developing STANAGs is considered a bedrock for multinational cooperation in the transatlantic area. In case the political relations deteriorate, and the fragile information exchange and coordination disappear, the EU would develop standards and military capability requirements that would differ from NATO ones. Consequently, countries would be forced to make a choice as to which institution (each with own differing requirements) they would assign which forces. In this scenario, there would be no winners, only losers.

On a more general note, both NATO and the EU have the mechanisms to further facilitate multinational cooperation on capability development. The common knowledge says that "cooperation in defence programmes is still seen as the best way to rationalise spending and generate economies of scale"[199] and to address "the prohibitive costs of purely national approaches to the development and production of large complex weapons systems in Europe".[200] According to the recent EDA data, the proportion of collaborative capability development projects has risen to one-third in twelve EU member states.[201] Furthermore, multinational cooperative initiatives can help both EU member states and NATO countries avoid "unmanageable interoperability issues in the future."[202] Yet the European defense market still lacks joint defense programs and investments in advanced military capabilities.

The international staffs in both institutions can help overcome the initial difficulties with creating cooperative projects and facilitate solving the collective action problem in at least four ways: 1) channel political will, develop mutual trust, and point to shared interests; 2) identify common operational needs by avoiding over-specification and by linking them to long-term budgetary commitment; 3) design the project framework based on state-industrial governance and divide the labor in accordance with competences rather than with national industrial policy of industrial return; and 4) help participating countries define an export policy at the early stage of the project.

The number of multinational projects might increase, yet their actual delivery is more questionable. The recently created Multinational Capability Cooperation Unit in the Defence Investment Division at the NATO HQ opened the doors for a more active role of the NATO staff in facilitating multinational cooperative projects through networking at the level of NADs, NADREPs, and national delegations and through regular briefings to CNAD. Although it gives NATO more active role in promoting multinational cooperation in the capability development process, the Unit remains severely understaffed.

With PESCO and the EDF, the European Commission's intention is to insert multinational solutions early on in the R&D, procurement, logistics, maintenance, and use of capabilities. In short, it earmarks the European money to influence national political decisions on how to develop European capabilities (however, PESCO is not only about capability development). Some skeptical voices are already suspicious that "the main output will be lots more bureaucracy"[203] and that PESCO may even delay capabilities due to yet unspecified funding and delivery time lines in case of several PESCO projects.[204] In addition, the PESCO selection procedure remains highly politicized, though some informal meetings between the EU Military Staff and DG GROW do connect PESCO to the CDP priorities (the EU Military Staff was not invited to participate in the selection of process of the first batch of PESCO projects). It also remains to be seen how disciplined the PESCO countries will be as they need to report annually on the progress of the projects and submit national implementation plans.

More time is needed to see whether the EDF would represent a real shift. Especially for the central and eastern European countries NATO still takes over the EU when it comes to military capability development. In addition, when put into perspective, money offered through the EDF (not to mention by NIAG) seems insignificant in comparison to the numbers the private industries invest into R&D in the United States. The Fund is therefore not expected to have an overwhelming impact on R&D in Europe any time soon.

The position of the United States Administration represents another hurdle for the EDF success. The EU member states have recently refused the United States' demand to access the EU funding within the EDF framework.[205] Washington replied with a hostile and confrontational tone after the EU declared that the American companies would not be eligible for the EU money. The United States consider the restrictions imposed on the third-country participation unfair especially because it would prevent its industry from competing on the EU defense market. In reaction to the EU refusing the United States a full access to the EU defense money, the United States has already resorted to countermeasures against the EDF: Washington has set up a new tool to subsidize European countries that decide to buy American equipment.[206] The European Recapitalization Incentive Program aims to help former Warsaw Pact countries to transition from the Soviet equipment to American-made products (and effectively locking them within the American equipment over the long-term). The first planned 190 million USD should go to six countries with two focus areas: helicopters in Albania, Bosnia, and Slovakia; and infantry fighting vehicles in North Macedonia, Croatia, and Greece. The second round will target also Poland, Hungry, and the countries in the Baltic region. European defense contractors see behind this initiative "an industry power grab from American companies".[207]

The EU argues that the EDF is "not defined as an instrument for partnership"[208] and aims to boost the European military-industrial complex, not the American one. Especially the European countries with large defense industrial base prefer the strict regulations on the technology and intellectual property transfers outside the EU. Their efforts to decrease the dependence on the American technology will thus continue, not least due to their frustration with the United States' reluctance to share their technological know-how, which has already widened the interoperability gap between the partners on the battlefield, and with the United States government restrictions regarding defense exports between EU member states in case of some defense technologies.[209] While the United States wants to keep an open access to the contracts on the European defense market, the EU considers urgent to improve its ETDIB and to integrate military supply chains. Especially when many of the EU member states have found themselves at "a major turning point," as "a cycle of major [armaments] programs is coming to an end,"[210] the choices over future technology providers will have direct long-term impact on the competitiveness of European industries.

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# Conclusions

This report provided a close look at the diffusion of military UAV technology in Europe and qualitatively assessed the key developments on the European military drone landscape. The political-strategic analysis of military UAV inventories with respect to all main classes in seventeen European countries revealed that despite the continuing proliferation of military drones in Europe, significant differences in military drone capabilities persist among European countries. While most of them have operational experience with small and tactical drones and some have industrial capacity for their production, only a handful of countries have acquired large advanced drones. Importantly, since no European indigenous advanced drone has achieved full operational capability yet, the European countries have to rely on American and Israeli UAV platforms. European countries thus continue to lag behind the United States in the development of military UAV technology. The analysis of the institutional layer also showed that both NATO and the EU, each with their own set of strengths and weaknesses derived from their respective institutional logics, facilitate the diffusion of military UAV technology. Lastly, although UAVs come originally from the military, today it is the commercial sector which sets the trends in unmanned technology.

The findings with respect to the three guiding research questions further indicated that:

**What are the key dynamics on the European defense market regarding military UAVs?**

- The United States continue to hold the monopoly in the category of HALE drones (Global Hawk and Triton platforms).

- Only ten European countries are operating (France, Germany, Greece, Italy, and the United Kingdom) or procuring (Belgium, the Netherlands, Spain, Switzerland, and probably Poland) advanced MALE drones from either the United States or Israel.

- Despite several competing multinational projects, run by the oligopoly of established defense aerospace centers on the European defense market, no flyable, competitive “made in Europe” advanced MALE drone has been developed yet. The most promising of them, Eurodrone, is expected to produce an operational MALE ISR drone, a European equivalent to the American Reaper, by 2025.

- Some European countries have formed various informal groupings, or “drone clubs”, to facilitate knowledge sharing and to develop mentoring relations between the have and the have-nots, and to enhance multinational solutions.

- In contrast to the situation in the advanced drone category, a larger number of countries in Europe possess domestic industrial base to produce TUAVs and SUAVs. Yet, American and Israeli TUAV and SUAV platforms remain popular in Europe.

- Although countries remain interested in tactical drones, there is a lack of clarity about their utility. Yet, the recent trend points to the rising popularity of tactical VTOL-capable drones.

- Commercialization of smaller drones has changed how and where the military procures its equipment. Although UAVs come originally from the military, today it is the civilian sector which sets the trends in unmanned technology.

- SUAV is the most dynamic class of drones, characterized by the highest diversity of users and services, due to the development of dual-use drone technology, economic opportunities, and opening of regulation on the emerging common European drone market.

- The current trend points towards the miniaturization of small drones in the form of personal reconnaissance system to increase troop protection capabilities.

- Although the primary function of UAVs for European countries has been to provide ISR capabilities several countries are now looking into armable MALE drones or arming tactical UAVs. The United Kingdom is the only European country which has used armed drones in lethal operations. France will become the second European weaponizer of MALE drones.

**How do regional institutions shape the European military drone landscape and supply what their member countries demand?**

- NATO and the EU shape the European military drone landscape in their role of facilitators of military technology diffusion, each via its unique institutional logic with a set of strengths and weaknesses.

  – NATO, driven by defense interests and military operational logic, works on military standards for all types of military UAVs, builds expert communities that capitalize on transatlantic link to the American technological and military know-how, provides procurement support, and acquires a fleet of HALE UAVs. NATO makes sure that capability development projects, either individual or multinational, are linked to the NDPP that defines capability targets required from each member country.

  – The EU, following economic interests and market logic, finances drone-related R&D projects, focuses on air traffic integration of drones into European airspace in view to build a globally-competitive common European drone market, supports countries using MALE UAVs, and facilitates contacts between civilian and military experts. The EU's main goal is to strengthen the defense technological and industrial base and to decrease the EU's dependence on foreign military technology by financially incentivizing multinational cooperation among its member countries.

- A more simplified observation points to an institutional division of labor: on the one hand, NATO's community of experts develops a body of military standards and acquires the strategic HALE UAV surveillance capability; on the other hand, the EU supports the development of European indigenous MALE drone capability and its integration into European airspace.

- Both organizations facilitate the diffusion of military technology through various enabling, funding, and networking mechanisms to sponsor R&T and R&D projects, shape requirements and national standards in all UAV categories, provide procurement support, and create networking fora (see TABLE 8).

- Since both CDP/CARD and the NDPP are closely coordinated and synchronized, there is a room for improvement for the inter-institutional NATO-EU cooperation in the area of capability development. If the two organizations manage to keep their cooperative frameworks pragmatic, flexible, and practical, they could combine their efforts to cooperate on future maritime unmanned systems and counter-drone technology.

- The unhealthy condition of the transatlantic relationship further strengthens the call for strategic autonomy among the EU member countries. In turn, the EU's effort to achieve strategic autonomy while the United States want to preserve the full access to the European defense market may negatively affect already strained transatlantic relations.

**Which trends are likely to affect the development, deployment, and employment of UAV capabilities by European countries?**

- The next-generation UAV technology is driven by the increasing level of autonomy and the concepts of manned-unmanned teaming and swarming, as the innovation in unmanned technology will leverage advancements in artificial intelligence, machine learning, and big data.

- The development of new-generation UAVs such as advanced supersonic drones, swarm-based air defense systems, or autonomous combat drones could alter the strategic balance of military capabilities.

- In the context of challenged Western air superiority, future UCAVs would need to perform better in high intensity combat air missions in contested airspace. For this reason, the next-generation drones will also include simplified attritable drones with lower production and acquisition cost. As no autonomous UCAV is close to becoming operational yet, these UCAVs will assume the role of a loyal wingman to manned aircraft.

- From large HALE drones to pocket-sized undetectable drones with powerful sensors, the proportion of unmanned technology as ISR capability will steadily increase. The HAPS technology using renewable solar energy may foster further innovation in unmanned autonomous surveillance platforms.

- As much more data is being collected than can be processed by human operators, the data surge will result in a greater reliance on data analysis software and may in fact negatively influence military effectiveness (who should get the information, how little information is enough).

- UAVs will be more used as electronic support measures (airborne electronic warfare) and for cargo and un-manned refueling (logistics).

- Since the number of state and non-state actors operating armed drones will increase, new or improved existing mechanisms would be needed to ensure effective arms control of weaponized drones, including LAWS.

- The development of counter-drone systems will characterize the future drone race on the European defense market. These should be able to produce a single local air picture (distinguishing between friendly, neutral, and potentially hostile drones), detect, disable, and intercept hostile drones, and even enforce no-fly zones for UAVs.

- Unmanned technology will continue to spread to the maritime, land, and space domains. The future unmanned systems will need to contain technological solutions for hybrid communication navigation network between different operational environments.

Photo from www.ga-asi.com

# Annex I Database of European Military Drones

## BELGIUM

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | 13x RQ-5A B-Hunter (AF) | RQ-20 Puma (A)[211]<br>8x RQ-11 Raven[212] (RRF)<br>Skylark |
| **Manufacturing/ ongoing R&D** | | EuroMALE (observer) | | UX5 HP (Trimble Belgium)<br>Guardian Eye (Aircraft Traders Belgium) |
| **Future acquisitions** | | 4x MQ-9B SkyGuardian for 226m EUR in service by 2025[213]<br>4 additional (European) MALE drones in the longer term for 310m EUR (2029-2030)[214] | tactical drones for 18m EUR (2021-2023) for ISTAR and tactical drones for 6m EUR (2024) for maritime surveillance (N), probably Camcopter S-100[215] | mini drones for 9m EUR (2021 and 2024) for ISTAR |

## CZECH REPUBLIC

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | | RQ-11 Raven, Puma, Wasp III and ScanEagle (A)<br>Elbit Skylark (A) |
| **Manufacturing/ ongoing R&D** | NATO AGS | EuroMALE – PESCO project[216] | | HEAS 90 (company Hacker) |
| **Future acquisitions** | NATO AGS | | Interested in acquiring armable tactical drones by 2024[217] | 6x ScanEagle (A) for 7.8m EUR in 2019; total investments in UAVs until 2025: 39m EUR[218] |

## DENMARK

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | Sperwer (A) | 12x Raven B in 2007 (A, N)[219]; replaced by Puma for 9.6m USD in 2012 (A, N)[220] |
| **Manufacturing/ ongoing R&D** | NATO AGS | | Tårnfalken (adapted version of the French Sperwer; abandoned in 2005)[221] | mini-UAV Heidrun, Huginn VTOL (SkyWatch) |
| **Future acquisitions** | NATO AGS | | Investments foreseen in the Defence Agreement 2018-2023 | |

## ESTONIA

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | | Raven |
| **Manufacturing/ ongoing R&D** | NATO AGS | | | Theia (Threod Systems)<br>ELIX-XL (Eli) |
| **Future acquisitions** | NATO AGS | | Investments planned by 2020[222]<br>RQ-20 Puma from the US by 2021 for 9.8m USD[223] | |

## FINLAND

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | 11x Ranger (AF) | Orbiter 3 (A) |
| **Manufacturing/ ongoing R&D** | | | | MASS Mini-UAV (Patria) |
| **Future acquisitions** | | | Launched studies on investments into new drone technologies | |

## FRANCE

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | 6x MQ-9A Reaper (AF; unarmed, 4 deployed in Niger)<br>4x Harfang (AF) | 23x Sperwer (A)<br>Patroller (A)<br>S-100 Camcopter (N)[224] | Elbit Skylark 1 and 1-LE (SOF)<br>Dracula and Thales Spy Arrow (SOF)<br>Wasp (US; SOF)<br>SpyRanger (A, SOF) |
| **Manufacturing/ ongoing R&D** | | nEUROn<br>Future Combat Air System (France, UK)<br>SCAF (France, Germany, Spain) by 2040<br>EuroMALE | Sperwer, Patroller (Segem/ Safran France)<br>Tanan 300 (Cassidian)<br>VSR700 (maritime VTOL UAV, Airbus)[225] | AR.Drone (Parrot)<br>DRAC (Survey Copter and Cassidian), DVF 2000, Copter 4, Aliaca, UAVTracker 120 (Survey Copter)<br>Delta Y (Delta Drone)<br>LP500 (Lehmann Aviation)<br>SpyRanger (Thales)[226]<br>Airshadow (Drone Volt)[227] |
| **Future acquisitions** | | 6x MQ-9 Reaper by 2019 (projected for 2014-2019), armed probably with AGM-114 Hellfire missiles and six with European munitions by 2020[228]<br>EuroMALE to have 8 MALE ISR systems in total by 2030 (AF)[229] | 15 VTOL systems as part of SDAM (N) and 30 tactical drones/ 5 Patroller systems by 2030 (A)[230] | Acquisition planned for SOF<br>Black Hornet 3 for 77m EUR (A; US)[231] |

## GERMANY

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | 8x Heron 1 (AF; leased from Israel since 2010), extended until mid-2020,[232] deployed in Afghanistan and Mali | 44 KZO (A)<br>84 LUNA (A) | ScanEagle |
| **Manufacturing/ ongoing R&D** | NATO AGS<br>EuroHawk (cancelled in 2013)[233] | EuroMALE<br>SCAF (Germany, France, Spain) | Rheinmetall KZO (A; Cassidian Airborne Solutions)<br>LUNA (A; EMT Penzberg) | Aladin (A; EMT Penzberg)<br>Mikado AR 100 B (A; AirRobot GmbH & Co. KG)<br>Aibot (Aibotix) |
| **Future acquisitions** | NATO AGS<br>Pegasus project: 4x MQ-4C Triton for 2.5b USD from the US, to be signed at the end of 2019[234], operational by mid-2025; ISR only | EuroMALE by 2025<br>Lease 5x Heron TP from Israel until 2027[235] to replace Heron 1 | Buy 15x LUNA by 2020 for 63m EUR<br>Skeldar V-200 (N), operational by the end of 2019[236] | Puma (N) in 2018[237] |

## GREECE

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | 7x Heron (N), leased from Israel for 3 years for 35.5m EUR[238] | 4x Sperwer (A) [239] | |
| **Manufacturing/ ongoing R&D** | | nEUROn | Phaethon J (BSK Defense)<br>HAI Pegasus II (Hellenic Aerospace Industry) | |
| **Future acquisitions** | | | New research program (INTRACOM Defense Electronics)[240] | 25x UAVs (A) for 2.1m EUR[241] |

## ITALY

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | 9x MQ-9A Reaper (AF) since 2006; 2 deployed in Kuwait<br>5 or 6x RQ-1B Predator (AF) since 2001 | | Raven |
| **Manufacturing/ ongoing R&D** | NATO AGS | nEUROn<br>EuroMALE<br>P2HH Hammerhead (Piaggio Aerospace) – cancellation after bankruptcy | Falco EVO (Selex ES/ Leonardo), dual-use[242]<br>AWHERO RUAS (Leonardo) | Asio-B (Selex ES/ Leonardo)<br>IA-17 Manta (IDS) |
| **Future acquisitions** | NATO AGS | 156 Hellfire II missiles, 20 laser-guided bombs, and 30 joint direct attack munitions[243]<br>P.1 HH Hammerhead (AF)[244] | | |

## NETHERLANDS

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | Sperwer | Raven, Scan Eagle (A)<br>Puma (A) |
| **Manufacturing/ ongoing R&D** | | | | HEF 32 (High Eye) |
| **Future acquisitions** | | 4x MQ-9 Reaper by mid-2020s[245]; foreseen investments of 100-250m EUR (AF)[246] | | Integrator (US, program RQ-21A Blackjack) to replace ScanEagle[247] |

## NORWAY

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | | Aladin |
| **Manufacturing/ ongoing R&D** | NATO AGS | | | In the past: Black Hornet (A; Prox Dynamics, acquired by FLIR in 2016)[248] |
| **Future acquisitions** | NATO AGS | | Camcopter S-100 (N)[249] | Nano UAVs II in 2022-25 for150-300m NOK[250] |

## POLAND

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | | Orbiter, ScanEagle, Fly Eye (A)<br>Warmate for 24m EUR |
| **Manufacturing/ ongoing R&D** | NATO AGS | | Orlik (PGZ SA ; WZL-2; PIT-Radwar)[251]<br>Manta (WB Electronics, Flytronic) | FlyEye (Flytronic, WB Electronics – also exporting)<br>Albators (VTOL)<br>Bee, Warmate/CUAV (WB Electronics)<br>DragonFly (Ważka, Wojskowy Instytut Techniczny Uzbrojenia) |
| **Future acquisitions** | NATO AGS | Zefir program (currently delayed[252]): procurement of either Israeli Hermes 900 or US MQ-9 Reaper, potentially armed; in total 6x MALE by 2022[253] | 24x Gryf/UCAV (A) by 2022; based on either British WK450 Watchkeeper or Israeli Hermes 450[254]<br>40x Orlik PGZ-19R (A) by 2023 for 790m PLN; another 20 planned by 2026[255]<br>Albatros (N)[256] | RQ-21A Blackjack for SOF for 1.2m USD (US)[257]<br>12x FlyEye for 10m PLN[258]<br>25x Wizjer by 2022[259]<br>6x Wazka (Dragonfly) system (A)[260] |

## PORTUGAL

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014–2018)** | | | | |
| **Manufacturing/ ongoing R&D** | | | | AR2 Carcara, AR 4 (Tekever Autonomous System) |
| **Future acquisitions** | | | Ambition to build TUAV domestically for AF by consortia[261] | 12x RQ-11B Raven (A) by 2021 for 5.9 m EUR for ISTAR missions[262] |

## SPAIN

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014–2018)** | | | 4x Searcher Mk III, 2x Searcher Mk II-J (A)[263] | Wasp, Raven, Puma (A)<br>Huginn (A, N)<br>ScanEagle, Black Hornet (A, N) |
| **Manufacturing/ ongoing R&D** | | EuroMALE<br>nEUROn<br>SCAF (France, Germany, Spain)[264] | Atlante (Airbus) | Fulmar (Wake Engineering)<br>Sniper (Alpha Unmanned Systems)<br>Atlantic, Tucan (SRC Everis)<br>Prototypes only: ALUA, SX8-UAV (SERTEC), SCRAB (SRC)[265]<br>Mantis, Pelicano (Indra) |
| **Future acquisitions** | | 15x EuroMALE by mid-2020s[266]<br>4x MQ-9 Reaper B (AF), operational by 2020[267] | Interested in acquiring armed tactical drones | The RAPAZ program:[268]<br>Fulmar X (A, N; Thales) for 1.3m EUR[269]<br>Investment of 4.3m into SUAVs to protect overseas training missions[270]; chose 6x Orbiter 3 (A) for 3.1m EUR[271]<br>2x Atlantic (A) and 6x Tucán (A, AF-training) for 1.5m EUR[272]<br>Condor (Dronetools), Conyca (Geodrone), Tarsis 75 (Aertec Solutions), anti-drone system Drone Hunter (IPB Systems) [273]<br>Antidrone system Drone Defender V2 (N) for 2m EUR[274] |

## SWEDEN

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | UAV01 Ugglan/ Sperwer (A)<br>8x UAV 3 Örnen/ RQ-7 Shadow (AF)<br>Eagle 2 | Swallow, UAV05 Svalan/ Raven Scout (A)[275]<br>UAV02 Falken/ Skylark I (A/SOF; Israel) since 2007[276]<br>Puma, Wasp (A)[277] |
| **Manufacturing /ongoing R&D** | | nEUROn<br>Tempest (UK, Sweden) | Apid 60 (N; CybAero) – bankrupt in 2018[278]<br>Skeldar V-200B (Saab together with Swiss UMS) | Dual-use drones (UAS Europe AB) |
| **Future acquisitions** | | | | |

## SWITZERLAND

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | | 16x Ranger (AF) | |
| **Manufacturing/ ongoing R&D** | | nEUROn | V-200, F-720 (UMS Skeldar) | eXom, eBee (SenseFly) |
| **Future acquisitions** | | 6x unarmed Hermes 900 by 2020 for 250m CHF to replace Ranger[279] | | Planned investment of 8m CHF to procure Orbiter 2 or Fly Eye |

## UNITED KINGDOM

| | HALE UAV | MALE UAV | TUAV | SUAV |
|---|---|---|---|---|
| **Currently operating/ operational experience (2014-2018)** | | 9x MQ-9A Reaper (AF), armed with Hellfire missiles[280], 8 deployed in Kuwait | Hermes 450<br>7 (and 37+ instore) x Watchkeeper (A) | Black Hornet<br>Scan Eagle (N) |
| **Manufacturing/ ongoing R&D** | HAPS Zephyr (Airbus) | FCAS (UK, France)<br>Tempest (UK, Sweden) | Gull 68 (Warrior Aero Machine)<br>Herti (BAE Systems)<br>Watchkeeper (Thales UK)[281] | RedKite (Blue Bear Systems Research) |
| **Future acquisitions** | MQ-4C Triton | Double the number of MALE UAVs by 2025[282]: 16x Protector (AF, "armed Sky Guardian) to be fully operational by 2024 and armed with Brimstone 2 missiles and Raytheon UK Paveway IV precision-guided bomb[283]; overall investments of 800m EUR into MALE by 2025[284] | | 30 Black Hornet (A) for £1.4m[285] |

**NOTES**
A = Army
N = Navy
AF = Air Force
RRF = Rapid Reaction Forces
SOF = Special Operation Forces

If not specified, the data come from one of the following five databases: 1) Fuhrman and Horowitz (2017) – drones per country between 2014-2016; 2) Center for a New American Security's Proliferated Drones – drone manufacturers per country; 3) International Institute for Strategic Studies' Military Balance (2018, 2019) – drones per country in 2017 and 2018; 4) Boosting Defence Cooperation in Europe (2018) – future investments into UAS; and 5) European Forum on Armed Drones – in-service drones per country

Since SUAV is the most dynamic category of drones and dominated by civilian commercial sector, this database lists only the most important and commonly-used platforms.

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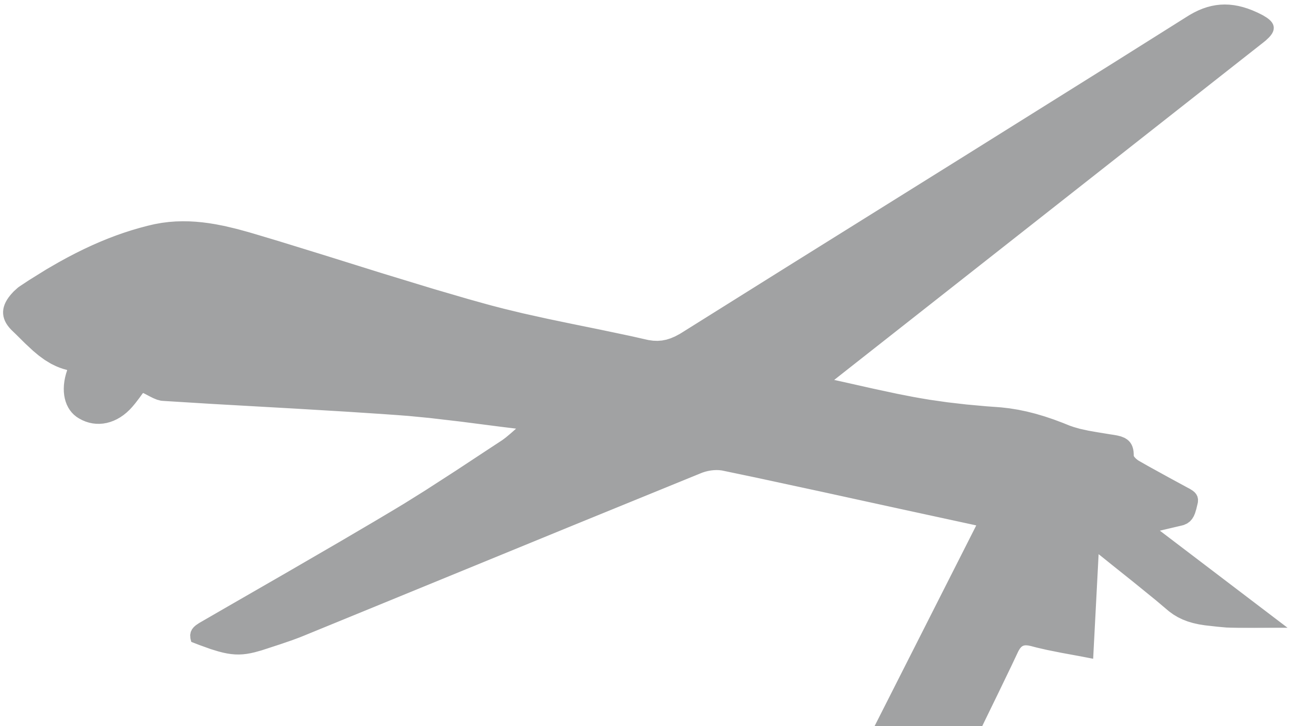

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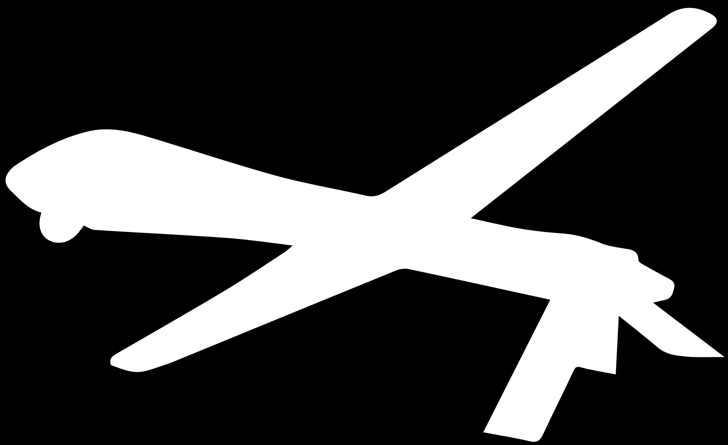

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