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Remote Defence

Unmanned & autonomous systems take hold in military toolboxes

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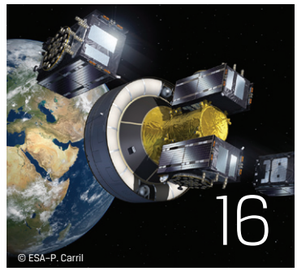

We hope this magazine will provide valuable food for thought and information about EDA's work. Should you have comments or recommendations, please get in touch: info@eda.europa.eu

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WELCOME

Great potential, many challenges

They are omnipresent in our daily lives and their potential keeps growing: smart machines and applications able to autonomously carry out tasks hitherto reserved for humans – from cutting grass to cleaning floors and driving cars. Certain autonomous functionalities have already made their way into the military domain where their possibilities are immense. The question is not *IF* unmanned and autonomous platforms will become key components of our defence toolboxes, but *HOW* Member States, armed forces and industry decide to prepare for what could be a technological, potentially disruptive step change for defence. The fact that unmanned/autonomous related aspects are included in several of the 11 EU Capability Development Priorities approved last June bodes well for the future as it shows that national and European defence planners agree on their enormous potential.

In this special edition of *European Defence Matters*, designed to introduce and nurture the debate at this year's European Defence Agency (EDA) Annual Conference (29 November 2018) on "From Unmanned to Autonomous Systems: trends, challenges and opportunities", our editorial team looks at the extent to which unmanned and autonomous applications are already used in the various military domains (land, air, maritime, space, cyber) and what their main challenges and opportunities are, now and in the future. They also touch upon EDA's work supporting Member States and industry in this new domain, from research to capability development. The industrial, regulatory and military/operational viewpoints are also represented through a series of interviews. I am particularly grateful to Eric Trappier (Dassault Aviation CEO), Patrick Ky (EASA Executive Director) and General Graziano (EUMC Chairman) for having agreed to share their views with our readership.

Let me conclude with an important remark. Considering the political, legal and also ethical aspects involved, it is worthwhile stressing that the use of force must always abide by international law (including International Humanitarian Law and Human Rights Law) and that this also applies to unmanned and autonomous weapon systems which must always remain under human control. Political, legal or ethical considerations related to fully autonomous weapons capable of taking decisions on life and death without humans in the loop are not assessed in this magazine, nor will they be addressed at EDA's Annual Conference, because they are outside the Agency's mission, work scope and competencies. Political discussions are underway in the appropriate fora (including the UN and the EU) to define common principles and boundaries for the military use of artificial intelligence and autonomous weapons. It is important, and urgent, that the research community and industry are provided with the required clarity about the limits in which they can explore the contribution unmanned and autonomous systems could make to strengthen Member States' defence capabilities, and with them European defence.

Jorge Domecq
EDA Chief Executive

From unmanned to (more) autonomous systems

Over the past decade, unmanned systems have become regular features in military operations. The extensive use of unmanned aerial vehicles (UAVs), in particular, has turned the spotlight on the huge operational benefits those systems can have, with a potential scope of action extending far into the land and maritime domains and even to space and cyber-related activities.

We are probably only at the beginning of a new technological (r)evolution as unmanned systems will get ever more autonomous with the help of Artificial Intelligence (AI) and cognitive computing. For defence capability planners, developers and operators, this means a lot of new challenges but also opportunities.

In the following pages, we assess some of those challenges and opportunities in the land, maritime, air, space and cyber domains respectively and ask the views of industry, regulators and military commanders.

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Autonomy of unmanned ground vehicles is today still limited to simple functions like 'follow me' and waypoint navigation

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Paving the way for autonomy in land systems

In the land domain, weapon systems with autonomous functions are well established assets used by Armed Forces to enhance soldier or camp protection. Their technological potential is considerable, as are the challenges they face.

The best known defence system with autonomous functionality currently deployed by the Armed Forces is the Active Protection System (APS) for armoured vehicles, which autonomously destroys incoming anti-tank missiles, rockets or projectiles. To be able to do that, APS combines either radar-based or infrared (IR) sensors which detect incoming projectiles with a fire control system that can track, evaluate and classify threat scenarios.

The entire process, from detection to tracking and engagement, is fully automatised as human intervention would only slow it down or make a timely response impossible altogether. Human operators simply couldn't act quickly enough to authorise or even supervise the required response. However, APSs are always pre-programmed in such a way that users can anticipate the exact circumstances under which the system will have to engage and respond, and in which cases it shouldn't. The type of threats that will trigger an APS response are known in advance or at least predictable with a high degree of certainty.

Similar principals also determine the functioning of other autonomous land weapon systems like Counter Rocket, Artillery and Mortars (C-RAM) systems used to protect military bases in war zones. Both APS and C-RAMs can thus be considered as autonomous systems which, once activated, do not require human intervention.

A challenge: autonomy for unmanned ground vehicles

To date, unmanned ground systems are usually used for explosive detection and disposal or reconnaissance of terrains or buildings. In both cases, robots are tele-operated and remotely controlled by human operators (although some robots could perform simple tasks like point-to-point movement without constant human help). "The reason why human intervention remains crucial is that unmanned ground vehicles face tremendous difficulties when operating autonomously in difficult and unpredictable terrain. Having a vehicle moving autonomously on a battlefield where it has to circumvent obstacles, cross moving objects and face enemy fire is much more complex – due to unpredictability – than using an autonomous weapons system such as the afore-mentioned APS", says Marek Kalbarczyk, EDA's Project Officer Land Systems Technologies. Therefore, autonomy of unmanned ground vehicles is today still limited to simple functions like 'follow me' and waypoint navigation. The 'follow me' function can be used either by unmanned vehicles to follow another unmanned/manned vehicle or a soldier, while waypoint navigation allows a vehicle to use the co-ordinates (as defined by an operator or learnt by the system) to reach its desired destination. In both cases an unmanned vehicle uses GPS, radar, visual or electromagnetic signatures or radio links to follow the lead vehicle or defined/learnt path.

Soldier protection

From an operational point of view, the objectives for using such autonomous functions are usually to:

- decrease exposure for soldiers in dangerous zones by replacing drivers with unmanned vehicles or driverless kits with autonomous following function in convoys, or
- provide support to troops in remote areas.

Both functions commonly rely on a so-called 'avoid obstacle' feature to prevent collisions with obstacles. Due to the complex topography and shape of certain land areas (hills, valleys, rivers, trees, etc.), the waypoint navigation system used in land platforms has to include LiDAR (Light Detection And Ranging) capabilities, or be able to use pre-loaded maps. However, since LiDAR relies on active sensors, and therefore is easy to detect, the research focus is now shifting towards passive vision-based systems. Pre-loaded maps are sufficient though when unmanned vehicles operate in well-known environments for which detailed maps are already available (for instance when used to monitor and protect borders or critical infrastructures). →

However, LiDAR is imperative for waypoint navigation every time unmanned vehicles have to enter complex and unpredictable environments. The problem is that LiDAR has its limits too, i.e. that its reliability can only be guaranteed for unmanned vehicles operating in semi-complex terrain.

Hence the need for further research and development in this domain. To that end, several technology demonstrators have been developed – for example ADM-H or EuroSWARM – with a view to exploring, testing and demonstrating more advanced functions, including autonomous navigation or cooperation of unmanned systems. These demonstrators, however, are still at an early research phase.

Many challenges ahead

Limited LiDAR is not the only challenge that unmanned ground vehicles are facing. According to the Unmanned Ground Systems Landscaping and Integration Study (UGS LIS), funded by the European Defence Agency (EDA), as well as another EDA-financed study on the 'Identification of all major technical and safety requirements for military unmanned vehicle to operate in combined manned-unmanned mission' (SafeMUVe), the challenges and opportunities can be divided into five different categories:

1. Operational: There are plenty of potential missions that can be envisaged for unmanned ground vehicles with autonomous functions (communication node, area surveillance, zone and route reconnaissance, casualty extraction, CBRN reconnaissance, follower mule, convoying for the distribution of supplies, route clearance, etc.), but operational concepts to back and underpin these are still lacking. It is therefore difficult for developers of unmanned ground vehicles with autonomous functions to develop systems which for sure will meet military requirements. Creating a forum or working group of defence users of unmanned ground systems with autonomous functions could solve this problem.

2. Technical: The potential benefits of unmanned ground vehicles with autonomous functions are considerable, but so are the technical hurdles still to overcome. Depending on the envisaged mission, unmanned ground vehicles can be equipped with different payload suites (sensors for ISR or CBRN monitoring and detection, manipulators for explosives handing or weapon systems, navigation and guidance systems…), intelligence kits, operator control suites and control hardware. This means that several enabling technologies, such as decision making/cognitive computing, human machine interaction, computer vision, state of battery technologies or collaborative intelligence, are absolutely critical. In particular, unstructured and contested environments pose huge challenges to both navigation and guidance sensors. Here, the way forward has to include the development of new sensors (quantum positioning, ultra-cold atom interferometers, smart G&C actuators…) and techniques such as decentralised and cooperative SLAM (Simultaneous Localization and Mapping) and 3D mapping, relative navigation, advanced hybridisation and data-fusion of available sensors as well as vision/IR aided mobility. The problem is not so much of a technological nature – because most of these technologies are already used in civilian applications – but rather of a regulatory order. Indeed, such technologies cannot immediately be used for military purposes as they need to be adapted to specific military requirements.

Against this backdrop, the EDA's Overarching Strategic Research Agenda (OSRA) is a tool that can deliver this missing piece. Under OSRA, several so-called Technology Building Blocks (TBBs) are being developed, addressing technology gaps related to unmanned ground vehicles, for instance: – Manned/unmanned teaming, adaptive cooperation between man and unmanned system with different levels of autonomy; Health and usage monitoring; Novel User Interfaces for Soldier (assets integration/control); Navigation in GNSS denied environment; Autonomous and automated GNC and Decision Making techniques for manned and unmanned systems; Multi-robot Control and Cooperation; Precision guidance and control of weapons; Active imaging systems; Artificial Intelligence and Big Data for Decision Making Support.


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> The increased use of unmanned and autonomous land systems will require changes in the military educational system too, to properly train system operators

Each TBB is owned by a dedicated panel (called CapTech) composed of governmental, research and industrial experts. Each CapTech will develop a roadmap for each TBB.

3. Normative/Legal: An important obstacle for the introduction of autonomous systems in defence is the lack of suitable verification and evaluation procedures or certification processes which can be used to prove that even the most basic unmanned ground vehicle with autonomous functions is able to operate correctly and safely, even in hostile and complex environments. In the civil domain, self-driving cars are facing the same problems. According to EDA's SafeMUVe study, the main gaps identified with respect to specific standards/best practices are concentrated in the modules related to the higher layer of autonomy, namely 'Automation' and 'Data fusion' aspects. Modules such as 'Environment perception', 'Localization & mapping', 'Supervision' (Decision-making), 'Motion planning', etc. are still in mid technology readiness levels (TRLs), and although several solutions and algorithms exist to perform the different tasks, no standards are yet available. In this sense, there is also a gap in terms of verification and certification of these modules, partly addressed by the EU funded European Initiative to Enable Validation for Highly Automated Safe and Secure Systems (ENABLE-S3) project. The recent establishment, by the EDA Steering Board, of a Land Test Centres Network of Excellence (LTE) is a first step in the right direction. The LTE allows national test centres to undertake joint initiatives in view of preparing the testing of future technologies, such as automotive systems and robotics.


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Patria AMV Vehicles during the Autonomous Vehicle Convoy Test at ELROB 2018 (Patria AMV 8x8 High Roof Version followed by autonomous Patria AMV 8x8)

4. Personnel: The increased use of unmanned and autonomous land systems will require changes in the military educational system too, to properly train system operators. Especially, military staff need to understand the technical principals of a system's autonomy to ensure they can properly operate and control it when necessary. Building trust between a user and an autonomous system is a prerequisite for the wider use of unmanned ground systems with higher autonomous functions.

5. Financial: Whereas commercial global players like Uber, Google, Tesla or Toyota are investing billions of Euros in developing self-driving cars, military spending on unmanned ground systems is much more modest, and fragmented too, as Member States have their own national development plans. The EU Preparatory Action on Defence Research (PADR) and the future European Defence Fund should help consolidate funding and support a European collaborative research approach to develop unmanned ground systems with more advanced autonomous functions.

EDA work

EDA has already been active in the unmanned systems land domain for some time. Specific technology aspects such as mapping, path planning, vehicle following, or obstacle avoidance were developed in collaborative research projects like SAM-UGV or HyMUP, both of them jointly funded by France and Germany.

The SAM-UGV project aimed to develop an autonomous technology demonstrator based on a mobile land system platform and characterised by a modular architecture both in hardware and software. In particular, the technology demonstrator proved the concept of scalable autonomy (switching between tele-operation, semi-autonomous and autonomous behaviour). The SAM-UGV project was further developed under the HyMUP project which proved the feasibility of mounted combat missions of unmanned systems, in coordination with regular manned vehicles.

Additionally, the protection of autonomous systems against enemy interference, safety requirements for combined manned-unmanned mission and the standardisation of UGVs are currently being addressed in EDA's PASEI project, as well as in the SafeMUVe and SUGV studies respectively.

Making waves

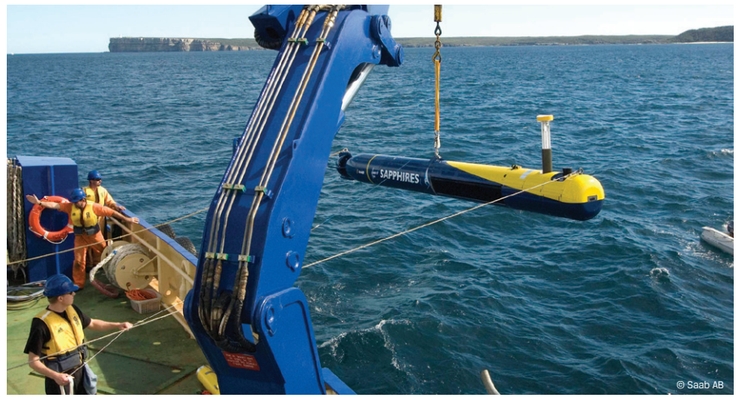
Unmanned Maritime Systems are a key component in the modernisation and transformation of naval forces, offering the opportunity to reshape and change the way navies are structured and operate, resulting in more agile and networked forces.

Unmanned maritime systems (UMS) are having a significant impact on the nature of warfare globally. With an increased availability of, and price decrease in, components and technologies that can be used in military systems more and more state and non-state actors are gaining access to the world's seas. Recent years have seen a proliferation of UMS in the maritime domain and so it is imperative that programmes and projects be pursued that ensure navies possess the requisite technologies and capabilities to guarantee the safe and free navigation of the seas.

The impact of fully autonomous systems is considered to be so extensive that any area of defence that misses out on this particular technological leap will also miss out on the technological evolutions of the future. Unmanned and autonomous systems can be used in the military domain to execute complex and exacting missions, especially in environments that are hostile and unpredictable, and the maritime domain perfectly illustrates this. The maritime world is challenging, often unmapped and difficult to navigate and these systems can be used to negate some of these challenges. They have the ability to complete a task without direct human intervention, using behaviours resulting from the interaction of computer programming with the external environment.

It can be argued that the applicability of UMS to naval operations surpasses its usage in any other military domain due to the hostility, unpredictability and size of the maritime environment. This complexity has ensured that every significant form of progress in the conquest of the seas has required a strong will and the mastery of the most sophisticated scientific and technological applications. This has always been the key to success.

> The maritime world is challenging, often unmapped and difficult to navigate and unmanned systems can be used to negate some of these challenges



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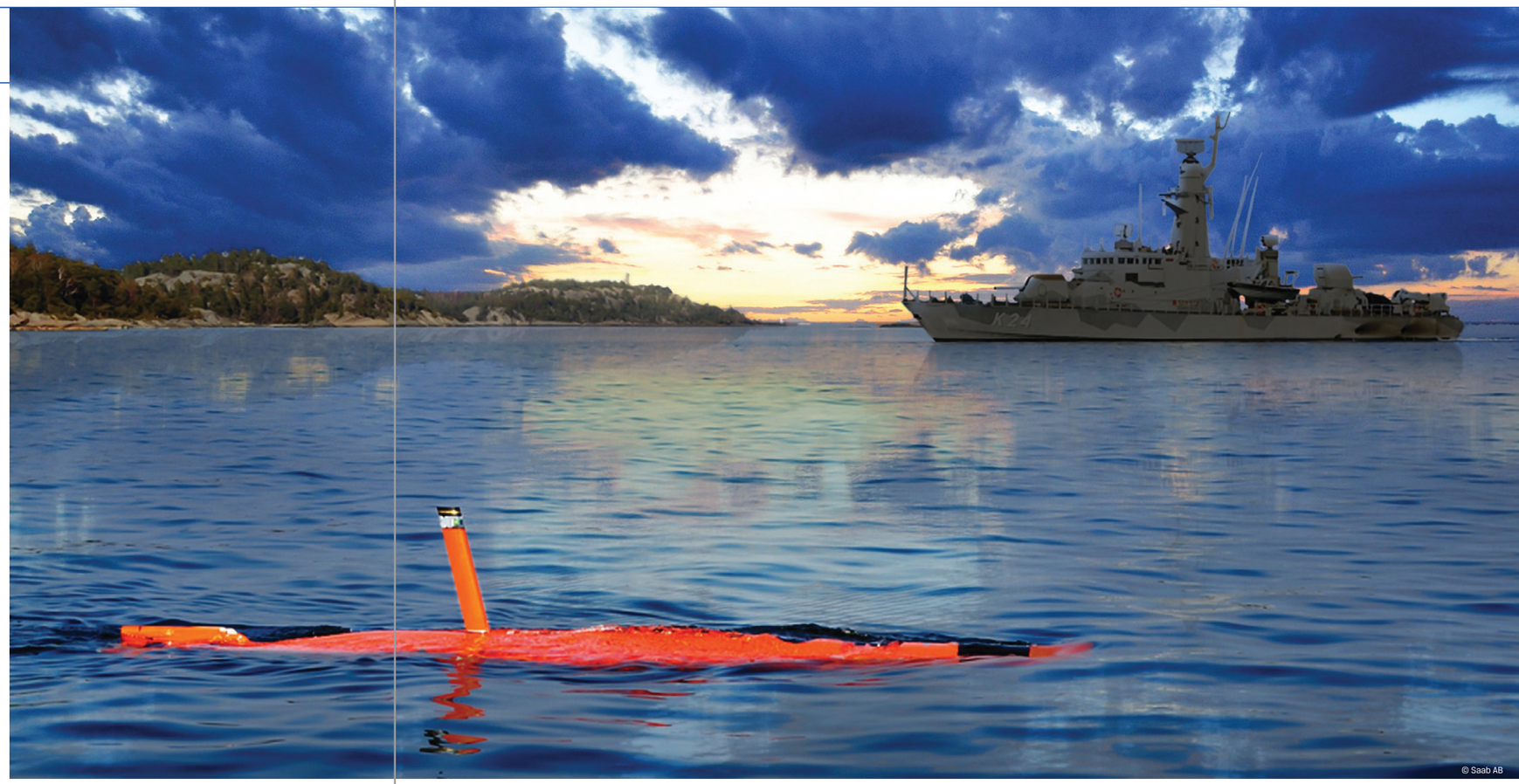

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UMS are becoming a more common feature of navies and they are being primarily utilised in a non-lethal capacity such as mine countermeasures, Intelligence, Surveillance and Reconnaissance (ISR) and intelligence gathering in the maritime environment. Furthermore, it is in the underwater domain that UMS have the greatest potential for adoption and utilisation. The undersea domain is becoming more fiercely contested, with increased competition for maritime resources and the continuing need to preserve sea lines of communication.

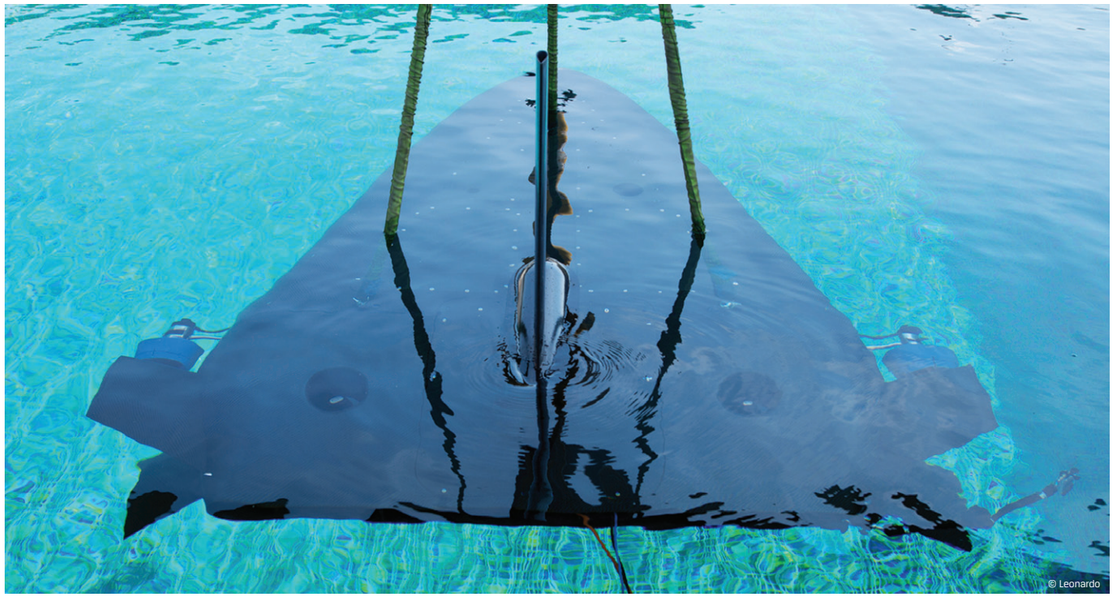
Many opportunities, but also challenges

The underlying technologies that support autonomous systems, including robotics, artificial intelligence, software and wireless networks all continue to develop rapidly. These advances offer additional opportunities to make a wider variety of autonomous systems that are smaller, cheaper and able to operate in swarms to overwhelm adversary defences. This ability to function autonomously would therefore allow systems to reach their goals, even in unpredictable and unstructured environments such as undersea landscapes, with a wide range of benefits such as the faster execution of tasks, higher level of readiness, increased coordination and synchronisation with other platforms and increased redundancy, range and persistence.

There is a perception that the principle benefit of UMS is the removal of personnel from the battlefield and the introduction of a direct machine replacement. In consideration of unmanned systems and developments in autonomy these systems should be viewed as complementary to personnel, where the benefits of autonomy are used to augment existing human capabilities for the success of the mission. "It is not a question of putting humans versus machines, but rather to take advantage of the benefits machines can bring to make personnel more effective", explains Paul O'Brian, the European Defence Agency's (EDA's) Project Officer for Naval Systems Technology.

Embracing new technologies

There still exists a challenge relating to the adoption and integration of UMS into the naval defence framework. The success of this is not only dependent on the development or acquisition of technology but also on organisational structures, the prevailing culture and the operational paradigms and tactics that need to be modernised. Referring back to the undersea environment, commanders are accustomed, more than their colleagues in other domains, to delegating tasks to assets that need neither constant monitoring nor control, as this could be detrimental to success rather than beneficial. The subsea culture →



Leonardo V-Fides wire-guidable vehicle for underwater identification & detection used both as ROV (Remote Operated Vehicle) and AUV (Autonomous Underwater Vehicle)

would thus appear to be the most receptive to autonomous unmanned vehicles.

EU Capability Development Priority

Underwater control, comprised of Mine Warfare, Anti-Submarine Warfare (ASW) and Harbour Protection, has been identified as one of the eleven 2018 EU Capability Development Priorities which were developed through EDA and approved by Member States in June 2018. Collaborative efforts to date have largely focussed on the development of technologies for Mine Counter Measures activities, as evidenced by EDA's UMS programme. ASW remains complex due to the nature of the platforms operating under the surface, and developments have been less visible in this area of warfare. However, UMS offer significant force multiplication options for ASW operations. This is particularly pertinent given the increasing proliferation of submarines and smaller submarines that can operate more easily in littoral zones. UMS can serve as offboard sensors, extending the range of detection without the corresponding increase in risk. Additionally, and as discussed previously, the capability to launch multiple vehicles provides a coordinated swarm effect and facilitates the coordination of patrols composed of different self-adaptive systems.

OCEAN2020

OCEAN2020 (Open Cooperation for European mAritime awareNess), funded by the European Commission's Preparatory Action on Defence Research and implemented by EDA, represents the ambition and vision of a European maritime initiative to respond to the above-mentioned challenges. The project has the principle objective of demonstrating enhanced situational awareness in a maritime environment through the integration of legacy and new technologies for UMS, ISTAR payloads and effectors, by pulling together the technical specialists in the maritime domain covering the 'observing, orienting, deciding and acting' operational tasks.

OCEAN2020 will pursue improvements in Unmanned Aerial Systems (UAS), Unmanned Surface Vehicles (USVs) and Unmanned Underwater Vehicles (UUVs) engaged in the project with the objective of achieving higher autonomy, launch and recovery capabilities, integration in existing ships Combat Management Systems (CMS) and in open architectures and sensor improvements. The project will culminate in two demonstrations, in the Mediterranean and Baltic seas. These events will show how innovative solutions for fusion of multiple data sources can be integrated with CMS into a secure network to create a recognised maritime scenario. It will also show how collaborative autonomy between multi-domain unmanned vehicles can provide a force multiplier.

> The applicability of UMS to naval operations surpasses its usage in any other military domain due to the hostility, unpredictability and size of the maritime environment

Change is in the air

Remotely Piloted Aircraft Systems (RPAS) are well-established in most European military forces where their operational benefits are both valued and exploited to the full: enhanced endurance, reduced risks to aircrew, an extended flight envelope due to the non-existence of human constraints, are examples. Does this mean they are the total panacea to modernise and improve national air capabilities? To answer this, we need to look at the pros and cons viewed from several different perspectives for today and looking ahead to the future.

Removing the pilot from the platform has obvious benefits but can also create new problems. Payload, for instance, is a prominent limiting factor when it comes to endurance and operational range but is offset by the need to install autonomous enabling systems with appropriate levels of redundancy. Furthermore, having a pilot onboard who can make quick and effective decisions in a multitude of unforeseen situations is a powerful control that can only partially be replaced by technology.

While sophisticated on-board systems might react faster, they are by no means cheap and even with advanced technology can still be fallible, even in simple but unfamiliar circumstances. Finally, because the safety of the other airspace users and of the people on the ground must be fully guaranteed, no compromise can be made on safety related functions. In turn, this also means that no instant budgetary savings can be expected as a result.

"Air Traffic Insertion (ATI) is another important aspect to be taken into account. In the ATI area, where the European Defence Agency (EDA) supports the on-going European MALE RPAS development, the system →

The European MALE RPAS is the first unmanned aerial system designed for flight in non-segregated airspace, its characteristics will include mission modularity for operational superiority in intelligence, surveillance and reconnaissance, both wide area and in-theatre

specification – and more specifically its safety levels – must match or even exceed the performances of a manned system," says Jean-Youri Marty, EDA Deputy Director & Head of Unit Air Domain. These are well identified technical issues addressed by EDA Members States through cooperative projects such as MIDCAS (Detect and Avoid) and ERA (RPAS Automation), but there is still some work to be done to prepare future systems.

With a growing level of autonomy, especially when leveraged by Artificial Intelligence (AI), RPAS will also challenge the approach to verification in the aviation environment, currently not adapted for the certification of non-deterministic systems. This issue has been identified as one of the key priorities to be addressed through the EDA Industry Exchange Platform on RPAS Air Traffic Insertion which has been established to steer the discussion between EDA, its Member States, European industry and stakeholders for the identification of the new research projects required to ensure the full integration of RPAS in European airspace.

Finally, in a peacetime environment, the challenge is also to integrate such a platform alongside the manned aircraft within a modernized European ATM system which will be a fully interconnected system enabled by a progressive increase of the level of automation support.

That said, the afore-mentioned operational benefits are a reality and make unmanned aerial vehicles (UAVs) truly valuable assets. As a consequence, the numbers of UAVs in the inventories of Member States' Armed Forces are expected to grow significantly over the coming years, be it for ISR (Intelligence, Surveillance and Reconnaissance) missions with systems ranging from micro-UAV to large, high-altitude platforms or for deep strike combat missions carried out with low-observable Unmanned Combat Aerial Vehicles (UCAVs).

Issues to be addressed to explore the full potential of UAVs

Nevertheless, many technological, regulatory and training-related challenges are still to be addressed and fixed before a wide range of unmanned aerial systems can realise their full operational potential.

As discussed previously, ensuring a safe air traffic integration of Unmanned Aerial Systems (UAS) into controlled airspace (and also into non-controlled airspace) as well as providing adequate cyber-protection of systems (which are by design highly connected) are among the key challenges to tackle.

Independence from third (non-EU) countries and companies also has to be guaranteed to ensure Europe can achieve the appropriate level of strategic autonomy that is required in this crucially important defence capability domain. This is exactly what EU Member States are doing by developing cooperative projects to come up with cutting-edge European technical solutions.

Providing suitable and comprehensive mission training and opportunities for tactical development and building a shared operational culture can also be challenging as RPAS units are - unlike conventional air force squadrons - often isolated and geographically separated from their coalition partners with little opportunity for cross-pollination of ideas or to build professional relationships. Moreover, many training regimes are highly platform specific and may be bound by intellectual property rights (IPR) and contractual restrictions that can restrict interoperability between platform types.

EMALE RPAS Community Working Group

The European Medium Altitude, Long Endurance, (EMALE RPAS) Community Working Group is chaired by EDA and, together with the European Air Group (EAG), supports Member States' efforts to resolve some of these issues. Since 2016, the Working Group and the EAG have been looking to improve communication and interoperability between their national RPAS communities through regulator meetings looking at doctrine, operational procedures, training, logistics and maintenance domains for synergies and opportunities to pool and share resources. The latest initiative is a low-cost training technology demonstrator project, which will see the deployment of 10 generic, desktop simulators across national RPAS centres of excellence and schools. The system is linked over a private network which will allow basic tactical training and communication between sites so that approaches to training and teaching protocols can be shared, procedures streamlined/standardised and best practices identified by all participants. The demonstrator will run until 2021 but its practical benefits will remain and further develop in the longer term, as building trust and understanding is the ultimate enabler for improved coalition capability.

> RPAS technologies are evolving rapidly. As the volume of real-time flight information available is skyrocketing, the need to assist the pilot or the operator in his decision-making is also growing

Step by step towards autonomous systems

RPAS technologies are evolving rapidly. As the volume of real-time flight information available is skyrocketing, the need to assist the pilot or the operator in his decision-making is also growing. Today's technologies make this possible: auto-pilot functions, anti-collision systems, real-time flight plan adjustment systems to avoid turbulent areas are already assisting pilots in their job. The next technological step would be the automation of the decision-making itself, leading gradually to autonomous systems.

As technology progresses (especially in terms of computing power and AI), we will see an increase in the automation level for certain functionalities potentially reaching fully autonomous capabilities for specific scenarios. Removing the human from the loop therefore becomes a technological option and might even be considered in cases where communication networks fail or short reaction times (not compatible with satellite communication links) are crucial.

Other scenarios in which RPAS can benefit from autonomous capabilities include emergency situations where multiple failures (loss of communication links, in particular) are involved. In such an emergency situation, the aircraft will still be able to react and behave in a timely and predictable way despite the unpredictable environment, ensuring the safety of other airspace users as well as the people and property on the ground.

Cooperative approach to emerging RPAS-related challenges is crucial

The relevance of UAVs for defence goes beyond large RPAS, like MALE systems, because more and more sophisticated micro and mini UAV systems are being exploited by a large spectrum of users, including some with malicious intent. Those systems are already (and increasingly) a threat to Member States' Armed Forces. Developing a response to this specific threat is now a must. Tackling this challenge through a cooperative approach is more than ever needed as it would enable Member States to synchronise their national efforts with a view to delivering common solutions which are quick, efficient and interoperable.

Whatever the level of autonomy Member States will decide to choose for their unmanned aerial systems, "a cooperative approach to proactively manage such potential projects in an EU context would certainly make sense, to take full advantage of technological progress while remaining in full control of the evolution in a coherent way across Europe," Mr Marty concludes.

The future needs space

© ESA-Stephane Corvaja

Space-based support has become almost indispensable for the military use of unmanned and autonomous applications, in particular when other (ground-based) services are unavailable or unreliable.

The revised 2018 Capability Development Plan (CDP) with its 11 EU Capability Development Priorities clearly reflects the indispensability of space as an enabler for the use of unmanned and autonomous systems in defence. Unmanned maritime high-end platforms, for instance, which have just been identified as a European priority to achieve maritime surface superiority through long endurance at sea, are just one example where support from space-based applications has become critical.

Equally, a whole range of other unmanned systems already used by the Armed Forces – such as Medium Altitude Long Endurance Remotely Piloted Aircraft Systems (MALE RPAS), smaller Unmanned Aerial Vehicles (UAVs) or even micro-drones, – will basically not be able to deploy and project their Information, Surveillance and Reconnaissance (ISR) capabilities. "If those systems don't have access to strong and resilient space telecommunication systems, space situational awareness tools and Positioning, Navigation and Timing (PNT) support provided by satellites, they are simply not operational", says Holger Lueschow, EDA's Programme Manager Satellite Communication.

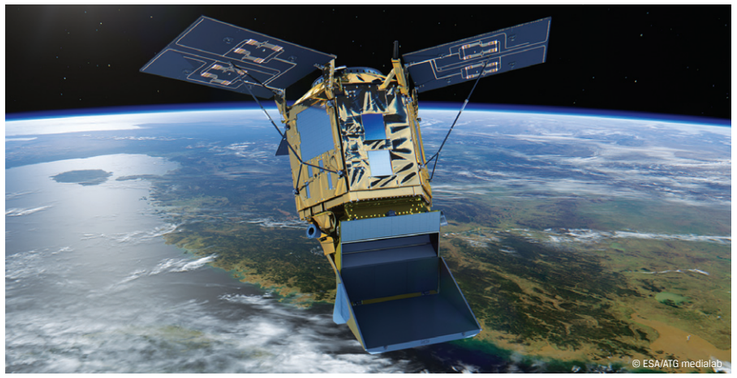
In a nutshell: they all are heavily dependent on space-based support.

Challenges and opportunities

The very nature of unmanned and autonomous systems is that they operate without the presence of humans in the cockpit or on the platform. They are either ground-controlled by operators (unmanned systems) or guided by a process without direct human interaction (autonomous systems). The autonomous functionality applies either throughout the whole operation or takes effect under emergency circumstances, for instance when the control link to the ground operator is disrupted. Hence the need for unmanned and autonomous systems to constantly rely on strong telecommunication capabilities, perfect situational awareness and precise and accurate PNT services.

This poses a variety of challenges for space operators, notably:

- **Assured access.** Users of unmanned and autonomous defence systems need to have guaranteed access to the space services or resources they rely on, at all times and to the full extent. This means that these services cannot be appropriated by other users or third parties. Also, recovery functions to quickly restore broken communication links need to be an integral part of the systems.
- **Jamming and interference.** Additionally, space services must be resilient to interference and must offer technical and procedural means to quickly remedy any interference that occurs on a service provided. Space system operators have to be able to identify the location and type of the interference or jamming source in order to take immediate and appropriate action.
- **Interception and intrusion.** Space services supporting unmanned and autonomous applications must guarantee full protection against any intruder trying to intercept transmitted data and information. This particular risk needs to be assessed throughout the process leading to the delivery of the space services. It requires a truly holistic approach which has to encompass the ground and space segments of the system, the deployed technologies, the industrial processes, the launch and operations of the satellites, and the users. Satellites and payloads hosting space →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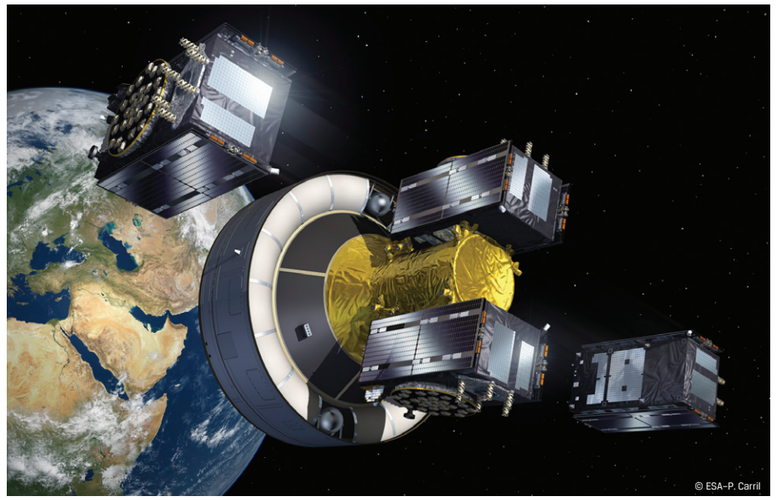
The Copernicus programme can deliver benefits to both civilian and military sectors

services need to be protected against any type of attempt to break into the satellite and payload control systems, including the Command and Control (C2) links of the satellite, the on-board processors and the ground control and mission components.

- **Dependence on third parties.** Specific attention needs to be paid to the risk of space projects becoming dependent on third parties (Third States and/or non-EU Organisations). Due to the sensitivity of national or European defence missions and operations in which unmanned and autonomous systems are used, such a dependency may not be acceptable as it could hamper Member States' and the EU's autonomy of action.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Although Galileo/EGNOS is a civilian programme, it could also benefit the Armed Forces

Galileo/EGNOS, Copernicus and GOVSATCOM

The European Union and its Member States are taking these challenges seriously. They have established an EU-owned positioning, navigation and timing capability (Galileo/EGNOS) and set up an EU space-based earth observation programme (Copernicus).

Another important proposal is currently under consideration: the EU initiative on Governmental Satellite Communication (GOVSATCOM). With the EU GOVSATCOM project, secure and guaranteed access to satellite communications will be provided for EU security and defence actors.

Although Galileo/EGNOS is a civilian programme, Member States' military users and the European Commission are expanding their cooperation to identify potential Galileo/EGNOS services which could also benefit the Armed Forces.

Under the EU Copernicus civilian programme, the specific 'Support to External Action' service is able to deliver products that can be of interest to EU military users and EU operations. On the other hand, EU GOVSATCOM is perceived as a dual-use capability and its intention is to support civilian and military user communities for crisis management, surveillance and key infrastructures.

EDA space activities supporting unmanned and autonomous systems

In parallel with these EU initiatives, the European Defence Agency (EDA) has put several space projects in place to support existing and future unmanned and autonomous systems.

For example, in the air domain, Remotely Piloted Aircraft Systems (RPAS) carrying out air and maritime surveillance missions, require Beyond Line of Sight (BLOS) communication capabilities which can only be provided through satellite communication links. There are two distinct types of satellite communications to be considered for RPAS; the first relates to the RPAS operation – the Command and Non-Payload Communications (CNPC) link, and the second relates to its payload (sensor data transfer link). Whilst the CNPC link has a limited bandwidth with a very robust waveform, the data link requires a relatively high bandwidth and the payload needs to be controlled.

EDA has also established a GOVSATCOM Pooling & Sharing Demonstration project to support, among others, this RPAS requirement. The underlying concept of this project is that EDA Member States operating national satellite communication assets will make their excess capacities available to other interested EDA Member States who don't possess their own governmental resources.

The project has clear objectives: providing Member States' Armed Forces and European Common Security and Defence Policy (CSDP) actors with reliable and guaranteed access to satellite communication in a resilient and secure context, along with the use of unmanned and autonomous systems. This is a cost-efficient solution, because it will avoid a situation in which each Member State operates its own national secure satellite communication project.

Another key benefit of the EDA GOVSATCOM project is that it contributes to the harmonisation of European military's needs and requirements for secure satellite communication. Thus, this project works against the fragmentation of a demand for such services and will also contribute to the EU GOVSATCOM project.

As regards EDA's activities in the field of PNT, Member States recently identified the requirements relating to military PNT and mandated EDA to act as facilitator for the EU Member States' MoDs in the EU Galileo/EGNOS programme.

Even though, at this stage, the military requirements of confidentiality, availability and integrity cannot be totally guaranteed by Copernicus services, EDA and the European Commission (based on the EDA mandate on Space-Based Earth Observation) have started to increase their interactions in order to identify potential common interests in the future, beyond 2025-2030.


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Cyber resilience, a prerequisite for autonomous systems – and vice versa

With defence capabilities increasingly interconnected, strong cyber resilience becomes ever more important. Military platforms, in all domains, must rely on communication networks protected against all types of cyber threats. This is particularly true for unmanned and autonomous systems. Conversely, autonomous systems shaped like intelligent agents tend to become indispensable for achieving the required high level of cyber resilience.

Autonomous cyber response capabilities rely on a smart use of emerging technologies such as machine learning, Internet of Things (IoT) and Big Data. "To ensure that autonomous systems used by our Armed Forces are both cyber resilient – a functionality which allows a dynamic endurance when a cyber-attack occurs – and able to perform their military tasks, following a 'system engineering' approach is essential", explains Salvador Llopis Sanchez, the European Defence Agency's (EDA's) project officer for cyber defence technologies.

In practical terms, it means that military capability developers must handle cyber protection requirements and military engineering needs (system design, life cycle management, etc.) simultaneously and in a coordinated manner, approaching the related system architectures with a security-centric mindset at the early stages of new developments. Artificial Intelligence (AI) may provide clues on how to build →

Europe needs to enhance its defence capabilities, taking into account that each operational domain (land, air, sea, space) has its own cyber-related challenges

robust security system architectures by identifying security design flaws. A system engineering approach is needed to enforce the compliance of all aspects of the final capability with mission specifications, validated and verified against user requirements.

Given that more and more defence products are developed, produced and commercialised off-the-shelf solutions provided by civil companies – especially in the unmanned and autonomous realm – the need for a system engineering approach to adapt these assets to the demanding defence and cyber resilience requirements – addressing the complexity of the digital battlefield – is even more pressing.

Other design characteristics that need to be taken into account when developing cyber resilience for unmanned and autonomous systems are inter alia interoperability, data integrity, the existence of secure and robust back-up communications and protection against electronic warfare. Moreover, cutting-edge autonomous systems require secure interfaces to permit software corrections and updates whenever needed. Configuration control and risk mitigation in the supply chain are also crucial to avoid compromising security.

Autonomous agents to enhance cyber defence

Cyber resilience is thus a key requirement for autonomous systems in general, and in the defence domain in particular.

On the other hand, autonomous agents – specialised digital artefacts – are increasingly used to enhance cyber defence and, many experts believe, they will even become irreplaceable in the future.

Some autonomous cyber defence tools using intelligent agents already exist today, monitoring network activities and ready to trigger immediate action when anomalous behaviour is detected. Early malware detection, crucial for cyber risk mitigation, is considered a high-potential activity in which autonomous systems shaped like intelligent agents deployed in cyberspace could excel in the future. The advantage is to provide a prompt response to achieve an agile secure architecture of the network.

That being said, more research and development work needs to be done to optimise the use of autonomous cyber tools in the future.

First and foremost, there is still a lack of unbiased data sets required for autonomous systems which need data sets to learn to adapt their behaviour. Indeed, the quality and efficiency of autonomous cyber protection systems rely on the type of programming and training which are installed on them prior to their deployment. Despite years of research into AI, generating an 'unbiased' training dataset is still a major challenge. Consequently, the performance of autonomous agents is in direct proportion to the data they are fed with. This lack of data becomes of even greater concern when it comes to military applications because generating data sets deemed accurate enough to represent realistic warfare scenarios is an even more complex undertaking.

In addition to that, there are numerous other technological, procedural and human related challenges to overcome. Take, for instance, the learning aspect. "The growing use of autonomous systems by Armed Forces automatically puts a stronger emphasis on human-machine teaming", underlines Salvador Llopis Sanchez. Operators and military commanders will therefore need to understand and come to terms with the restricted influence they will have on the course of action in operations, especially in situations where human intervention is reduced to a minimum.

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It is therefore essential to make sure military commanders decide in advance on the level of autonomy they are willing (or can afford) to accept, as part of the concept of operations. Whatever decision is taken, the military commander should always maintain the option to intervene during an operation to change (upgrade or degrade) autonomous functionalities in line with the previously agreed mission objectives.

Cyber-supported situational awareness

Situational awareness is required to take decisions in real time. "Cyber-supported autonomous systems could become paramount to provide this enhanced situational awareness", says Salvador Llopis Sanchez. In the future, we might see autonomous systems react to unpredicted scenarios (such as degraded or contested electromagnetic environments) and automatically apply 'spread spectrum' techniques. Due to the increased data flows coming from remote sensors (belonging to what could be defined as the 'Defence Internet of Things'), massive amounts of data must be filtered and processed to provide actionable information.

Cyber-supported situational awareness will likely become part of military operations' command and control information systems. To that end, a decision support mechanism for cyber operations will assist military commanders in their understanding of the implications of cyberspace, proposing remediation plans to achieve mission assurance. Artificial Intelligence, too, is expected to have a massive impact on future cyber risk mitigation. AI techniques have already been extensively explored for advanced malware detection tools and the prediction of cyber-attacks.

EU Capability Development Priority

The potential benefits that European Armed Forces could draw from the use of cyber-resilient autonomous systems have also been recognised by EU Member States. One of the 11 EU Capability Development Priorities approved by Member States in June 2018 is called 'Enabling capabilities for cyber responsive operations'. Therein, the wider cyber domain is identified as a key area where Europe needs to enhance its defence capabilities, taking into account that each operational domain (land, air, sea, space) has its own cyber-related challenges.

Cyber defence research and technological development has been identified as one of the key areas for action, including research topics on self-configured networks, automated cyber resilience or architecture agility in cyber defence.

One of the challenges of OCEAN2020 – a technology demonstrator for enhanced situational awareness in a naval environment under the Preparatory Action on Defence Research, is to encrypt and apply cyber security measures to exchange classified information. The aspects to be addressed are linked with multi-sensor information fusion and information exchange mechanisms.

This is an underlying problem which might be related to more sophisticated multi-level security systems and secure gateways to connect different information classification levels. In the past, a Network Enabled Capability (NEC) required similar innovative solutions to be adopted.

To allow for deeper insight into the cyber defence aspects of autonomous systems, EDA will promote best practices in system engineering framework for cyber operations through its 'Cyber Defence Requirements Engineering (CyDRE)' study expected to be launched in late 2018. The goal is to avoid the design and development by Member States of their own cyber defence systems in complete isolation, which would result in disjointed and uncoordinated systems, applications, services, standards, vocabularies and taxonomies. In the past, attempts to solve this problem were often hindered by a lack of mutual understanding due to the missing common approach to cyber defence systems engineering.

"Unmanned systems are a key capability in today's operational environment"

Europe's future role and level of autonomy in the field of defence-related unmanned and autonomous systems will to a large extent depend on the depth and quality of its defence technological and industrial base. To hear the industry's assessment of current and future trends, we sat down with the CEO of Dassault Aviation, **Eric Trappier**, who is also the current president of the AeroSpace and Defence Industries Association of Europe (ASD).

Dassault and Airbus DS have announced plans to jointly develop and produce a Future Combat Air System (FCAS) as a globally competitive next-generation European fighter aircraft. How big a strategic step-change would that be for European defence?
At the 2018 ILA Berlin Air Show, Dassault Aviation and Airbus Defense and Space have announced a global agreement to develop and produce a Future Combat Air System. The objective of this agreement is to federate the respective strengths of the two companies in order to secure European sovereignty, strategic autonomy and technological leadership of Europe in the military aviation sector in the long term. For sure, the joint political will expressed by France and Germany and their respective industrialists to engage in a critical development for the future of European defence represents a very important step.

Will it include other European countries and companies and will it make use of the EDF?
The French Minister of Defence, Florence Parly, and its German counterpart, Ursula von der Leyen, have signed during the ILA show a High Level Concepts of Operation Document (HLCORD). This process was followed by a Letter of Intent between the two countries in June 2018. This shows there is a political will from both countries to be the pillars and the advanced echelon of this cooperation. It seems to me that when the right conditions are met, this cooperation should be extended to other countries.

In general terms, how important will unmanned air systems, such as the MALE RPAS in which Dassault is also involved, be in the future European defence toolbox? How do you see the unmanned segment evolving in the next 5 to 20 years?
In 2013, with my colleagues from Airbus and Leonardo, we alerted our respective authorities about the strategic urgency to develop our own capabilities in the field of drones. MALE RPAS was born based on this awareness. Unmanned systems are representing a key capability in today's operational environment, at national level and in operations abroad. I am convinced that because of its operational and industrial added value for Europe, MALE RPAS is called to become a founding and valuable flagship. It is now in the hands of the countries involved to go ahead with a development contract.

Do you foresee synergies between the developments of the European MALE RPAS and of the FCAS?
MALE RPAS is a key component of the FCAS.

What is your assessment of the new EU defence initiatives (CARD, PESCO, EDF) so far? From a defence industrial point of view: are we moving in the right direction?
I am pleased about the shift that has been jointly initiated by Member States and the European Union: Defence and Security have become priorities for the future of the Union. In order to shape these priorities, the EU has developed initiatives such as CARD, PESCO or EDIDP that have emerged in recent months. Other initiatives such as EDF are still under discussion. It may still be a bit early to make an assessment or draw conclusions as these initiatives are still recent. On the substance, what is important for the industry is the awareness that a collective effort was needed to create the conditions for developing a real European Defence by the Europeans themselves. This includes an adapted budget, a lean and efficient →

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capability process as well as an appropriate governance for the defence sector which is quite different from the civilian one. What is also important for industry is the overall coherence that links each of these initiatives in order to have sufficient and focused visibility to rapidly achieve concrete results.

Are you happy with the proposed EDIDP rules and what is your take on the planned arrangement for participation of third country entities established in Europe?
The European Defence Industrial Development Programme (EDIDP) that was adopted this summer is a first step. The industry represented in Brussels by ASD was mobilised from an early stage to make a useful contribution to it. From my point of view, there are two main things that are important.

Firstly, capability development. It is the main challenge of the programme and focuses on two key issues for Europe: strategic autonomy and competitiveness of the industry.

Secondly, the funding put in place by the EU in the framework of this programme. It adds to the existing resources of the Member States and, therefore, is a tool capable of providing a leverage effect. During the negotiations on this programme, Member States and the European Union endeavoured to align the objectives of autonomy and competitiveness with legal reality and industrial constraints.

As regards EDIDP, thanks to the efforts made by all, a consensus was finally found on a framework and measures, particularly in terms of eligibility, to guarantee that European interests are met.

Since the defence sector is specific, additional progress will have to be made on the EDF which is not yet agreed. For example, there is the question of a 100% coverage of all costs which would match the conditions of our main competitors. There is one point that is central for all European initiatives: European money must primarily go to the European industry, i.e to actors whose policy is not defined or constrained by considerations expressed outside the EU.

Member States recently approved new EU Capability Development Priorities as part of the revised CDP. What's the European defence industry's view on them? Do you feel industry is ready and capable of taking them up and delivering the required capabilities?
The EU, which has to deal with new strategic challenges and must meet new requirements for the protection of its citizens, needs a clear roadmap in terms of capability priorities. From this point of view, the process enabling Member States' convergence on capability development priorities (CDP) represents an important step forward. The CDP thus already provides a useful reference framework: a global picture of Member States' capability needs in generic priorities areas. Industry has developed very good working relations with all EU institutions. In the light of recent developments in the field of EU capabilities, industry is of course prepared, with the support of Member States, to strengthen its contribution in this domain.

As the President of the AeroSpace and Defence Industries Association of Europe (ASD), I am fully confident about the European industry's capabilities: it has the means and skills required to meet the European capability challenges, including through the robust network of its main Primes and the small and medium-sized industries and enterprises which form an envied ecosystem in the world.

Europe still lacks joint defence programmes and investments. What, in your view, can and should be done to stimulate more cooperation?
Europe is making a big shift in defence. The past decade has been marked by a period of under-investment in this area. We see an evolution now because European countries are changing their policies and are actively thinking about the modernisation of their defence systems. Undoubtedly, this new situation offers new perspectives and opportunities. So, I do believe that cooperation in Europe will develop. Nevertheless, it can neither be decreed nor become a dogma, particularly in the defence field. It must be based on political will, mutual trust and shared interests. It must also increasingly meet the needs of efficiency in economic and financial terms. It is difficult to draw the profile of a successful cooperation. In the defence sector, cooperation first must ensure that the operational contract of our armed forces is fulfilled. Then, it seems to me necessary that the cooperation meets the main following criteria: – be an expression of the common operational needs avoiding as much as possible over-specification; – rely on a firm and long-term budgetary commitment by Member States; – be driven by an efficient state/industrial governance able to take decisions and make compromises; – have an export policy defined upstream of the programme; - and rely on a division of labour based on competencies and efficiency rather than considerations of geographical fair return.

Joint European defence R&T is moving ahead, supported by EU funding. Do you think a future European Defence Research Programme can make a difference and boost Europe's defence technological and industrial base (EDTIB)?
More than ever, defence research is a strategic priority to ensure the maintenance of a strong, state of the art and respected European defence industry. As you know, this industry is a long cycle industry that devotes a significant portion of its revenues to research. Every decision that is made in this area produces a strategic effect. Secondly, the technological choices have a direct impact on the future competitiveness of industry on the international market. Europe is at a major turning point, as a cycle of major programmes is coming to an end. The future must therefore be urgently prepared in a context where the range of threats is widening and where new technological developments are emerging.

In this context, Europe also needs a coherent roadmap, fully in line with the identified capabilities needs and capable of producing convergence on the required future technologies. I therefore think that such a European research programme is likely to have beneficial effects for the whole community, provided there is a strategic steering of the Member States, the establishment of suitable conditions for defence and the identification of ways that will allow an efficient industry contribution.

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Dassault Aviation is tasked to ensure the leadership for the New Generation Fighter within the FCAS

What else, in your view, is missing today to develop a strong European Defence Technological and Industrial Base (EDTIB)?
To ensure an adapted development of the European defence industry, it will also be important to look after the three following aspects.

Firstly, the European industrial sector has to be preserved, developed and organised in order to reduce Europe's strategic dependency, in particular as regards the supply of critical components. Secondly, we need a more systematic benchmark of the policy and measures taken by the major strategic partners of the EU in order to ensure that a balanced level playing field is respected at international level. And thirdly, we need to build an EU political and legislative environment that is fully adapted to the defence specificities in order to speed up and to support the development of industrial cooperation in Europe. As a consequence, we need a strong EDTIB.

In your view, is there enough political and industrial leadership to make Europe become strategically autonomous in the defence industrial domain?
Considering the evolving strategic context, and in order to remain an influential player in the world, Europe must be able to shape its own future. In this perspective, strategic autonomy represents both a political objective and a condition for the survival for the European defence industry. The on-going discussions concerning FCAS illustrate these challenges. Indeed, the objective is to set up the most relevant cooperative organisation in which the companies involved will contribute with their respective 'know-how' and skills to produce the most efficient and competitive European FCAS. In this context, and as it was officially stated, France is the leader nation for the FCAS. As far as Dassault Aviation is concerned, my company is tasked to ensure the leadership for the New Generation Fighter within the FCAS. We, as an aircraft manufacturer, have a prominent role to play in supporting strategic activities on which Europe must be positioned on the long term, and we must remain strong to be able to face upcoming challenges.

Eric Trappier is chairman and CEO of Dassault Aviation since January 2013. He also chairs the European Aerospace and Defence Industries Association (ASD), the French Aerospace Industries Association (GIFAS) as well as the Conseil des Industries de Défense Françaises (CIDEF). In April 2018, Mr Trappier signed an industrial agreement with Airbus Defence & Space to develop and produce the Future Air Combat System, in Franco-German cooperation. He also contributed to the launch, in September 2016, of the study to define the future MALE observation drone, carried out in German-French-Italian cooperation by Airbus Defence & Space, Dassault Aviation and Leonardo.

"EASA cooperates with defence stakeholders on the insertion of large military UAS in European airspace"

The current proliferation of Unmanned Aircraft Systems (UAS) – small and large, commercial and military – raises a number of regulatory and safety-related questions which need to be tackled urgently, with the European Aviation Safety Agency (EASA) playing a central role. *European Defence Matters* spoke to EASA Executive Director **Patrick Ky** about the main challenges ahead.

More and more types of unmanned aircraft are emerging. What are the main regulatory and safety-related issues to be dealt with? Is Europe well on track to meet this challenge?

Starting in 2019, Europe will have harmonised rules to operate UAS in the 'open and specific' categories, which are the smaller end of the market. The new rules will address safety and environmental aspects as well as security and privacy needs. The rules will address operational as well as technical aspects and include effective means for operators and their competent authorities to address safety risks when UAS are flying in non-segregated airspace together with manned aviation. For example, smaller 'buy & fly' drones will have to be operated only in visual line of sight (VLOS) and the pilot will be required to have a specific level of competence depending on the class of the drone. Drones that are operated in the open category will need to comply with technical requirements defined by European harmonised standards. Their presence in the airspace will have to be detectable locally by citizens with standard mobile terminals, e.g. mobile phones, and law enforcement authorities (such as police) will also be able to track drones to their operators. More complex operations such as beyond visual line of sight (BVLOS), posing higher risks with regard to manned aircraft, will only be authorised on the basis of operational risk assessments. Adequate mitigation means it will have to be put in place by the operator and approved by the competent authority.

As far as large certified MALE-type RPAS are concerned, how confident are you that the 2020-2025 timeline set for the RPAS accommodation phase in the European ATM Master Plan can be met?

Here the key word is 'accommodation'. By 2025, it is not certain that large RPAS will be routinely operated in all parts of the Single European Sky. However, it is very probable that there will be areas in which, under a certain number of pre-requisites, unmanned traffic can be operated in civil airspace.

European armed forces have gained substantial expertise in operating large military RPAS which could help pave the way for integrating large RPAS in non-segregated European airspace. Does EASA intend to use this military experience as a blueprint for civil unmanned cargo aircraft?

EASA is indeed cooperating with military stakeholders under the leadership of the European Defence Agency (EDA) on the development of a Concept of Operations (CONOPS) to accommodate military drones in certain categories of airspace and identify viable opportunities for the insertion of large military UAS in the European airspace. We expect this work, which relies largely on current operational experiences gathered by military operators, to be finalised by the end of the year. This can be used for all types of UAS flying in un-segregated airspace. As far as civil unmanned cargo aircraft are concerned, EASA has started to work on the appropriate set of regulations. As you can imagine, there will be other safety aspects to be taken into account besides integration in civil airspace!

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"The new rules will address safety and environmental aspects as well as security and privacy needs"

The low-level airspace ('U-Space') is crucial for military aircraft, particularly helicopters. How are the views and interests of the military taken into account?

Low-level drone operations are of concern not only to military aircraft, but also to all sorts of operators who routinely fly below 1000ft. There are also other concerns such as the possible safety risk to third parties, especially in urban environments. We will take all these into careful consideration when looking at implementation regulations for the U-Space.

A smooth integration of large certified RPAS into non-segregated European airspace will require good civil-military cooperation. To that end, a 'Coordination Mechanism' involving the Commission, EASA, SJU and EDA was established in 2016. How would you assess this cooperation so far?

Any mechanism enabling a dialogue between military and civil stakeholders is welcome. In particular, the articulation of a meaningful roadmap is essential in setting the right level of ambitions and expectations. It will also be increasingly necessary to have discussions at a more technical and operational level, and we welcome the coordination role played by EDA for the military side. From this perspective, the mechanism set up by the Commission is the right approach, but it needs to be complemented on the technical and operational side.

Patrick Ky became EASA Executive Director on 1 September 2013. Prior to leading EASA, Patrick Ky was in charge of the SESAR programme, Europe's ATM modernisation programme. He also held different managerial positions in the French Civil Aviation Authority, in a consulting company and in Eurocontrol. In 2004, he joined the European Commission to work on SESAR.


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"RPAS can effectively contribute to EU-led military and civilian operations"

To assess the operational impact of unmanned systems on CSDP missions and operations, now and in the future, *European Defence Matters* interviewed the new Chairman of the EU Military Committee (EUMC), General **Claudio Graziano**.

What is the EUMC's view on the operational use of unmanned capabilities such as RPAS in the framework of CSDP missions and operations?

Back in 2013, the then High Representative/ Vice President (HR/VP), Ms. Catherine Ashton, pointed out that "RPAS are very likely to constitute a key capability for the future" and that they offer "a broad spectrum of capabilities that can contribute to various aspects of EU-led military and civilian operations". In line with this, the EUMC tasked the European Union Military Staff (EUMS) to draft a concept for the operational employment of RPAS in the framework of EU-led military operations. With input from several Member States, EU institutions and agencies, and in cooperation with the NATO Joint Air Power Competence Centre, the EUMC agreed in March 2014 on the "Concept for the contribution of Remotely Piloted Aircraft Systems to EU-led Military Operations". The document provides a conceptual framework for the use of RPAS in EU-led military operations.

Noting that RPAS have been used by armed forces for three decades as effective operational capabilities, the concept describes the features of RPAS and underlines their potential to contribute to various aspects of EU-led military and civilian operations. The document also refers to the potential dual-use benefits of RPAS which can also be useful in conflict prevention and peace-building civilian activities. In accordance with the EU Treaties, the remit of CSDP will cover the whole spectrum of crisis management ranging from peace enforcement to post-conflict stabilisation operations. Within this framework, the use of RPAS is envisaged for a wide variety of tasks where military means might be considered in order to address a crisis, from the separation of fighters by force to assistance with humanitarian operations.

In your view, which are the most important operational benefits that unmanned systems such as RPAS can provide to CSDP military missions and operations, today?

The global landscape evolves and information is more and more critical. Thanks to their broad capability spectrum and long endurance, RPAS can effectively contribute to EU-led military and civilian operations and missions. Regarding payloads and missions, RPAS are flexible and adaptive and, therefore, can be employed in multi-task roles or be easily re-tasked within the same single sortie. RPAS can operate as local tactical assets or at long range for prolonged periods of time. Additionally, RPAS are not technically limited by human performance or physiological characteristics and some of them may potentially perform tasks in high threat environments or contaminated areas where the use of manned aircraft would constitute an unacceptable human risk.

Situational awareness in crisis management missions and operations requires clear and concise information and intelligence on all aspects of the air, ground and sea situation within an area of operation. This requires reliable, permanent and persistent surveillance. Especially long endurance RPAS, able to carry out Intelligence Surveillance Reconnaissance (ISR), Imagery Intelligence (IMINT) and Target Acquisition (TA) from an airborne platform can contribute to early warning, operational assessment, situational awareness and target intelligence. This supports the decision-making process, as well as the planning and execution of CSDP missions and operations at all levels of command.

Information superiority has also become a key concern in crisis management. EU forces can benefit from airborne assets like RPAS operating as a force multiplier and complementing other assets in providing permanent, all weather coverage with high quality sensors.

Additionally, we expect European-led military forces to face more and more asymmetric tactics and strategies. For example, the increased use of Improvised Explosive Devices (IEDs) in conflicts. Equipped with specific sensors for IED detection, RPAS could effectively contribute to the protection of ground forces, providing vital information to counter IEDs.

In accordance with the EU Concept for the contribution of RPAS to EU-led military operations, these systems are expected to operate over both land and sea. On maritime missions and beyond the littoral, RPAS can effectively conduct ISR missions, in support of naval operations, for instance anti-terrorism and anti-piracy missions.

Looking ahead, where do you see the biggest potential for future unmanned platforms like RPAS in CSDP military operations? And the biggest challenges?

A broader and more intense operational use of RPAS will open new possibilities for quality information gathering, especially in the field of surveillance and reconnaissance. In view of that, a common understanding, along with common standards for the operational planning and employment of RPAS, should be developed.

Additionally, an extensive use of RPAS in CSDP operations would result in greatly increased data gathering (videos, radar pictures and so on), which in turn requires thorough and time-consuming analysis. This will be a real challenge for operation commanders as it will involve more experienced analysts and dedicated software – not currently developed to the extent that it could replace a human in conducting the full processing of data.

At present, there are considerable limitations to the operation of RPAS in non-segregated airspace. The aim is to operate RPAS in a similar way to today's manned aviation, based on the regulations applied to manned aircraft. The integration of RPAS in European airspace is a complex task, and requires close cooperation between civil and military actors. In the framework of the EU RPAS Steering Group (ERSG), the relevant stakeholders have set up a roadmap for the integration of civil RPAS into the European aviation system addressing, in particular, regulatory aspects. The same ERSG framework could be used as a basis to help establish the process of integrating military RPAS into the non-segregated Air Traffic Management (ATM) environment.

It should be noted that, despite the inherent potential, the current survivability characteristics of RPAS do not necessarily allow them to be used in high-threat environments. It is preferable that RPAS equipment and procedures are developed cognisant of expected threats.

Another challenge ahead relates to data links, which include all means for both communication between the RPAS and the control station (ground or airborne) and data transfer. The operational range of data links is still affected by different factors like the location and altitude of the RPAS and the ground control stations, as well as the orographic and atmospheric conditions. Technological improvements are important in this respect as the loss or interruption of the data-link could result in degraded mission effectiveness or a mission failure.

Finally, a possible wider development of RPAS involves a more effective self-protection capability, as well as a higher level of resilience to cyber threats, from jamming to capturing data transfer, taking them down or over by malicious actors. In this context, effective counter measures will have to be envisaged when planning and executing future CSDP operations.

As the new Chairman of the EUMC, what are your main ambitions and priorities for the years to come?

Today, we are facing many conflicts and crises directly or indirectly connected to Europe's security. Threats like terrorism, violent extremism, migration or the need to provide sustainable development and cyber security can only be addressed by an integrated approach from all actors and EU institutions. The EU Global Strategy on Foreign and Security Policy (EUGS) provides the guiding principles for the way ahead.

We have already made real and visible progress in the field of security and defence. Today, the EU has a set of security and defence tools and initiatives at its disposal. The EUMC, 'custodian' of military expertise, is determined to maintain the momentum, to preserve what has been achieved and to move forward in accordance with political guidance.

Let me give you some good examples.

One very prominent upcoming project is the revision of the Military Planning and Conduct Capability (MPCC) in order to further develop the EU's Command and Control capability to achieve a more coherent, uniform and effective operational planning and conduct, as part of the EU's integrated approach.

To further enhance the effectiveness of EU missions and operations is another strategic goal. As an example, the three EU-led training missions deployed in Africa are aimed at laying the foundations for a sustainable, locally-controlled security and stability – a prerequisite for development. By doing this, they expand the security environment and provide a 'forward and proactive' defence, thousands of kilometres from European borders. In post-conflict reconstruction scenarios, CSDP EU missions and operations play an important role, and the military capabilities are particularly effective in supporting the stabilisation process.

The EU has been taking several important actions to better deliver on its operational commitment by implementing more comprehensive tools both in the cooperative and financial areas. Firstly, the Permanent Structured Cooperation (PESCO) and the idea of establishing a comprehensive funding mechanism through the European Peace Facility (EPF). Also, military/civilian cooperation is another area of high interest, where I hope to achieve relevant improvements.

The EU-NATO partnership should continue, on various fronts, in a complementary and inclusive way. The EU and NATO have already agreed on a set of common actions, and this is also the case on key topics such as military mobility, counter-terrorism and 'Women, Peace and Security'. In the field, the spirit of genuine cooperation is already in place as seen in Kosovo between EULEX and KFOR, or in the Mediterranean Sea where EUNAVFORMED Operation Sophia works closely with NATO's Operation Sea Guardian. It is my priority to continue in this direction, with increasing determination.

The solid EU Defence and Security package we have put in place together is active and moving forward in an ambitious and pragmatic way. As we continue on this journey, the EUMC and its Chairman are comitted to enhancing the defence aspect of the Global Strategy and ensuring the EU is able to cope with the new security challenges. According to the tasking we get from our political leadership, we will continue to provide our best advice and recommendations, based on our unique military expertise.

General Claudio Graziano took office as EUMC Chairman on 6 November 2018. He previously served as Italian Chief of Defence (since Feb. 2015) and Chief of Staff of the Italian Army (2011-2015). Other positions previously held by General Graziano include Chief of Cabinet of the Italian MoD *(2010-2011)* and UNIFIL Head of Mission/Force Commander *(2007-2010)*.

CARD: From trial run to first full cycle starting in 2019


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On 20 November 2018 the European Defence Agency's (EDA) ministerial Steering Board welcomed the report on the trial run of the Coordinated Annual Review on Defence (CARD), which has already proven to be an essential initiative in fostering coherence in European defence expenditure and capability development.

There is a growing consensus that Europe needs to do more to protect its interests and values globally. The adoption of the EU Global Strategy (EUGS), the Commission's European Defence Action Plan and the activation of the Treaty of Lisbon articles on Permanent Structured Cooperation (PESCO), all point in this direction. Member States are giving more importance to defence issues, as demonstrated by increases in defence expenditure and renewed interest in multinational cooperation.

Whilst the benefits of multinational cooperation were never disputed, concrete measurable progress remained difficult to track, in particular due to the lack of a shared tool capturing collaborative efforts at the European level. By adopting the Implementation Plan of the EUGS, Member States agreed to create the Coordinated Annual Review of Defence (CARD) as a means of fostering increased consistency between national defence plans from a European perspective and promoting more systematic defence cooperation among Member States.

Shaping the CARD concept in a changing EU defence context

On 18 May 2017, the Council of the EU endorsed the modalities to establish the CARD and launched the CARD Trial Run. Over the following months, EDA collected all available information on Member States' defence expenditure and capability development efforts, grouping it along the three lines indicated in the Council conclusions: (i) Member States' aggregated defence plans, (ii) the implementation of the EU Capability Development Priorities, and (iii) the development of European cooperation.

The information gathering phase was followed by bilateral dialogues between Member States and EDA, supported by the EU Military Staff (EUMS), aimed at clarifying, validating and completing the data compiled by EDA in each Member States' CARD Initial Information Document.

The consolidated data, aggregated at EU-level, provided the basis for the analytical work that resulted in the CARD Aggregated Analysis presented to Member States' Capability Directors in June 2018.

The CARD Trial Run Report, which derived from it, reflects the main findings and conclusions, including dedicated contributions from the EU Military Committee (EUMC), as well as recommendations and preliminary lessons learned. The European capability landscape which emerges from the report offers a view of what Member States collectively achieve, including future trends at the European level. This view is enhanced through the coherence with NATO defence planning activities, as nearly all Member States invited EDA and the EUMS to attend review meetings of the NATO Defence Planning Process (NDPP) or the Partnership for Peace Planning and Review Process (PARP) and made their replies to the NATO Defence Planning Capability Survey questionnaires available to both EU institutions.

The EDA Steering Board encouraged Member States to implement the recommendations of the CARD Trial Run Report, including in the development of the 'Strategic Context Cases' (SCCs) for the implementation of the 2018 EU Capability Development Priorities, and tasked the Agency to forward the report to the Council with a view to confirming the CARD as a standing activity and launch the first full CARD cycle in autumn 2019.

CARD Trial Run findings

The CARD Trial Run findings confirmed that there is a positive trend regarding the overall defence spending of the 27 participating Member States over the 2015-2019 period, although in real terms defence expenditure in 2017 still remained below the 2005 level.

Investment in general, and procurement expenditure in particular, are increasing across Member States, but at a very different pace and scale. The 20% collective investment benchmark was reached in 2016 and defence investment will likely continue to increase further, representing some €47 billion of investment in 2017. However, 12 Member States represent 81% of the total EU defence investment.

Investment in defence research and development has decreased from 23.5% of total investment in 2015 to 21% in 2017 and is estimated to decrease further over time. The fact that the collective benchmark, aiming at 2% of total defence spending being invested in defence Research & Technology (R&T), has never been reached raises concerns regarding the long-term European technological innovation capacity, being driven by only eight Member States, representing 95% of European defence R&T expenditure.

> "The CARD is an essential intermediate step in the overall EU capability development process"
> Jorge Domecq, EDA Chief Executive

Over the 2015-2020 period, one quarter of Member States allocated more than 50% of their defence investment to the Priority Actions from the 2014 EU Capability Development Plan (CDP), while the vast majority of investments supporting these priorities were allocated to national projects.

The EU Military Committee's contribution to the CARD Trial Run established that the EU does not have available all of the required military capabilities necessary for the implementation of the EU CSDP military Level of Ambition (LoA) derived from the EU Global Strategy. These deficiencies are reflected in two sets of High Impact Capability Goals (HICG), addressing major shortfalls in the short-term and medium term. The level of Member States' deployed forces in CSDP and non-CSDP operations and missions remained rather constant over the last three to four years, with an average level of 48,000 troops, although there is a disparity between Member States in terms of type of operation, engagement framework and overall operational effort. While defence expenditure related to operational activities remained stable, representing some 3.5% of Member States' total defence budget, there is room for further enhanced cooperation between Member States.

Data shared by 12 Member States show a steady increase in relative terms in the collaborative dimension of capability development, from 24% in 2015 to nearly 31% in 2017. Data shared by 15 Member States shows that the collaborative part of European Defence R&T expenditure remained around 11% between 2015 and 2017 but decreased by 6% in absolute terms.

Tailored collaborative opportunities presented to individual Member States were well received. The top collaborative areas retaining Member States' interest were Short Range Air Defence (SHORAD), armoured vehicles (including main battle tanks), helicopters (light and medium), medical support, cyber defence, satellite communications, tactical Unmanned Aerial Systems (UAS), maritime mine countermeasures and maritime security. All these collaborative opportunities are linked to the recently approved 2018 EU Capability Development Priorities.

Trial Run conclusions, recommendations and preliminary lessons identified

The conclusions of the CARD Trial Run can be summarised as follows:

- the bilateral dialogues were particularly well received by Member States as evidenced by reactions in the various fora where the aggregated analysis and the report were presented. These meetings allowed Member States, EDA and the EUMS to engage in discussions on collective defence expenditure, operational commitments, the implementation of EU Capability Development Priorities and potential collaborative opportunities;
- the CARD made use of all information available to EDA in view of limiting – to all possible extents – additional requests for information to Member States, thereby reducing the administrative burden on Member States. Some gaps were identified, particularly with respect to forward-looking financial information, highlighting the need for accurate and high-quality data to drive the analysis; →

- the CARD Trial Run highlighted the fact that Member States still carry out defence planning and acquisition mostly from a national perspective. The EU needs to move from ad hoc multinational projects towards a systematic and structured alignment of Member States' defence planning. Member States do cooperate, but an accurate and comprehensive EU overview on which areas, to what extent and with whom, is still lacking.

CARD Trial Run recommendations on the European defence expenditure landscape

Pursuing further consistency in defence spending and promoting a European technologically innovative capacity, the CARD Trial Run recommendations on the European defence expenditure landscape propose that Member States include in their multi-year defence plans voluntary national objectives regarding the annual growth rates of their defence budget and R&T expenditure, as well as concrete measures aimed at rebalancing defence expenditure in favour of investment programmes and enhancing their participation in collaborative projects.

CARD Trial Run recommendations on the European capability development landscape

The recommendations focusing on the European capability development landscape propose that participating Member States aim for greater coherence between their national capability development plans, including on timelines, engage more in cooperative activities, and consider channelling investments on medical capabilities into ensuring a European capability in support of Common Security and Defence Policy (CSDP) operations.

The report also invites Member States to enhance their participation in European collaborative projects, notably making best use of the recently established EU defence initiatives such as PESCO, the Preparatory Action on Defence Research (PARD), the European Defence Industrial Development Programme (EDIDP) and soon the European Defence Fund (EDF).

Preliminary lessons identified

Preliminary lessons identified focus on the mutual benefits of the CARD bilateral dialogues, the challenging timelines of the CARD Trial Run and potential improvements in data collection, especially with regard to forward looking financial data and collaborative expenditure. Furthermore it is acknowledged that the coherence of output between the CARD as well as the Capability Development Plan, and respective NATO processes, such as NDPP has been and will continue to be ensured where requirements overlap, while recognising the different nature of the two organisations and their respective responsibilities.

CARD as the cornerstone of recent EU security and defence initiatives

"The CARD is an essential intermediate step in the overall EU capability development process", stresses EDA Chief Executive Jorge Domecq. Several new EU security and defence initiatives where launched quasi simultaneously – the CDP revision, CARD and PESCO. The coherence between these initiatives must be ensured and the way they affect each other is not only to be understood but purposefully planned.

"A coherent approach from priority setting to output is important and adequate sequencing is critical to ensure that the different steps of the overall approach reinforce each other. In a somewhat simplistic manner, we could say that the CDP tells us what to focus our common efforts on, the CARD gives us an overview of where we stand and identifies next steps, PESCO in turn gives us options on how to do it in a collaborative manner, while the EDF could provide the funds to support the implementation of cooperative defence projects in general, but with a bonus, if in PESCO", Mr Domecq explains.

'Pathfinder' for cooperation opportunities

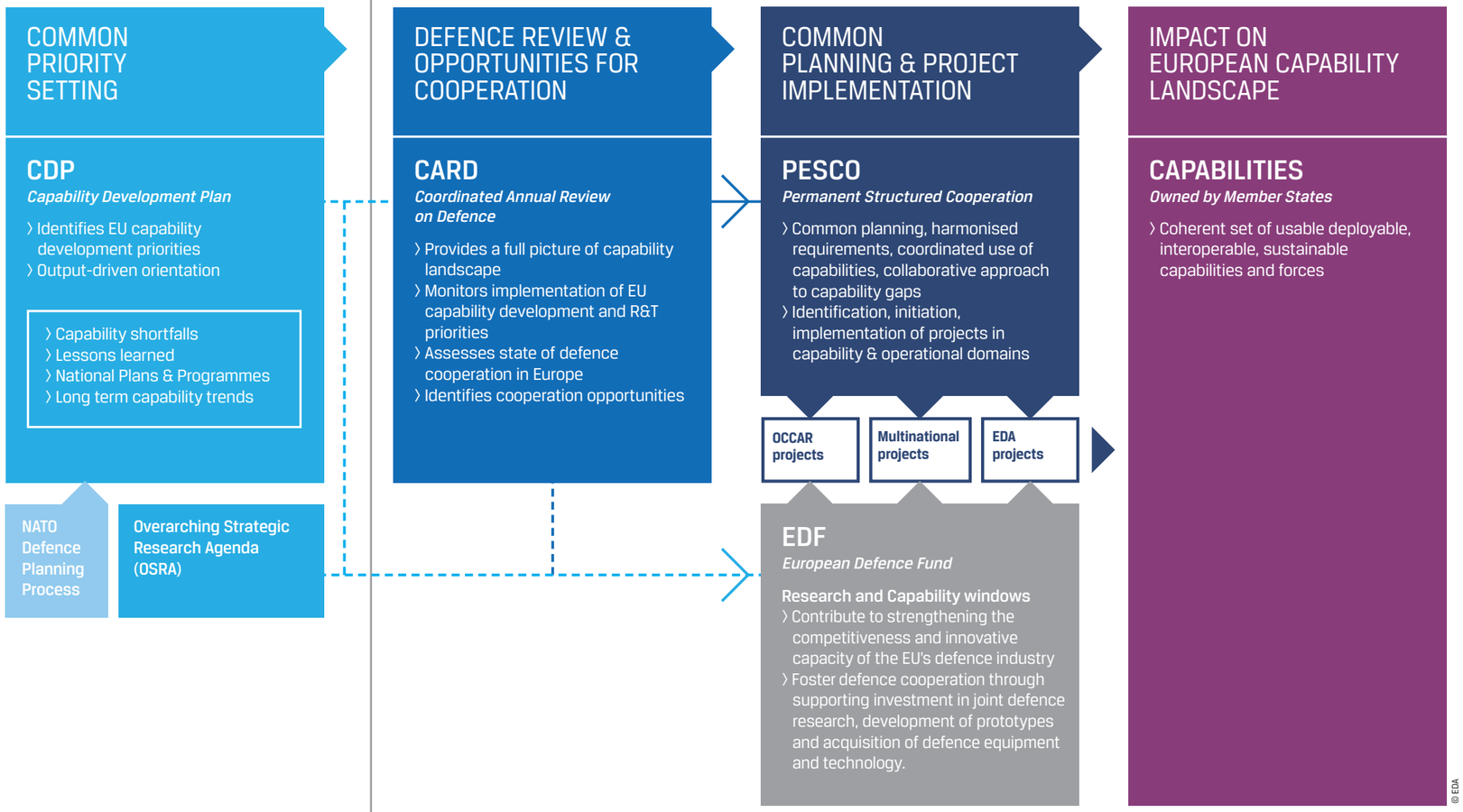
The CARD introduces a monitoring mechanism, driven by Member States and one of the major expectations of the CARD is to act as a pathfinder in the identification of opportunities, where Member States can join their efforts in collaboratively developing or procuring defence assets. The CARD will be built-up incrementally over time and will play a crucial role in providing a comprehensive picture of Member States' defence plans and capabilities, the state of play regarding collaboration, as well as progress towards EU priorities. It will help identify Member States' needs through a structured review process which can lead to cooperative projects. This is the point where the CARD connects to PESCO.

Under PESCO a lot has been done in a very short timeframe. It is however important to underline that PESCO is much more than an umbrella for projects, it is primarily about common planning, increasing spending, collaborating more, and using existing capabilities, if needed, all in a structured and more efficient manner.

The third initiative, the European Defence Fund, which provides major EU-funding to defence projects for the first time, is not yet in its full cycle. While the research window is already in its test phase with the Preparatory Action, the capability window will do the same with the start of the European Defence Industrial Development Programme (EDIDP) next year.

"Even if we ensure that all these three initiatives are smoothly coordinated and harmonised, and Member States commit to work along these lines, there is one element which is indispensable for coherent capability development at European level, and that is Common Priority Setting through the Capability Development Plan, which must be the baseline for CARD, PESCO and EDF," underlines Jorge Domecq.

A coherent approach from priorities to impact



Towards the first full CARD cycle in 2019

The CARD Trial Run will provide a baseline for subsequent iterations of the review. Work accomplished until now will be discussed with all relevant stakeholders to understand the necessary lessons learned. Under the auspices of the Austrian Presidency of the Council, a workshop on lessons identified will take place at the end of 2018. A second workshop is planned for early 2019, under the auspices of the Romanian Presidency of the Council, will address the methodology for the first full CARD.

The first full CARD cycle will be based on the 2018 EU Capability Priorities, which encompass the entire capability spectrum and have a wider scope than the 2014 CDP Priority Areas which were used as the reference for the CARD Trial Run. Greater attention will be paid to prioritisation, notably in relation to R&T.

Concrete efforts aimed at raising Europe's global role are underway. A prerequisite to reaching the level of ambition defined in the EUGS is instilling greater coherence in the way Member States plan and develop capabilities. The CARD offers Member States a tool to increase consistency between their national defence plans from a European perspective and to engage more systematically in defence cooperation.

And the winners are...

In February 2018, the European Defence Agency launched the 'EDA Defence Innovation Prize' rewarding companies and research organisations that have proposed innovative ideas, technologies, products, processes or services applicable to the defence domain.

The two winners of the first contest have been selected: AITEX, a Spanish research and innovation centre specialising in textiles, and Clover Technologies, a Spanish company providing advanced technology services for information systems and communications.

Both were awarded the 2018 EDA Defence Innovation Prize for ideas put forward in two specific sectors:

Autonomous detection, identification and monitoring through sensor and platform networking in the field of CBRN protection technologies

Winner: AITEX

Winning idea: A 'wearable computing' system composed of electronic devices (including sensors able to monitor environmental and personal parameters) fully integrated into textile solutions.

We asked AITEX Project Manager José Manuel Ramos Fernandez to explain the idea in more detail:

"We envisage that the soldier of the future will be equipped with a 'wearable computing' system composed of many electronic devices fully integrated into textile solutions, which will be of paramount importance in order to reduce the equipment weight and increase the soldiers' operability. Sensors able to monitor environmental and personal parameters will be key components of that.

We therefore propose the development of a new family of sensors to identify and quantify a wide range of chemical warfare agents (CWA). Our idea is to produce Electronic Noses (ENs) integrated into textiles based on an array of sensors composed of Graphene Oxide (GO). They will be capable of identifying and quantifying a wide range of chemical warfare agents. The complete system will be printed on a textile substrate producing a fully wearable system which has significant advantages compared to traditional rigid and semi-portable ENs. Moreover, the graphene-based electronic noses integrated in textiles can also be used on a variety of platforms, in all types of infrastructure and more generally, everywhere where textiles are present.

The implementation of this idea needs the involvement of a multidisciplinary team since the required developments touch upon different technologies: materials, electronics, software etc. Moreover, the end users' engagement - i.e. that of Ministries of Defence and Armed Forces - in the development process is crucial to ensure the system complies with their requirements because, at the end of the day, what counts is that it is useful and enhances EU defence capabilities. We believe that a multidisciplinary approach coupled with the end users' guidance would allow the idea to be developed through a collaborative effort that needs the involvement of multiple Member States.

Participating in the EDA Defence Innovation Prize contest has given us the opportunity to both promote a civil innovation in the defence realm and stress the necessity of collaborative research programmes to tackle complex developments using a multidisciplinary approach".

AITEX, based in Alcoy, is a leading Spanish centre of research, innovation and advanced technical services for the textile sector. AITEX is a private non-profit association set up in 1985 as an initiative of the Valencian Regional Government, through the Valencian Institute for Small and Medium Industry (IMPIVA), to make the textile sector more competitive. AITEX's key activity domains include smart textiles, nanotechnology, materials and sustainability and biotechnology.

Integration of multi-robot swarming concepts in support of future defence capabilities in the field of Guidance, Navigation and Control

Winner: Clover Technologies

Winning idea: A blockchain-based platform for the secure coordination and information exchange between the nodes which are part of a robotic swarm

The winning idea is explained by Clover Technologies Project Manager Fidel Paniagua Diez

"Swarm robotics is an emerging technology present in the Future Operational Environment of almost every European nation. However, before it can be implemented in real scenarios, the challenges still pending related to swarm robotics – i.e. computational and storage limitations, heterogeneous communication protocols, information security, etc. – must be solved.

Our project aims to provide a solution to some of these challenges with a blockchain-based platform. The designed solution includes additional layers of security that provide integrity, confidentiality and authentication. Moreover, it supports the automatic implementation of several steps and improves swarm command and control traceability.

More precisely, our proposed solution has three main elements. First, a blockchain platform which allows a secure coordination of a swarm robotic. Second, a so-called Group Key Distribution Algorithm which securely allows the management of the joining & leaving operations within a swarm robotic. And third, a Java Card technology which offers a tamper resistant solution for storage and management of the sensitive information in a robot.

As previously stated, our main goal is to offer a common platform for the secure coordination and exchange of information between the nodes which are part of a swarm robotic. Therefore, robot manufacturers in the defence industry will need access to this platform. Consequently, we are going to work on an application programming interface (API) which will allow the manufacturers to use its capabilities in a simple way. Furthermore, new services such as charger points, weather information, waypoints and so on, will be added to the platform and made available to the robots in order to facilitate swarm coordination.

Finally, let me stress that in order to develop this platform, we will need the collaboration of Ministries of Defence, Armed Forces and industry. Hence, this award is really important for us because we are sure that it will provide us with new contacts that will help us to achieve a more powerful and rich solution."

Clover Technologies, based in Leganès/Madrid, is an industrial company providing advanced technology services for information systems and communications. It is also active in other domains such as IT solutions and information security management, ITSEC and Common Criteria consulting and evaluation and Blockchain consulting and development, security assessment and conformance analysis of security standards and protocols, design and development of UAV security solutions, as well as professional promotion, certifications training and awareness activities.

A guide to ever safer military aircraft

© Italian Air Force

The European Defence Agency's (EDA's) third edition of the European Military Airworthiness Certification Criteria (EMACC) handbook was published early this year. It assists European Ministries of Defence and aviation authorities in the development of new airworthiness certification programmes for military aircraft or in the quality assessment of existing ones.

Every time a new type of aircraft or aeronautical product is developed (civil or military), its compliance with established minimum safety standards must be demonstrated from the outset, i.e. during the design phase. For standard applications, such as commercially used passenger and transport aircraft or helicopters, tailored sets of technical airworthiness requirements are summarised in 'airworthiness codes', also known as certification specifications, and used as the basis for the verification tests to be performed as part of the airworthiness certification process.

With the approval by Defence Ministers in 2008 of the 'roadmap for the EU-wide forum for Military Airworthiness Authorities (MAWA)', representatives and subject matter experts of national military airworthiness authorities were tasked to work on 'common certification/design codes' for military aircraft and aeronautical products.

However, as innovation constantly delivers new materials, technologies and design features, predefined airworthiness codes need to be adapted (for each product certification) as they don't cover all the necessary elements to assess a new product's airworthiness. In such cases, special requirements must be agreed between the manufacturers and the airworthiness authorities.

In contrast to the civil aviation industry, where new technologies tend to be introduced rather gradually and smoothly, the value of a new military air asset depends first and foremost on the disruptiveness of its technology and its – often unusual – design. As a result, a simple adaptation of traditional airworthiness codes, in many cases, does not suffice and tailor-made military-specific airworthiness certification programmes must be developed instead.

Against this backdrop, a dedicated Task Force was established in 2009 under the direction of the EDA Military Airworthiness Authorities (MAWA) Forum to develop a harmonised approach to generic airworthiness certification criteria that could be used to assess and certify the design-airworthiness for all EU military aircraft programmes.

Building on the US handbook

Since 2009, a European Military Airworthiness Certification Criteria (EMACC) handbook has been gradually developed, building on the work of the US Department of Defense which issued the Mil-HdBk 516, a document containing airworthiness certification criteria for use in all new US military fixed wing aircraft programmes. The EMACC Handbook contains qualitative criteria that should allow Airworthiness Authorities and manufacturers to define appropriate requirements to be met in order to reduce risks in system safety for each specific case.

The MAWA Forum Task Force aligned and combined the MIL-HdBk 516 criteria with the specific airworthiness requirements of European and US civil airworthiness codes and equivalent defence standards, including UK Defence Standards (DEF-STAN) and NATO Standardization Agreements (STANAGs). Thanks to the efforts made by the national experts of the MAWA Task Force and the technical support provided by EDA, the first edition of the fully harmonised EMACC document was issued at the end of 2012.

Today, the 3rd edition of the EMACC handbook, fully aligned with the US MIL-HdBk 516 Issue C, can be downloaded from the EDA website at www.eda.europa.eu/experts/airworthiness/mawa-documents

Several national military airworthiness authorities already require contractors to use it on a mandatory basis.

Way ahead

Building on user feedback and lessons learned, the EMACC Handbook will be further developed and improved under the responsibility of the Design and Production Advisory Group (DPAG) of the EDA – Military Airworthiness Authorities (MAWA) Forum. The next edition, scheduled to be issued by 2020, is set to include more guidance on the tailoring process as well as additional references and criteria to cover the latest Remotely Piloted Aircraft Systems (RPAS) certification standards, Air-to-Air Refuelling (AAR) operations, ship-borne operations and cyber threats.

EMACC User Experience

3 questions to...

Davide Turati

Head of Military Airworthiness and Mission and Requirements Analysis at Leonardo Helicopters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You were among the first manufacturers to use the EMACC for establishing a Certification Basis. What was your overall experience?

The EMACC has been used by the company to establish the Certification Basis for a new helicopter, as a complement to the EASA CS-29 which was the main pillar of the airworthiness requirements. As such, the definition of the applicable standard for each criterion was straightforward, since EMACC was used to define standards only for those criteria not covered already by CS-29. The selection has been easily accomplished thanks to previous Company and Authority experience in similar applications, nevertheless, some degree of guidance in the choice of standards would have been beneficial to the process. The resulting Type Certification Basis (TCB) has been positively evaluated by the Authority and has been agreed with no major discussions.

For which activities or applications would you say the EMACC is the most relevant tool?

The EMACC could of course be applied to define the certification basis for new types or modifications of military aircraft. In addition, the EMACC could be used to verify the completeness of an already existing TCB. For dual use (civil/military) applications, it is essential to define the additional airworthiness criteria to complement a civil-based TCB when used for military applications.

How could the EMACC be further improved in the future?

Regarding our specific product, the EMACC could be improved by introducing new topics such as more detailed safety criteria for helo-ship operations. In addition, selection criteria among the different standards could be added. As it is, the EMACC is for the sole use of experienced airworthiness specialists: additional guideline material to select the appropriate standards for the different applications could be of use for small or new NMAAs and could support the uniformity of criteria across the Member States. For rotary wing applications, only the CS-29 has been provided with standards for some criteria: this may not be the most adequate standard for cases such as flight or crash loads definition.

First AAR Conference in Eur ope points at ways to fill capab ility gap

On 12 September, some 200 experts, stakeholders, industry representatives and political and military decision-makers from the European, transatlantic and international Air-to-Air Refuelling (AAR) community gathered in Brussels for the 1st AAR Conference in Europe organised by the European Defence Agency (EDA).

The conference discussed the current state of play (notably Europe's shortfall in this domain) as well as the future opportunities and challenges of AAR from a European, transatlantic and international perspective.

In successive sessions and panels, the political, operational and regulatory aspects and problems were analysed and possible solutions discussed. The event opened with speeches and presentations by the then Belgian Minister of Defence, Steven Vandeput, the Assistant Secretary General for NATO Defence investments, Camille Grand, the chairman of the Aerial Refueling Systems Advisory Group (ARSAG), General John Sams, as well as the EDA Chief Executive, Jorge Domecq. The conference then continued with high-level panel discussions and debates.

Example for close EU-NATO cooperation

In his speech, Mr Domecq praised AAR as a domain in which Europe is catching up on its shortfall in full complementarity with NATO. Even though Europe is still heavily dependent on US AAR assets, "it is slowly but surely catching up thanks to national and multinational air-to-air refuelling initiatives which aim to develop a future capability that meets our operational requirements", Mr Domecq said.

The aim is not to duplicate NATO's efforts but for Europe to be able to act and to become credible partners, he stressed. "I very much welcome our NATO partners to this conference. The work we do together in AAR is exemplary for how we promote close EU-NATO cooperation. The joint political commitment complemented by the excellent staff-to-staff cooperation has led to a synchronised and harmonised approach towards dealing with the AAR shortfall, both on the NATO and EU side". EDA's AAR activities are fully synchronised with NATO's roadmap for AAR improvements. "This prevents unnecessary duplication but more importantly creates opportunities for further collaboration (...) By increasing the European AAR capability, the participating nations also strive to meet their NATO Defence Planning Process (NDPP) targets", Mr Domecq stated. "The Multinational Multi-Role Tanker Transport Fleet (MMF) is a perfect example of how to get from this shortfall to a capability".

Way ahead

Conference participants widely agreed that considerable work still lies ahead as Europe's remaining 30% AAR shortfall, especially during operations, cannot be fixed overnight. Discussions pointed towards a variety of complementary steps that should be taken to fill the gap in the coming years, in particular, to:

- promote and further expand the MMF beyond the five current participating countries (Netherlands, Luxembourg, Germany, Norway and Belgium). To date, the fleet has ordered eight A330 Multi-Role Tanker Transport (MRTT) aircraft, the delivery of which is expected between 2020 and 2022. There are currently three options for additional aircraft in place (a potential increase to eleven aircraft in total);
- encourage European countries with national AAR programmes in place to procure more assets, especially MRTT aircraft;
- increase the procurement of A-400M wing pods to be pooled and shared;
- improve the standardisation and streamlining of the international tanker clearance process.