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EDM

EUROPEAN DEFENCE MATTERS

Pushing limits

Defence innovation in a high-tech world

› VIEWS OF EU PRESIDENCY

OpEd by Slovenian Defence Minister Matej Tonin

› INTERVIEW

Departing EU Military Committee Chair, General Graziano

› IN THE FIELD

'BISON COUNTER 21' fosters European C-IED capabilities

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Breaking new ground

In defence, status quo cannot be an option. While potential adversaries, state and non-state alike, are uninhibitedly harnessing new technologies and unconventional methods to gain a military edge, Europe cannot stand idly by. Continuous defence innovation at national and EU-level is therefore a must if Europe wants to retain the military clout it needs to protect its citizens and values and play a global role.

It's easier said than done, though, as this requires close cooperation between the military and the civil/commercial world which undisputedly shapes and drives today's technological innovation. Europe's defence planners and developers must embrace civil partners with whom they need to build flexible yet trustful partnerships and whose commercial technologies, products, applications and services they must harness for defence needs.

In the following pages, we put the spotlight on a (non-exhaustive) list of technologies our in-house experts think will have the biggest impact on defence in the future; we also briefly present the work the European Defence Agency, as the EU hub for collaborative defence innovation, research and capability development, is already delivering in those domains.

Yet, the call for innovation extends beyond technologies. It also points to an urgent need for the defence sector to become more attuned to new, imaginative concepts and ways of organising things and solving problems; and more open to taking risks. We give the floor to innovation experts to develop on those 'non-tech' aspects and ask defence innovators from some of our Member States – France, the Netherlands and Estonia – about their specific national approaches and experiences.

This magazine also includes guest articles by Slovenian Defence Minister Matej Tonin (as the current holder of the rotating EU Presidency) and EIB Vice-President Kris Peeters, an interview with departing EU Military Committee Chair, General Claudio Graziano, and much more.

As always, we hope you will enjoy your read. Should you have comments or recommendations, please get in touch: info@eda.europa.eu

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Game-changer

Ever faster technological change is setting the pace of our societies' and everyone's life. It's no different in the defence realm: the level of protection a state or a group of countries can provide to its citizens is tantamount to its ability to embrace and use technological progress.

This has been true since time immemorial. What has changed, however, is that defence innovation and disruption no longer primarily stem from military labs, but from the usage the Armed Forces make of civil applications and services developed and marketed by private high-tech companies. Hence the need for Ministries of Defence to team up with today's civil movers and shakers of tech innovation to ensure EU Member States' Armed Forces can maintain military superiority over Europe's potential adversaries.

In the following pages, we assess the most promising and disruptive tech trends for defence and look at how a sample of EU Member States – France, the Netherlands and Estonia – tackle the defence innovation challenge. With the help of a defence innovation expert from the Armament Industry European Research Group, we also analyse Europe-wide trends and hear from industry how innovation impacts defence capability development and production cycles.

Foresight and incentives are crucial for supporting innovation, similarly in the defence domain. This year's European Defence Agency (EDA) Tech Foresight exercise and the Agency's Defence Innovation Prize contest, both presented in this magazine cover story, are testament to that.

Driven by global threats, shaped by civil high-tech

Until recently, Europe's armies based their long-term capability planning on achieving relatively fixed and predictable results. No longer: new civil technologies and their potential applications in the last decade have evolved at such break-need speed that militaries must now factor 'innovative resilience' into their systems. This demands agile capabilities that can absorb new technologies throughout their lifecycle, becoming mainstream during their operational use, thus avoiding obsolescence or early retirement of systems.

Some of the most trail-blazing innovations such as artificial intelligence, robotics or quantum physics are transforming military operations and battlefield strategies in every direction, from logistics to frontline automation to situational awareness undersea and in space.

The European Defence Agency (EDA) defines these emerging disruptive technologies (EDTs) as "significantly changing the rules or conduct of conflict within one or two generations", thus forcing militaries to adapt their planning and long term goals. NATO takes a slightly different tack, splitting the concept into 'emerging' versus 'disruptive' technologies, defining the former as reaching maturity during 2020-2040, and the latter as having a major, even revolutionary, impact on defence and security functions.

"In the end," says Panagiotis Kikiras, EDA's Head of Unit Technology and Innovation, "no matter how you define EDTs, you end up with a pretty similar list of technologies. And that creates a good initial basis for synergies among the different institutional players in Brussels and our Member States, as well as convergence between the EU and NATO."

For its part, the Agency has identified around a dozen EDTs as the most important for its constituent defence ministries. EDA is using its 2018 'Overarching Strategic Research Agenda' (OSRA) and technology-specific groups of national defence experts (CAPTECHs) to shape how each EDT will be studied and developed.

"The OSRA gives the Agency what it lacked before: a structured process for delivering technology," said Jean-François Ripoche, EDA's Director for Research, Technology and Innovation. "Moreover, we now have a new EDT action plan, which should be approved in December 2021, thus setting out the framework for the technology groups' work."

Of the EDTs identified by the Agency, six stand out for their strategic implications: artificial intelligence (AI), big data analytics, robotics and autonomous systems, hypersonic weapon systems and space, new advanced materials, and quantum-based technologies. Their significance – and examples of what the Agency is doing to husband efforts toward their development – are explained on the following pages.

1. ARTIFICIAL INTELLIGENCE

With the possible exception of big data analytics, no other EDT has more cross-cutting implications for military operations than AI, which derives from the ability of algorithms to make optimal or quasi-optimal choices to achieve specific goals.

Combining AI with other technologies and functions will yield new military capabilities that were previously found only in the realm of fiction. Using it to crunch big data, for example, will enable fast decision-making and animate sensors, the testing and application of new materials, or the rapid-fire coordination of fleets of autonomous military platforms.

Applying AI to logistics is already generating significant improvements to operational efficiency and military supply lines, thus helping reduce costs. Building AI into a soldier's suite of sensors, for example, would yield more effective reaction time in the field while enhancing communication and data flows at all levels of the chain of command.

AI will inevitably shift into predictive battlefield assessments while vastly accelerating real-time situational awareness in all operational domains. That will add up to faster and better-informed decisions for military and political leaders. Meanwhile, future progress in machine-learning and quantum computing should further advance the speed and efficiency of nearly all military tasks, making AI the most versatile EDT.

How EDA contributes

EDA is laying the groundwork for Europe's armies to exploit AI in many operational areas. Based on an EDA action plan, approved in December 2020, three major projects will be launched in the coming months.

The first project will explore the concept and rules for an EU-wide pool of defence data, guided by the principles of sovereignty over data, security and trust, data interoperability, and the portability of data and services.

"The idea is that each Member State and its industry could contribute data that is anonymised and then made available to all others for purposes of research and simulation. Here we're mainly talking about the development and testing of new algorithms", said Kikiras, adding that the Agency will soon send a request for information to the industry, research, and defence ministry stakeholders for feedback on the four principles. Their views will be collected and reviewed by the end of 2022, after which the Member States will decide on the way forward.

The second project will focus on analysing the requirements for defence-trusted AI. This pertains to matters of human oversight (known as the human-in-the-loop rule), the technical robustness and safety of operational AI, traceability and accountability, and the overall rules of data governance.

The third project aims to map out the requirements for a unified EU framework to validate and certify military AI-based systems.

Harmonised certification would help confront threats in areas such as cyber security where fast-tracked solutions could be fielded more quickly such as enabling networks to self-configure/self-patch when detecting vulnerabilities.

By its very nature, however, this project presents daunting challenges since any shift toward pan-EU certification – whatever the sector – cuts across huge numbers of institutional, regulatory, and industrial players. Fortunately, there are precedents to emulate.

"We will turn to the European Union Aviation Safety Agency (EASA) and the European Union Agency for Cybersecurity (ENISA) to see how they developed their methodology and principles of validating and certifying AI and then apply them as appropriate to military AI," observed Kikiras. "It's not just about the process of validation, but infrastructure as well – the facilities and how you test against reference AI models. For example, when testing an intelligence-gathering swarm of drones, what reference models to use? These are some of the issues that need resolving."

One encouraging development is a recently completed two-year study by EDA and the European Space Agency (ESA) known as "Cyber-Defence for Space" that analysed the cyber threats to ground and space infrastructure. Its results were presented in early November, along with recommendations for creating cyber-operational centres services for cyber threat intelligence for space, utilising AI technologies

2. ROBOTICS and AUTONOMOUS SYSTEMS

Militaries' increasing reliance on robotics and autonomous systems (RAS) is destined to change how wars are fought, in fundamental ways. Autonomous platforms that support human soldiers are already in the field, transporting heavy loads, ferrying supplies back and forth, functioning as battery recharging stations, and providing support for medical evacuation.

These are only the most obvious examples, though. Robotics and autonomy also entail man-machine interfaces such as exo-skeletons that are now augmenting the strength, endurance and situational awareness of soldiers. Moreover, the exponential pace of robotics research in simulating human behaviour could eventually reduce or eliminate altogether the need to deploy humans on the frontline. This would completely alter the threshold for military intervention since the political price of soldier casualties would no longer be a factor.

Elsewhere, there is vast research into the applications of 'swarming' technology where fleets of small, relatively cheap systems are deployed for a diversity of tasks, from reconnaissance to communications to defensive tactics. A key advantage of swarming is that adversaries cannot easily intercept or neutralise the large numbers of devices involved. Their use will greatly accelerate the speed of war – and the need for faster defensive/offensive tactics and decision-making.

How EDA contributes

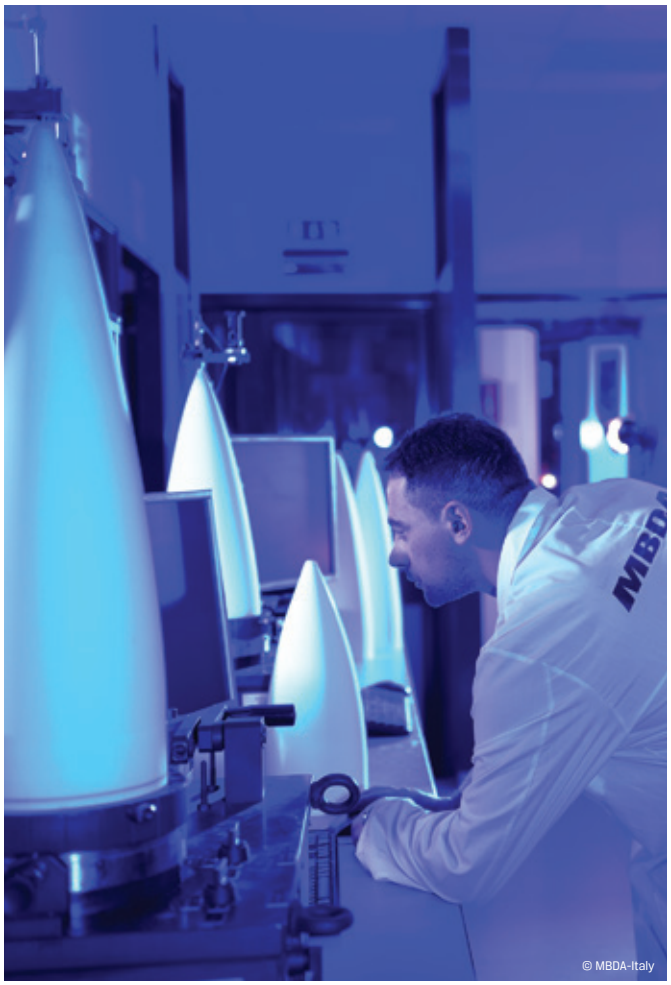
Given the importance of robotics and autonomous systems, EDA and its Member States are devoting considerable time and money to researching and developing the technologies and their future applications.

The Agency has many projects with an intelligence, surveillance and reconnaissance (ISR) angle, particularly when it comes to swarming. A project it completed in 2020, for example, demonstrated cooperation between air and ground autonomous systems, and there's now interest among EDA countries to carry this forward.

"In the near future there will also be more studies and projects on swarming for combat support services such as using drones to deliver ammunition or medical supplies in the field," said Kikiras. "Several of our Member States are interested in this idea as a potential multi-nation project."

EDA is developing an action plan to define first the technological needs and challenges of autonomous systems and then a comprehensive proposal to develop solutions. "This should be an excellent tool for identifying ways to increase cooperation with EU and NATO entities to avoid redundant efforts, while promoting the complementarity of all the activities that link to autonomous systems," he said, adding that the action plan will support common concepts and requirements regarding standardisation and interoperability of autonomous systems.

The action plan's output will also increase the coherence of RAS-related activities of EDA's capability technology work groups by boosting synergies between them, allowing for a better allocation of resources. "The Impact of the OSRA will be quite evident here. When Technology Readiness Levels (TRL) are low – 1 or 2 – it helps the CapTechs avoid duplication in their initial work," he said.



3. SPACE and HYPERSONIC WEAPONS SYSTEMS

By many accounts, there is a silent new Cold War taking place in space and the upper reaches of Earth's atmosphere as China, Russia, and the United States race against each other to enhance the usage of space for military tasks, while developing hypersonic weapon systems (HWS). Defined as surpassing the speed of Mach 5 (five times the speed of sound) or 6125 kph, hypersonic delivery systems have direct implications for Europe's security and defence. Along with AI, quantum computing, autonomous systems, the technology will be a game-changer for future warfare.

"HWS is an area of capability you must achieve if you want strategic autonomy," said Kikiras. The technology will vastly increase the speed and effectiveness of air-launched strike missiles, for example, and the manoeuverability of re-entry glide vehicles. By most estimates, recent advances in new materials and propulsion systems have shortened the expected deployment of HWS to the foreseeable future, i.e. within the next 10 years, making HWS emergent and disruptive in the fullest sense of the concept.

As for space, new platforms and ground-space links are needed for situational awareness, defensive planning and C2. EDA is working closely with its Member States and partner organisations to coordinate capability development in both areas.

How EDA contributes

EDA's on-going hypersonic research flows from an October 2020 foresight workshop on hypervelocity systems that brought together experts from 12 Member States, plus partner countries Norway and Switzerland. The group confirmed that countering hypersonic threats raises serious technical issues. For example, detection is partly hampered by the Earth's curvature, which points to highly compressed timelines for detecting, tracking, and countering targets. This requires developing innovative radars and other sensors, new algorithms capable of estimating a target's position, and new types of interceptors.

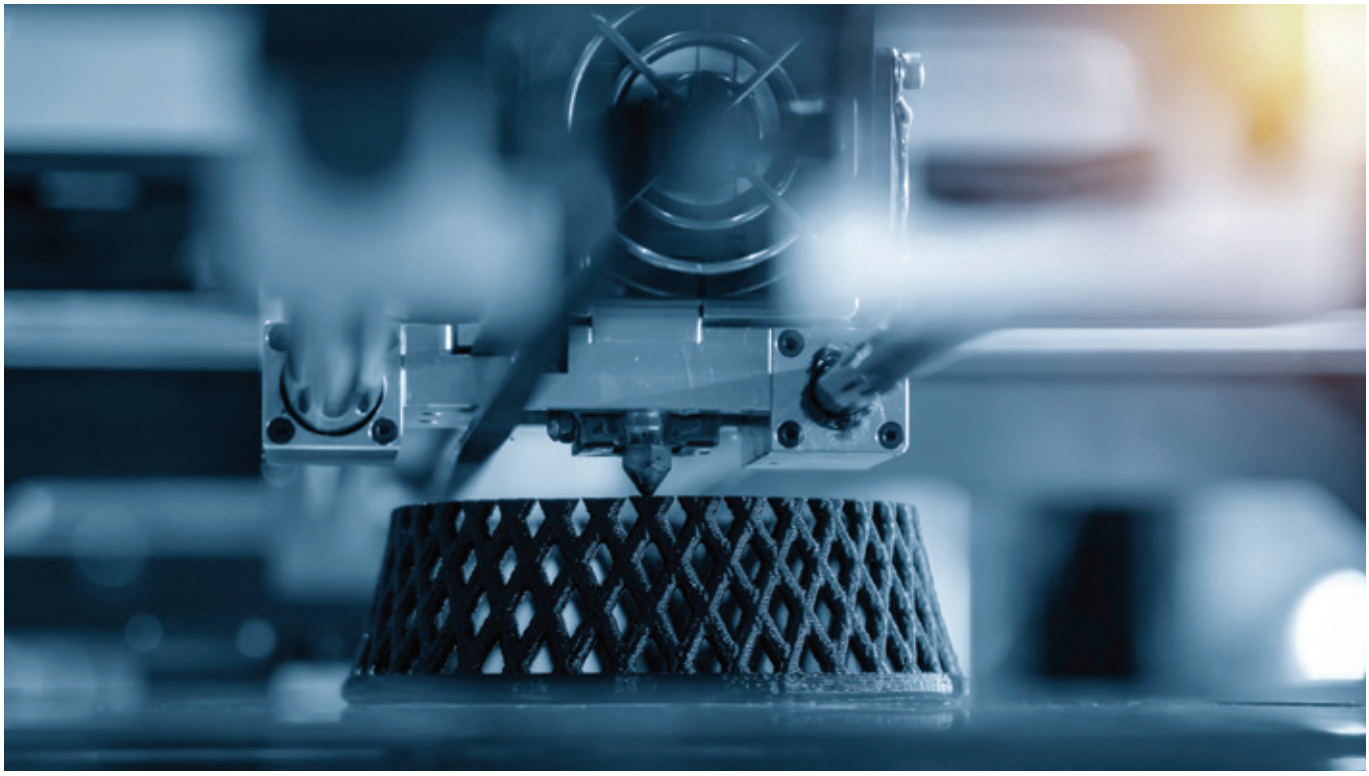
The workshop determined that space-based tracking systems that use geo-stationary or low-Earth orbit systems are probably the most suitable option for detecting hypersonic threats. That means research must focus on the following areas: new materials and thermal effects management, advanced flow physics, thermodynamics, aero-thermodynamics and extreme ruggedisation, advanced computational fluid dynamics, guidance and control systems for hypervelocity vehicles, and propulsion technologies.

The experts also noted that Europe needs new specialised facilities to test hypersonic technologies. While the USA and China each have three wind tunnel sites for Mach 6 velocity testing, Europe has none. Thus a priority goal should be joint European test facilities among EDA countries. Based on the group's recommendations, EDA is now preparing a study to investigate Europe's technological gaps, and will draw up technology roadmaps in 2022, with follow-up research projects focused on missiles and munitions, electro-optical sensors, radar technologies, new materials, and guidance, navigation and control.

As for efforts to protect Europe's space sector, one of EDA's recently concluded research projects points to the defensive potential of clustered imaging radar satellites.

Known as MIRACLE II (Micro-Satellite Clusters II), the 41-month project involved only two countries (Italy and Norway) and a modest budget of EUR 2.9 million, but it developed new concepts and technologies for clusters of imaging radar satellites. This showed that micro-sized platforms offer a new approach for deploying imaging sensors at reduced cost. Previously this had only been achieved with electro-optical sensors.

MIRACLE II's architectural concepts for the satellites demonstrated how to maximise operational performance for spatial/temporal coverage and resolution, low vulnerability, and timeliness – all with direct application for Europe's militaries.



4. NEW ADVANCED MATERIALS

New materials and manufacturing processes carry wide disruptive and emergent technological implications for Europe's militaries. Agile manufacturing techniques such as 3D printing are transforming military acquisition procedures, supply management and logistics planning, for instance, while new bio-responsive textiles and equipment for soldiers are already in the field or being tested.

Combining new materials research with other EDTs such as artificial intelligence, synthetic biology or nano-physics holds immense promise for pushing the boundaries of molecular structure and their properties in ways we can only imagine today. The end-results will be cheaper, stronger, lighter, more durable and higher-capability materials, including new forms and levels of energy generation and conservation for military application.

How EDA contributes

In 2018 EDA launched its own-funded project known as "STILE" (Smart TextILEs in Defence), awarding companies from Portugal and Spain to carry out the development of STILE's proof of concept and testing.

Based on advanced materials and sensor technologies, the consortium came up with a textile system that incorporates multiple user features and functions into the design. These include environmental, threat and physiological monitoring, flame retardancy and temperature regulation, wireless data exchange, and other functionalities. Rigorous testing in 2020 and earlier this year proved the system's robustness. Moreover, STILE's 'dual use by design' approach offers cross-cutting opportunities to private companies, while preserving its availability for the defence sector.

EDA is now preparing an even more ambitious goal: a long-term programme entailing nine new-materials projects whose output will have air, land, maritime and cross-cutting applications. Known as ICARO ('Innovative materials for CApability-driven Research for Outstanding European defence'), the programme will have an eight-year lifespan, a budget of €60 million, and is set to launch in 2022.

ICARO's conception and methodology are directly linked to EDA's Overarching Strategic Research Agenda, and will draw in more than half of the Agency's CapTech expert groups. The latter will be involved in ICARO's research into low observation capabilities, lightweight structures, sensing technology, energy harvesting and management, and self-adapting and sell-assembly materials.

"This is a very exciting field of research," said Kikiras. "We're talking about materials whose properties would enable them to switch quickly from one function, such as camouflage mode, to another such as energy harvesting. Each Member State will be able to choose which of the nine project is most suitable for its needs, meaning the research can take place either nationally or in collaboration with other Member States, with all deriving benefits from the effort in one way or another."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5. BIG DATA ANALYTICS

Though a field in itself, the exploitation of big data is heavily tied to AI and especially machine-learning, both of which require increasingly large streams of data to make the most accurate decisions. Data analytics, of course, has been around as long as computers have, but what has changed is how pervasively it is now collected and analysed, which is where AI enters the picture.

Big data's sheer metrics present special problems for militaries, which need to collect, process, analyse, distribute and act upon operational data across the entirety of their organisational structures, with little or no margin for error. For most modern armies, that inevitably points to the so-called cloud – the nexus of servers that could be hosted outside the traditionally closed C4 networks. Since most militaries do not have the full internal computing power or manpower to handle the amounts of operational data they generate and need, it means that computing paradigms like cloud computing could be utilised to effectively mitigate this problem. And that raises fundamental issues of trust, security (including availability, integrity) and accessibility.

How EDA contributes

Recognising early on the challenges raised by migrating military IT services to cloud computing infrastructure and services, EDA launched a four-year study project in 2019 known as CLAUDIA ("Cloud Intelligence for Decision Making Support and Analysis").

Wide-ranging in scope, CLAUDIA's various work packages focus on crucial ways the cloud can be used for military operations such as simulation and C2, 'tactical cloud' infrastructures to enable intelligence, surveillance and reconnaissance tasks, scenario generation, or big data analytics to support decision-making.

Via one of its pilot projects, CLAUDIA has already demonstrated the cloud's potential for countering hybrid warfare by analysing cues in open-source data. Its current work strands, launched in January 2021, are focused on tactical cloud infrastructure and distributed simulation. Lying ahead will be work to: test so-called fog computing (i.e., analytics via devices at the tactical edge of operations), potentially link national military simulators into a federated system, and explore the concept of modelling and simulation as a service.

Ultimately, based on CLAUDIA's overall outcome, a future operational tool to support the intelligent management of open and classified data sources to enhance decision-making could be developed for the Member States and EU Council.

6. QUANTUM TECHNOLOGIES

Quantum physics offers virtually unlimited and instantaneous computing power – once it is mastered. Despite large investments in quantum computers, particularly by the private sector, it is still early days before it can be fully exploited. However, its potential applications are many for the military: supercomputing, encrypted key distribution, crypto-analysis and decoding or used for surveillance and detection.

Quantum-based sensors are so sensitive to the tiniest disturbances at the magnetic levels, for example, that they will be used to locate and detect deployable objects underwater, meaning the days of stealthy movements by submarines and other vessels will be over. Satellite-based quantum sensors will do the same over the Earth's surface.

How EDA contributes

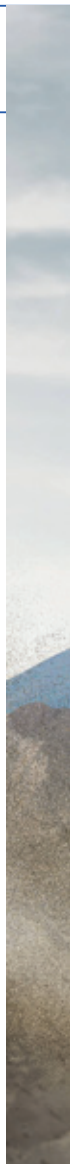
EDA's Member States have universally acknowledged quantum technology as an emerging and disruptive defence technology. The Agency held its first workshop on quantum sensing for optronics in March 2019, followed by a technology foresight workshop on quantum technologies for defence in May of that year. Since then, EDA has organised a number of follow-on initiatives and projects to foster R&T activities focused on quantum technologies.

On-going projects include EDA's three-year study known as QUANDO ("Quantum technology for Defence with application to Optronics"), which runs until 2023. It also launched the project, "Quantum Laser-based Multi-parametric Portable Sensor", which covers the same period (2020-2023). Finally, with funding from the European Commission, it launched in 2021 the four-year project called "QuantaQuest" to identify key quantum-based technologies for secure communications and navigation in defence.

As Kikiras notes, "If you see how much money DARPA (the US Defence Department advanced research agency) has put into quantum computing without getting the commensurate results for all the effort, we've decided to shy away from that, because it still seems far away and it is currently led by the private sector. Instead, we are focusing on quantum sensing because it stands to deliver tangible operational results much faster."

"EU should become a full stakeholder in defence innovation"

The need to embrace defence innovation is a complex and multifaceted challenge for all Ministries of Defence (MoD) and armed forces. Yet, national approaches vary across Europe making it difficult to identify a common pattern. To get a better European overview, we sat down with **Jean-Pierre Maulny**, the Deputy Director of the French Institute for International and Strategic Affairs (IRIS) who is the scientific coordinator of the Armament Industry European Research Group (ARES) which has published a series of studies into the subject*.



All major disruptive defence applications stem from the private sector which means that open cooperation with civil tech companies is indispensable for military innovation in the future. Are Europe's national MoD ready for that?

What EU Member States' MoD and armed forces are seeking, above all else, is technological superiority that will give them an edge over the enemy. If this superiority can be gained through innovation produced by companies in the civil sector, there is nothing against using these companies. Besides, today we're seeing a number of Member States trying to open up defence markets to civil companies – SMEs and start-ups in particular – to gain access to these innovations. A growing number of labs are being set up within the armed forces to encourage these companies to come and pitch their innovations. The only specific requirement placed on companies from the civil sector is the military-grade ruggedness stipulated by the armed forces. This is true in defence electronics in particular: in the armed forces' digitalisation programmes, products have to be protected against cyberattacks and jamming. Quite often we can't simply transpose an innovation from the civil field: it has to be adapted to meet military requirements.

Where do you see the main stumbling blocks for Member States' militaries to embrace that new kind of 'open innovation'?

First, there must be the assurance that the innovations are operational. That means that products from the civil sector must be made absolutely secure, as mentioned earlier. This is a precondition stipulated by the military if they want to use innovations from the civil sector. They also have to be tested under operational conditions. One of the main challenges stems from the fact that defence ministries have to adapt their structures so that the military can test these innovations from the civil sector. This can only be done if there's close coordination with the procurement agencies or the structures involved in conducting arms programmes, such as the DGA in France. Besides, the defence innovation agencies we've seen spring up in recent years, first in the US then in the UK and in France too, include the various innovation stakeholders in these new structures. That includes the structures that conduct and purchase arms programmes, the end-users – namely the military – but also, when possible, people from academia or the business sector. So the military need to test these innovations a lot further upstream, using labs that are part of these defence innovation agencies, or labs that report directly to a particular army. If the outcomes are to live up to the expectations, we need to be able to network more in structures that include the various stakeholders – which is a challenge in itself.

Open innovation is also likely to reshape the innovation governance in the development and production of military capabilities, both nationally and at European level. What can be expected in this respect?

Open innovation implies major adjustments to the structure of innovation governance and this is a real challenge.

First of all, we need to be able to attract the companies that develop innovations, which were often designed primarily, if not exclusively, for the civil market. That is no simple matter. The defence market is not like any other market. For security reasons, information is classified. There are generally steep barriers to entry and European defence markets are still nowhere near open enough. For a company operating in the civil sector, adapting the product to supply a military client entails additional costs, the quantities of products sold are always small and the prospects of picking up other

military contracts are quite limited. Lastly, reputational damage is becoming a major issue today. Companies are contending with a growing body of corporate social responsibility obligations and banks are reluctant to finance products for military use.

Today it is the defence ministries who are seeking to attract SMEs and start-ups with potentially useful technologies for the military, not the companies who are seeking to enter the military market. The French and British MoD have decided to increase the share of direct purchases from SMEs and start-ups with a view to capturing these new technologies developed by the civil world. However, prime contractors are also seeking out these companies because they are developing technologies and products that, as a main system manufacturer, they will be able to incorporate. This last solution, which entails inclusion in the prime contractors' supply chain, is probably the most promising one.

And at EU level?

The European Defence Fund (EDF) may be a useful tool for establishing this new defence innovation ecosystem, given that prime contractors from a limited number of EU Member States will have to partner with innovative SMEs and start-ups from other EU Member States in order to submit competitive bids in EDF's tender calls. So the EDF may be a good opportunity to encourage efforts to eliminate the distinction between the civil and military communities.

Top-notch defence technologies are crucial but probably not sufficient on their own. What additional innovative approaches and processes are required to ensure successful military innovation in Europe?

The first thing to bear in mind is that, for a long time yet, the burden of financing defence innovation will fall primarily to the Member States, since there is not really a European defence market, even if we are seeing a partial removal of the barriers between EU national defence markets. As a result, companies are understandably reluctant to finance defence innovation. Today, defence research and technology funding represents €12.7 billion a year in the US, as against just over €1.6 billion within the EU. The US is therefore spending nearly eight times more than Europeans on its defence research, and few countries attain the target set by PESCO, namely to devote 2% of their defence budget to research and technology. So the EU Members States must, as a matter of priority, raise their defence R&T budget.

The second is to align the management of arms programmes on the pace of innovation in the civil sector. Forty years may pass between the time an armament programme is launched and the time the armaments are decommissioned. The pace of innovation in the civil domain is often far swifter: sometimes under two years, particularly in the area of digitalisation. This is why the management of arms programmes needs →

to be adjusted so that these innovations can be taken on board in real time. Weapons systems must have open architectures and programme managers mustn't hesitate to freeze an item's specifications in order to speed up the go-live, while at the same time making provisions for equipment upgrades over time. This means that subsequent versions of the Rafale and the Eurofighter will reap the benefits of work on the FCAS and the Tempest programme.

Lastly, we must eliminate any partitioning of innovation that comes from the civil world and innovation from defence. The Action Plan on synergies between civil, defence and space industries released by the European Commission in February 2021 is a step in that direction, though it remains to put the EU communication guidelines into practice. Doing so will necessitate synergy and coordination between European research programmes in the civil, space and defence domain. This is not as easy as it may seem, given that the programme governance systems are not the same, nor are the rules for protecting technology and intellectual property rights. This synergy is nevertheless a key to success, because it will enable us to more effectively rationalise the use of public funding. The European Defence Agency (EDA) has a role to play here.

Is enhanced defence cooperation, i.e. the systematic use by Member States of existing EU tools such as the CARD, PESCO and the European Defence Fund, not the most efficient innovation model of all for Europe?

The CARD, PESCO and the European Defence Fund have driven us to cooperate more closely at European level. This is essential because we have scarce defence funding and we need greater interoperability in our equipment, less fragmentation of the defence industry, fewer silo effects between civil space and defence industries, and ultimately a more competitive EU Defence Technological and Industrial Base (EDTIB).

However, cooperating more does not necessarily mean cooperating more effectively. There is a risk in the current path of reform of national defence innovation models: that of creating models that are incompatible with each other. Between those who will have reformed their innovation model by eliminating the separation from the civil world and opening it to SMEs and start-ups, and those who will continue to maintain the barriers in place between defence innovation systems and civil innovation systems and, in so doing, potentially stunt the technological capacities of future arms systems.

So we need to talk about the reform of the defence innovation model at the European level, otherwise we will have difficulty cooperating within a European framework. The defence ministries need to talk to each other about the issue and the EU can arrange this dialogue. Maybe the EU should become a fully-fledged stakeholder in defence innovation rather than simply putting up the funds, as the European Commission will do with the European Defence Fund. Maybe it should become a true client and structure the shape this innovation will take. If we decide to go ahead with this change, the EDA will have a role to play.

What about national defence industries? How will they be affected by the new

innovation models emerging throughout Europe?

Defence companies apply three strategies to take into account this blurring of the barrier between civil and defence innovation.

The first strategy consists of broadening the scope of their action to include the field of technologies that come from the civil world, particularly with regard to digitalisation or artificial intelligence. We can already see this strategy playing out, particularly in companies in the defence electronics industry. Generally speaking, there are only a handful of companies left today that operate solely in the defence field. Companies are seeking to embed their strategy in sectors where there are synergies between products for the civil market and those for the defence market. By doing so, they can rationalise their investments and not depend on one market only.

There are drawbacks to the former strategy: companies can't become a player in digitalisation or artificial intelligence from one day to the next. Sometimes they need to be able to forge partnerships with companies that have a real grip on these technologies. However that involves a risk: that of becoming dependent on these partners and endangering the security of supply. The so-called GAFAM (Google, Amazon, Facebook, Apple, Microsoft) are not European and if we work with these companies, we create a critical dependency for years to come.

The third strategy is to include in the innovation and supply chain SMEs and start-ups that do business in innovative technologies. In that case, we need to open up the supply chains to this type of company. In this respect, the launch of the EDF couldn't come at a better time. The rules by which this fund operates allow for partitioning to be removed at several levels: between civil and military innovation, but also between the EDTIBs, since the prime contractors will feel free to choose SMEs and start-ups from other European Member States. We may then be able to start consolidating defence industries from the bottom up by creating synergies between European supply chains.

With national defence budgets under serious constraints, new innovative financing models might be needed to ensure sufficient investment in defence research and capability development. What do you expect there?

One of the problems the defence industry will have to contend with in the future is that of investments and financing for this industry sector. We are seeing private equity funds and even banks gradually pulling out of this industry due to ethical considerations, and a return to public financing or even public shareholding in order to buoy up a defence eco-system that is essential to the development of the weapons of the future. Public financing, be it national or European, is essential therefore to support this eco-system of innovative SMEs with a dual business focus. Setting up accelerators by networking innovation stakeholders from different backgrounds, university laboratories, companies and public funding bodies on a given programme may enable these SMEs and start-ups to grow and become part of a network of innovation for the defence community. But to achieve real development, the sector will also need to work on improving citizens' everyday life and well-being, work for other sectors such as healthcare, and assume a fully-fledged role in a strategy of energy transition and decarbonisation. It must be able to attract investors, not deter them. This should encourage them to keep a low profile when communicating about the 'defence' component of these companies' business, while at the same time pursuing the public policy objective to draw them into the defence sector.

Can Europeans learn anything from the successful US defence innovation strategy?

It is true that the Americans were the first to see the benefits to be gained by leveraging innovations from the civil business sector, especially as they have an established ecosystem in the digital and artificial intelligence industry that is extremely well-developed and undoubtedly the best in the world. This move to break down the partitions between the civil and defence sectors dates from 2014 and what was known at the time as the third offset strategy. This policy was also a way of responding to China's particularly intensive work on artificial intelligence. As a result, many European Member States are adjusting their model of defence innovation, based on what they were able to analyse of the reform carried out in the US. However, there is no call for vacuous, naive admiration of the American model. The US' third offset strategy was also one of the responses to a defence procurement model that the US armed forces themselves considered particularly inefficient. There is no need to feel inferior to the Americans: we just need to trust in European engineers.

Jean-Pierre Maulny is Deputy Director of the French Institute for International and Strategic Affairs (IRIS) and Head of the Armament Industry European Group (ARES Group), a network of European researchers specialised in the defence industry.

ARES was created in 2016 by IRIS who coordinates the Group. Its aim is to provide a forum to the European armament community, bringing together top defence industrial policy specialists, to encourage fresh strategic thinking in the field, develop innovative policy proposals and conduct studies for public and private actors.

* ARES recently published a series of case studies related to 'Defence Innovation: New Models and Procurement Implications' in a number of different European countries. More info: https://www.iris-france.org/ares/

All the threads come toge the Defence Innovation Ag

Florence Parly, the French Minister of the Armed Forces (MAF), created the French Defence Innovation Agency (AID) on 1 September 2018 as the spearhead and catalyst of innovation within the Ministry.

In liaison with the French Armament General Directorate (DGA), the AID brings together all the national defence innovation key players to enhance the Defence Ministry's reactivity to foster, detect and capture technological advances and disruptions, in particular from the civilian domain.

French E-FLYCO project – New type of attack boat using retractable hydrofoils to go faster and better absorb waves

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The AID acts as an independent, autonomous body with its own vision. Its mission is to capture innovation and accelerate its deployment for the benefit of the Ministry as a whole, military and civilian end-users, whatever their field: operations management, equipment, support, operations, administration.

Designed to be dynamic and responsive, the Agency benefits from a light agile organisation (around 100 people) that pilots all innovation structures working inside or within the French MAF (defence cluster, tech labs, etc.) in order to capture opportunity innovations. It provides a single point of contact for any innovation project owner as well as new tools such as the Innovation Defence Lab, designed to accelerate the experimentation, prototyping and deployment of innovation.

Innovation clusters specialised in dedicated defence domains have been created in different regions of France relying on the local industry capabilities. New networks of innovators are promoted, both internally in the MAF and externally with the creation of a defence innovation 'club' tasked with ensuring that the defence dimension is included in the global innovation ecosystem. A purchasing unit dedicated to innovation acquisition has also been set up within the AID to explore new procurement approaches by making extensive use of the provisions of the French public procurement code and relying on simplified market models.

Finally, the AID is attempting to renew France's defence prospective vision by assembling a group of science fiction authors and futurologists to develop their vision on the possible futures. In concrete terms, the AID has decided to set up a 'Red Team', or a cell of 4 to 5 people, tasked with proposing disruption scenarios. The aim is to guide innovation efforts by imagining and thinking about solutions that will either provide or protect against disruptive capabilities. The task of the cell is to construct valid strategic hypotheses that are liable to disrupt current capability plans.

"Innovation in France follows philosophy of procurement and cooperation"


© AID

Interview with **Dr Emmanuel Chiva**, Director of the French Defence Innovation Agency (AID)

Defence innovation has become a topic in many if not all EU countries. What makes the French AID special? What are the main characteristics of the French defence innovation model?
Yes, I agree that 'Innovation' is an important strategy for many defence administrations in the world and for probably most of our EU partners. In 2018, Florence Parly, the French Minister for the Armed Forces, stated that our armies are fully up to date and that our defence and security systems are efficient thanks to their innovative design, based on French expertise. This rationale led to the creation, on 1 September 2018, of the French Defence Innovation Agency (AID) with around a hundred people, aiming at orientating and supporting innovation from low Technology Readiness Level (TRL) basic research to higher levels with participative projects of end-users, including the militarisation of ideas and technologies coming from the civilian world.

The basis of the French defence innovation model is a holistic approach of innovation: the AID is in charge of orientating the innovation policy – which is chaired by a Defence Innovation Committee – but also of detecting, experimenting and adapting the innovation to be able in the end, both to accelerate and deploy it.

Some call it the 'French DARPA' in a reference to the US super-agency of innovation. Is this the ambition?
The DARPA is a historically famous illustration of a defence innovation approach. But the French AID action differs from the DARPA for at least two reasons. First, on the financial aspect, the DARPA budget is about $3.5 billion a year while the AID's budget has been recently raised to €1 billion for 2022. Second, their roles are not the same either: the Defence Innovation Agency is in charge of the coverage of all the domains of innovation in the defence field, while the DARPA is sharing this responsibility with several innovation structures, some of which are related to the different services (Army, Navy or Air Force...). The organisations chosen by France and the USA can therefore not be considered at the same level as France has made the choice of one Agency federating Innovation for the whole Ministry, compared to the DARPA mission which is to prevent a technological or strategical surprise, and therefore push the effort and the innovation exploration to the extremes without looking for an immediate return on investment. DARPA and AID are answers to different expectations and therefore are not guided by the same criteria for success.

France counts many large, historical defence companies which suddenly must work with new tech start-ups from outside the military bubble. How do you make this work?
The French 'historical' defence companies have already understood the need to grab innovation from sources that are external to our traditional ecosystem. Regarding this aspect of innovation, the governmental mission carried out by the AID is to broaden this detection and facilitate its incorporation so that it could benefit both start-ups and the main defence companies. Since the beginning of the Agency, we have been scanning more than 750 promising companies. In the future, some of them will provide us with technologies or capabilities in order to help our forces succeed in their missions. These products can be stand-alone equipment or part of more ambitious projects lead by major companies. The aim is not to compete but to complete.

At the creation of AID, Minister Parly said it would be "turned towards Europe". To what extent do you reach out to European partners for cooperation?
Innovation in France is following the philosophy of procurement and cooperation and remains a priority. We, Europeans, know that the most efficient way to spend our defence budgets means sharing topics from the very early stage of new technologies in order to be able to share the R&D costs and equip ourselves in the future in the same way. This can also be seen as a mandatory condition for interoperability and a responsibility we endorse for the good use of public money.

The increasing effort of the European Commission to foster cooperation with the PADR (Preparatory Action on Defence Research), the EDIDP (European Defence Industrial Development Programme) and now the European Defence Fund (EDF), has been receiving very enthusiastic support from France. These are not vain words: every week of this year, there have been exchanges between experts of the Agency and our European colleagues in order to define and select EDF 2021 then 2022 topics, more particularly for research. Let's not forget the increasing number of multilateral projects led by the European Defence Agency (EDA), based on Member States hard work within the EDA research domains working groups (CapTechs), and there are numerous other examples.

Instead of 27 national defence innovation strategies, would it not be more efficient to just have a joint European one?
Having one unique and shared strategy is an obvious target but we need to be aware that all the European countries have not been starting their innovation approaches at the same time and do not share the same schedule or ambitions.

It is therefore very important to create the favourable conditions for an innovation dialogue and to be able to produce a unique strategy, the innovations structures need to form a strong network. European countries will surely get most benefits and advantages in innovation if they provide a round table where their specialists can join and exchange about their priorities, projects and opportunities. Such discussions will eventually transform into cooperation projects and in the end into a global and coherent strategy shared between all the Europeans participants.

Provided by the different members and cultures, the numerous ideas will probably be heterogeneous at the beginning, so they will have to be collected and synthesised: the EDA is expected to play a role in this process while pursuing its mission of supporting the Member States.

Keeping the proven old, embracing the new

As in other countries, the military has long been a central driver of technological innovation in the Netherlands. Today, as elsewhere in Europe and the world, the private sector with its young and vibrant high-tech players has taken over that role, with obvious consequences for the country's defence R&T and innovation approach.

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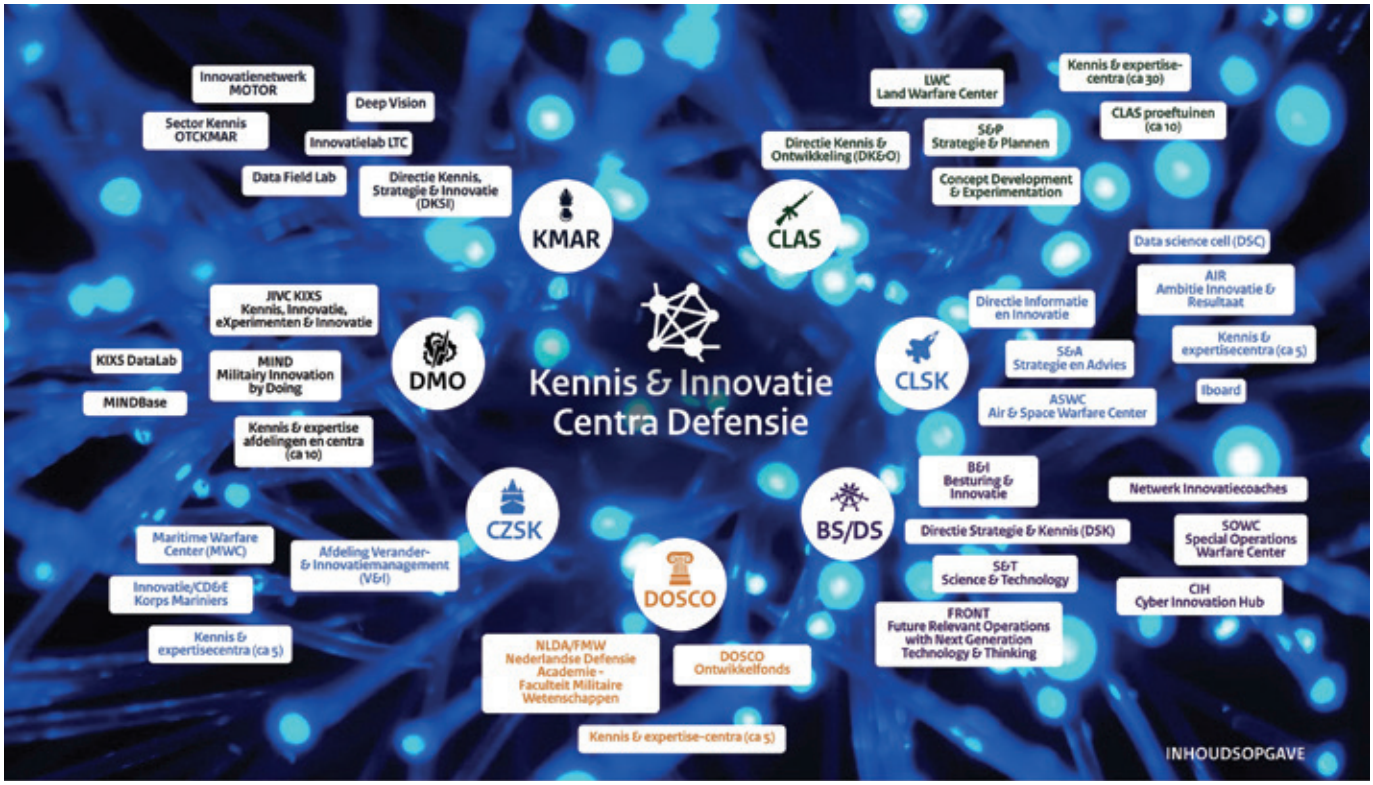

Dutch defence innovation cosmos

Acknowledging the irreversible rise of new emerging and disruptive technologies (EDT) that can be applied in defence, but also knowing that their full operational integration into existing high end military platforms (weapon systems, frigates, planes, etc.) will take years if not decades, the Dutch have opted for a mixture of both approaches, old and new.

The idea is to maintain and improve some of the proven traditional ways and means to promote military innovation inside the restricted defence environment; while at the same time embrace a much more open, flexible and short-cyclical innovation agenda relying on defence-relevant tech products and services available on the commercial market.

This is also the chosen course of action that emerges from the MoD's Defence Strategic Knowledge & Innovation Agenda (Strategische Kennis- en Innovatieagenda, or SKIA) for the years 2021-2025, published in November 2020: the Netherlands will continue to both invest in classical (long-term) defence R&T and, simultaneously, increase their efforts to apply available civil technology for military purposes, in what is called 'short cyclical innovation'.

Innovation centres, linked in a vast network

This trend had started even before the latest version of SKIA was published, several years ago when the Dutch MoD started to look for ways to better use and integrate commercial tech assets from the outside world into existing defence capabilities.

A first important step was made with the creation of numerous innovation centres, dealing with different specific topics and placed high up in the MoD hierarchy. They started to experiment and look for ways to embrace civil innovations (in parallel to the traditional defence R&D unit which continued its work in the classical defence environment), using both a demand and opportunity-driven approach.

The demand driven innovation approach, where solutions are searched from the outside world for well-known military problems or demands, saw the Dutch MoD actively reaching out to civil partners (especially start-ups and SMEs) at technology fairs, business platforms etc. with the help of the existing Regional Development Societies, which are provincial facilitators for start-ups. A special Field Lab Smart Base was also set up, offering possibilities to test and improve assets for future military bases, which attracted many start-ups and SMEs. Under the opportunity-driven innovation approach, the Dutch MoD started to scan the commercial market for assets that could potentially be interesting for defence. Here the MoD teamed up with so-called innovation hubs or incubators, usually build around universities or tech-companies.

Today, all those actors – innovation centres, innovation hubs and incubators to name just a few – are interconnected and part of a wider, decentralised and flexible Defence Innovation Network (Innovatienetwerk Defensie), a true innovation ecosystem, on which the Dutch defence innovation efforts and ambitions depend.

"Flexibility is paramount for innovation"

Interview with **Auke Venema**, Head of the Dutch MoD's 'Knowledge & Innovation' Department, and **Col. Pieter van Broekhoven**, Chief Innovation Advisor and Head of 'Future Relevant Operations with Next generation Technology' (FRONT) centre at the Dutch MoD.

Images © Dutch MoD

What are the main characteristics of the Dutch innovation strategy in Defence?
To keep up with the current, rapid pace of technological development in a constantly changing environment, it is necessary to be agile and adaptive while, at the same time, follow a path that is insightful and measurable. Our defence innovation strategy entails all these characteristics as it is based on four main pillars.

First, it acknowledges the need to adapt to the innovation pace of the outside, civil world. It is clear that civil developments will not wait for the military to catch up. It is also clear that our adversaries will use those civil developments even if, in the first place, they were never meant to be used in armed conflicts. As our Armed Forces have to be effective, we must adopt the innovation pace of the world around us. Without that, we won't be able to face today's threats, and even less those of the future.

Secondly, we need to combine this short-cyclical innovation with traditional military innovation. Because despite the emergence of new technologies and warfare methods, we will still be confronted with classical weapon systems which also continuously become more high-tech and robust. In reality, there is no obvious separation between short-cyclical and classical innovation; both are fusing, effectively using best practices from both worlds.

Thirdly, we put a lot of emphasis on Concept Development & Experimentation (CD&E) that enables us to drastically reduce the lead time of modernisation projects. The development of both new equipment and new concepts will become more efficient. Both engineers and soldiers are encouraged to constantly look for opportunities in this domain.

And finally, there is the need to closely cooperate in ecosystems with civil incubators and accelerators. Short cyclical innovation is often driven by start-ups. Although agility is key in early design stages, a certain robustness and maturity is necessary in the implementation phase. This is where civilian incubators and accelerators come in. They are part of so-called ecosystems, often connected to universities or tech companies, and therefore have access to important developments which we, as the MoD, are interested in. Promising start-ups are given the opportunity to participate in start-up programmes, which transforms them from inventors to entrepreneurs.

How big of a challenge is/was it to get the civil tech innovators to engage with the MoD?
We have no problems finding innovators interested in engaging with the MoD. On the contrary: many innovative companies and start-ups are attracted by the opportunities for product development as well as the experimentation and testing facilities offered by the Ministry.

And to get the military structures to open up to the civil world?
If, at the beginning, there was perhaps a certain reluctance from the military side to open up, it has rapidly vanished. The real problem lies in the procedures, regulations and legislation. Making the defence structures 'innovation compatible' is one of the biggest challenges we are confronted with.

The Dutch model is based on a network of 'innovation centres' and ecosystems. Would you say that decentralisation and specialisation are key prerequisites for success?
Decentralisation and specialisation surely boosted demand driven innovation. Since we never used a centralised model with a single innovation unit, we cannot determine if they were prerequisites. We do however notice that it is essential, though not simple, to constantly share knowledge and experiences for building up an efficient defence-wide knowledge base. Also, we should not forget that funding is a key prerequisite for success.

Is there something particular from the Dutch defence innovation model that could/should be applied at a wider EU level?
The most important thing is not to be fixed on a single model/approach but to embrace flexibility. Even in our relatively small defence organisation we don't use one innovation model as a blueprint. Every service uses its own variant of the model, suitable for their specific needs. This flexibility is needed even more at the wider EU level. Flexibility plays an important role, especially when working in networks and ecosystems. Flexibility is also our leading principle in our efforts to make procedures, regulations and legislation 'innovation compatible'. There is no doubt that regulations are indispensable for the effective deployment of a military organisation and for governmental organisations as a whole. However, when it comes to innovation, a mind shift from rigidity to flexibility is paramount.

Industry-led, Ministry-supported

Estonia has a hands-on, market-oriented approach to defence innovation, predominantly driven by industry and supported by the Ministry of Defence (MoD).

With its land-centric and reserves-based defence forces, the small country has opted for cost-effective innovation procurement targeting high-end technologies, applications and services already available in the market, rather than investing in complex and mostly costly long-term research and development programmes.

However, to achieve a high level of development and international competitiveness for Estonian defence products, the Ministry of Defence (MoD) has invested around €6 million in defence industry R&D over the last decade. This includes support to the Defence Industry Association, a yearly defence innovation competition (since 2013), co-funding for European Defence Fund (EDF) projects, etc..

In addition, the Estonian defence forces and the voluntary Defence League supported the industry in testing and developing their products. Overall, since 2013, the MoD co-funded over 50 national and international projects conducted by the Estonian defence industry. Business diplomacy is also used by the Ministry to support the defence industry to enter new markets and boost exports. Every year, about 50-60% of the Estonian defence investment budget goes to local industry.

Creating the right conditions for industry

The key elements of the Estonian defence innovation policy are reflected in two guiding documents of the MoD: one on research and development (R&D) policy, and one on defence industrial policy.

An updated version of the defence R&D policy (covering the period until 2030) is currently in the process of being adopted, while the defence industrial policy (covering the period of 2013-2022) is also undergoing a review for the next period until 2030. Both these policies operate on a basis of a clear-cut recognition that Estonia's financial and human resources – both in the defence sector and nation-wide – are very limited and restrict the possibilities in terms of scale and impact of innovation.

Estonia's defence innovation strategy is therefore predominantly focused on creating the right conditions for the country's small but very vibrant and technology-minded defence industry to become even more competitive in global

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markets. It mainly aims at enhancing the home industry's export potential. This can be explained by two major factors. First, the relatively small size of the Estonian defence market which is simply too restricted for home companies to rely on exclusively. Secondly, the fact that the Estonian MoD does not give out any 'state guarantees' to buy national products, which means that national defence producers and their products have to be competitive under normal market conditions. This lack of preferential treatment has not hampered defence innovation in Estonia, on the contrary: the country's particularly vibrant start-up culture has allowed the country to thrive and even become a leader in areas such as Artificial Intelligence (AI), robotics or cybersecurity.

"Competition is a driver for innovation"

Interview with **Col. (ret.) TarmoRänisoo**, CEO of the Estonian Defence and Security Industry Innovation Cluster.


© Estonian Defence and Security Industry Innovation Cluster

The Estonian defence innovation model is driven by industry, rather than by the MoD. With success?
Yes, it's working just fine.

How do you make sure Estonian companies know which products the Armed Forces really need?
To be successful you need to know your customers and understand their needs. The Estonian defence industry is focused on exports markets and these areas are primarily dominated by new technologies.

What can Europe learn from the Estonian approach?
I have only one simple recommendation for EU Member States: open up your national defence sales markets for European competition! Competition is a driver for innovation and protective measures will hinder it. Competition among companies will boost the development and invention of new and better products and solutions. Products that are commonplace today once were technological breakthroughs: cars, planes, cell phones, televisions, the personal computer, and internet all show how innovation can change your life. Companies will race to be the first on the market with new or better technologies.

Innovation Cluster

The Estonian Defense Industry Association (EKTL) leads the implementation of the national defence innovation strategy. Established in 2009, it actively participated in shaping Estonia's defence industrial landscape which has grown from some individual companies to more than 100 privately-owned local companies offering defence industry products and services. Those range from ships, drones, autonomous unmanned ground vehicles and IT cyber-digital solutions to AI-assisted software, special clothing/footwear, demining equipment, medical equipment, heavy industry products and energy solutions for the Armed Forces, to name just a few. Since all Estonian defence producers have to focus on export markets, innovation and competitiveness are crucial.

To support them in that endeavour, the EKTL created in 2012 the 'Estonian Defence and Security Industry Innovation Cluster', a specialised network to enhance the ties between Estonian companies, R&D institutions and clients (triple helix) and promote international cooperation and exports.

The Cluster and its members promote innovation in the defence and security industry, develop new and highly competitive products/services for export and participate in international projects and programmes. Its declared objective is to increase the export volume of the Estonian defence and security industry tenfold by 2029. The Cluster is also co-financed by the European Regional Development Fund.

Future military scenarios: evolution or revolution?

Throughout 2021, the European Defence Agency (EDA) held a Technology Foresight Exercise, the results of which will help identify and define the main challenges Europe's armed forces will most probably have to face in the next 20 years and beyond, as well as the defence toolbox needed to tackle them.

In the short term, the exercise outcome will feed into next year's revision of the EU's Capability Development Plan (CDP) to be steered by EDA. It will also serve for future updates of EDA's Overarching Strategic Research Agenda (OSRA) and the Key Strategic Activities (KSA).

The methodology applied and the activities developed were designed to support the central objective of the foresight exercise: the identification of new technologies, weak signals and innovative trends to support the R&T and capability planning processes and inform future defence policies and programmes of the EU and its Member States. To achieve that, the exercise looked up to 20 years into the future, to provide a strategic vision of the possible impact those new technologies will have on defence in 2040 and beyond. The exercise was based on a methodology which combines different existing methods and processes along with best practices and lessons learned from the wider EDA community of foresight practitioners.

10 future scenarios identified

The exercise stretched over 2021 with successive activities and meetings that brought together representatives from different international organisations, Ministries of Defence, non-governmental bodies, academia, industry and civil society. With the help of a multidisciplinary group of foresight experts, so-called Futures Tellers, multiple possible futures were described in the Futures Narratives meant to widen people's vision and imagination and to encourage them to think outside the box about what could be possible towards 2040+, and what kind of challenges this would entail. Based on these narratives, the experts then entered a complex thinking and discussion process (Divergent Thinking, Convergent Thinking) from which, at the end, emerged 10 future scenarios, i.e. developments which, according to the experts, are very likely to materialise over the next 20 years in Europe – all of them somehow relevant for defence:

- **Software-based battlefields:** a scenario where software and algorithms will determine military missions' success more than platforms, as the result of disruptive developments and the introduction of Artificial Intelligence (AI), faster communication networks and system-of-systems defence solutions.
- **Space as an operational military domain:** by 2040, all global powers will have a fully established space force resulting in opportunities but also in threats and challenges. This scenario will call for the establishment of new concept of operations, regulatory frameworks and international agreements.
- **Extended and augmented reality everywhere, also in defence:** the merger of brain-computer interfaces and augmented/virtual reality in the battlefield will lead to a pervasive robotisation of the battlefield and the rise of (mis-) information-driven capabilities.
- **Dominance of unmanned and autonomous platforms on the battlefield:** in 2040, the extensive integration of unmanned platforms in the military domain will trigger major changes to the structure and organisation of Defence Ministries, particularly as regards military operational doctrine, equipment, acquisition policy and logistics implications.
- **Hybrid human-machine teaming, including the military:** by 2040, there will be a seamless integration and cooperation between humans and machines. This scenario deals with the consequences this development will have on technology, as well as ethical and regulatory frameworks.
- **Proliferation of more and more sophisticated biological weapons:** by 2040, climate change, global migration and the rise of megacities will result in new diseases, natural catastrophes and new resistant microbes created by the widespread misuse of antibiotics and other drugs. New biohazard stemming from the use of synthetic biology and gene edition technologies will emerge, which may be used as a bioweapon or biothreat.
- **Enhanced cognitive abilities of soldiers (human enhancement):** this scenario outlines the key impact advances in biotechnology, synthetic biology, gene edition technology and brain-computer interfaces will have on soldiers as those technologies can be used to enhance human being's cognitive and physical capabilities.
- **Real time mapping of dynamic environments:** by 2040, quantum sensing and quantum navigation will have made leaps ahead in the development resulting in real-time mapping capabilities of ever-changing environments. The

EDA illustration created by Philippe Lozinski

consequences on military capabilities are addressed in this scenario.

- **Use of misinformation:** by 2040, the misuse of information will become a weapon targeting all information systems and enabling a scale of influencing operations challenging the capability of nation-states to counter or control. The boundaries between military and civilian domains will continue to blur.
- **Environmental problems, energy supply, climate change:** by 2040, climate aspects and biodiversity will become geo-strategic drivers and subjects of conflicts and confrontations. Energy supply, too, will remain a major factor of strategic dominance. From a defence point of view, and despite the huge investments made in new energy generation and storage systems, energy will remain a critical challenge for most defence systems and operations.

The impact those 10 scenarios will likely have in the defence domain, and the types of adaptations they will require, were then analysed from different time perspectives, i.e. very short term (2024), medium term (2030) and long term (2040).

Final conclusions

As this magazine went to press, the outcome analysis of the exercise was in the final stretch. A final report with the exercise conclusions will be available on the exercise website soon: https://eda.europa.eu/what-we-do/all-activities/activities-search/technology-watch-foresight

"The industry will have to adapt"

Introducing innovative technologies or processes in the defence domain can only be successful if done hand in hand with the defence industry. How are Europe's defence producers coping with innovation-driven challenges and how is their way of working impacted by the current innovation push? We asked **María Luz Gil Heras**, Technology Acquisition Manager at Indra*, about her views and assessment.

Innovation is everywhere in defence, from new disruptive technologies and management forms to close cooperation with the civil world. How does this affect the industrial side of capability development, i.e. the way defence equipment is designed, produced and maintained?

The defence industry makes intensive use of technologies and, therefore, innovation plays an important role. The growing level of complexity and integration of the required solutions makes it compulsory that the technologies used are state of the art, so as to meet the needs of our customers. In addition, the defence industry must have the capacity to develop and produce advanced equipment; something that requires strong investments and government support. Technological progress is helping industry to reduce delivery times and costs and to increase the performance and reliability of the defence equipment. New management techniques, the adoption of new design methodologies, as for example the 'Design for Excellence', and new technological advancements – combined with highly qualified engineering and sophisticated manufacturing skills – are transforming the defence industry.

We are in the midst of a digital transformation of our industry, 'Industry 4.0' if you want, where technology has a key role, but transformation also covers other important aspects such as people, processes, culture and governance. Within the design process, modelling and simulation as well as the creation of digital twins are options that could be used throughout the whole life cycle. Of course, the latest technological advances in many areas are delivering new high-performance designs. Digitised supply chains, 3D-printing and augmented/virtual reality are being adopted for production. In the field of maintenance, prediction is significantly improved thanks to monitoring, analytics as well as smart and remote customers assistance. This allows for a more efficient operational use and an extended life-cycle of the systems.

As regards the civil industry, it has experienced a huge development due to massive demand of electronics or information and communication technologies (ICT). It is a fact that the investments in civil R&D are currently higher than in the defence domain which makes the defence industry more dependent on civil technologies, while it mainly concentrates its R&D on critical technologies. One the main issues resulting from this situation is the obsolescence problem the defence industry has to face with respect to the maintenance of its systems. Another problem lies in the fact that the volume of specific electronic parts required by the defence industry is not comparable, because it's much lower than that used in the civil industry. This implies that investments needed to adapt civil products to specific defence requirements are sometimes difficult to justify.

Can you give an example of innovative impact on the defence industry?

Something that the defence industry, like other industries, is doing is to connect its processes and information. Information can flow now better than ever before, both inside and outside of the organisation. Big amounts of data can be stored and analysed for business improvement but also to collect data from the different systems and use it for the improvement of the

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María Luz Gil Heras

> "Most of the EU's future programmes will be implemented through international cooperation to achieve a common objective."

design processes, for manufacturing and operation. New ways of management and software solutions are being adopted by the companies. One example can be found in the incorporation of Product Lifecycle Management (PLM) tools that help to manage the whole lifecycle of a system from its concept to the design, manufacturing and up to the system withdrawal. PLM tools integrate product data with processes and business systems, as for example sales and supply chain systems.

With regard to the supply chain, there is a need for anticipation and close collaboration with industry and its suppliers. The digitisation of this relationship and the application of new analysis techniques making use of artificial intelligence and cloud solutions will help to increase the capacity to deliver on time and to be more cost effective in the production phase.

We must not overlook the fact that all these innovations and breakthroughs bring also new challenges, for example the cybersecurity need to protect data and systems within the organisations.

Under the impulse of the EU defence initiatives (CARD, PESCO, EDF), defence capability planning and development in Europe is set to become more collaborative and multinational. How will this change industrial processes?

There is no doubt that all these EU defence initiatives will offer big opportunities but also challenges. The European defence industry is experiencing great changes as a consequence of the development of common policies within the framework of the Common Security and Defence Policy (CSDP) and there will be no other way of working for countries and industries than through cooperation. Most of the EU's future programmes will be implemented through international cooperation to achieve a common objective. Industrial models and processes will have to adapt to this new way of working.

To define the future military capabilities, governments and industries from different countries will have to enable mechanisms of communication and coordination and develop common processes, systems and tools. It will also be also very important to include SMEs and research and technological centres within this ecosystem and ensure there is an appropriate knowledge management derived from cooperation.

In your view, are Europe's defence producers prepared to live up to those challenges?

This is a long-distance race. It will require continuous work and strong commitment by the Ministries of Defence and the industry to be prepared and face all these challenges. In this respect, the support and enhancement of the European Defence Technological and Industrial Base (EDTIB) is very important. Many of the initiatives show that Europe is aware of this, but this ambition has to be implemented gradually through a solid workplan, continuously monitored and updated, that must strengthen the European defence industry, increase its global competition and efficiency and overcome the current defence market fragmentation.

*Indra is one of the leading global technology and consulting companies providing proprietary solutions in specific segments in transport and defence markets, as well as a leading firm in digital transformation consultancy and information technologies.


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One trophy, two winners

'Too close to call' was the jury's verdict after assessing many excellent proposals received from contenders from across Europe for EDA's Defence Innovation Prize 2021.

Hence, the announcement of two winners for this year's contest which rewards the most innovative ideas, technologies and solutions related to Human-Machine Interfaces enabling Human-Machine-Teaming for Defence.

ASTARTES

The first of the two winning projects is called ASTARTES (Air Superiority Tactical Assistance Real-Time Execution System) and was proposed by Design AI, a German deep tech start-up specialised in Artificial Intelligence.

We asked Frederik Mattwich, the company's co-founder and Chief Technical Officer (CTO), to explain and summarise his team's winning project:

"Supporting human pilots with their tactical decision making speed is an expected future role of Artificial Intelligence (AI).

In order to overcome the ethical and technical challenges such an AI assistance system poses, many steps will be necessary to gain confidence and understanding of how AI decisions are made. We have identified one such step which is scientifically reproducing the published results from Google Deepmind's AlphaStar.

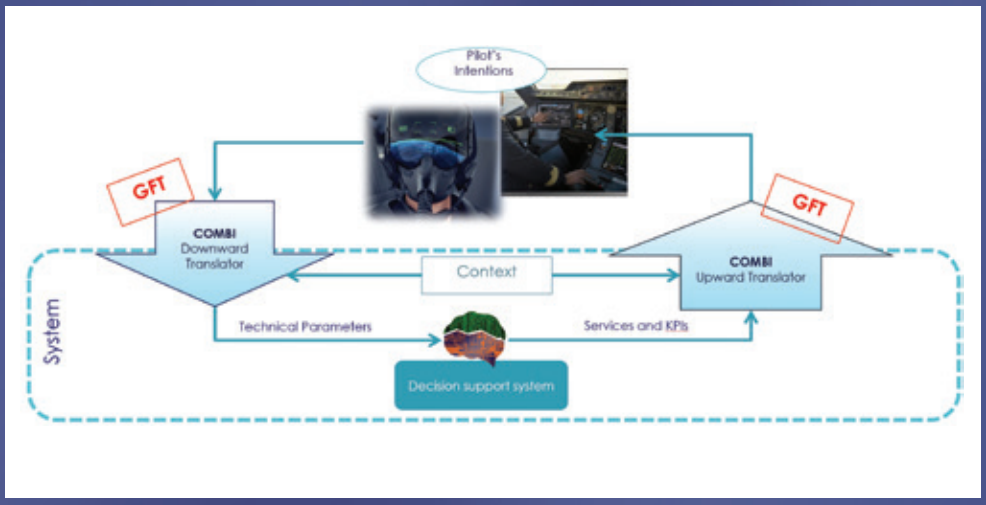
A planned next step is to transfer the results from a reproduced AlphaStar to 'Command:Professional Edition' which is used (among others) to teach air combat tactics in the German Officer Academy in Fürstenfeldbruck. Through this serious gaming approach, ASTARTES aims to visualise AI assisted tactical decisions and thus make it transparent as well as explainable, and also to facilitate its evaluation from a military personnel perspective. It will be essential for all stakeholders to understand the strengths and, most importantly, the drawbacks and limitations of AI in the context of military applications.

Our overall vision for ASTARTES is the development of a digital (super) human-level AI assistance system, which will combine the data from all platforms and provide real time tactical support to a human commander in every situation, reduce his workload in the NGWS (Next-Generation Weapon System) context and speed up the OODA loop (observe–orient–decide–act) drastically. The AI is planned to potentially also support pilot training in an Live-Virtual-Constructive context as well as tactical scenario analysis".

DESIGN AI

Design AI GmbH is a German deep tech start-up specialised in Artificial Intelligence. It focuses on bringing state-of-the-art innovations from AI research to the industry in the areas of Reinforcement Learning, Computer Vision, Natural Language Processing, Business Intelligence and Predictive Analytics. It manages to bridge the gap between user-centred concept development and agile research and development of AI systems, especially through the combination of Design Thinking and Artificial Intelligence. Experienced in various industries, the company is focused on the defence sector, where it successfully brings state-of-the-art AI into the field of mission planning and execution.

COMBI



The second of the two winning projects is called COMBI (Bidirectional Communicator) and was proposed by Thales, a global high technology company active, among others, in digital and "deep tech" innovations.

We asked Marc Gatti, Human Autonomy Teaming (HAT) Department Director at Thales AVS/DMS France, to explain and summarise his team's winning project:

"COMBI is a high-level operator 'intentions' translator from and to operator to and from plural intelligent systems within his working area.

The future of defence operations are expected to become even more complex. A similar mission to one carried out today will include several intelligent systems that combine the operator's platform with those controlled remotely (teammates, drones, etc.). A more complex environment will not only increase the operator's workload but also further distance from him to the vital decision-making process. Genuine collaborative work (from a human point of view) between humans and intelligent systems will be a game changer for future defence operations whatever the environment: ground, sea, sky or space.

Classically, the distribution of roles between human and artificial agent is called "authority sharing". It is limited to the analysis of the tasks to be performed (task analysis) and to the development of related autonomous functions. The operator is then responsible for adapting this assistance, to meet the technical parameters for carrying out the mission. However, authority sharing is not enough to tackle complex future defence missions (time consuming and technical skills). The collaboration level between human and artificial agents should be increased and this is the objective of the Human-Autonomy Teaming (HAT) concept.

One of the most important characteristics of HAT is efficient dialogue between participants. This is the way to establish a shared representation of the situation to reduce misunderstandings and improve decision-making. However, the way dialogue is performed depends on the situation. To reduce the cognitive workload of managing complex systems, the communication level must be conducted at a high level of abstraction.

Human activity is organised according to a goal to be achieved which is driven by intentions (Leontiev, 1984). COMBI takes advantage of these intentions to establish a dialogue between the operator and the intelligent systems, reducing drastically the human mental workload.

COMBI is composed of: - a top-down transfer function that translates pilot's high-level intentions into intelligible parameters for the solvers, optimising their treatment; - and a bottom-up transfer function that translates solver results into the high-level pilot referential operational intentions and parameters".

THALES
Together • Safer • Everywhere

Thales (Euronext Paris: HO) is a global high technology leader investing in digital and "deep tech" innovations: connectivity, big data, artificial intelligence, cybersecurity and quantum technology. The company provides solutions, services and products that help its customers (businesses, organisations and states) in the defence, aeronautics, space, transportation and digital identity and security markets to fulfil their critical missions, by placing humans at the heart of the decision-making process. In the field of aeronautics, Thales supports aircraft manufacturers, armed forces, airlines, operators, pilots, crews and passengers in making improvements to flight efficiency, safety and comfort. The secure, natively connected systems that Thales designs allow aircraft, helicopters and drones to fly under all conditions and to interface with all parts of the aeronautical ecosystem, on the ground or in flight.

"Europe has to step up for its own security"

In the following Opinion Editorial, Slovenia's Defence Minister **Matej Tonin** elaborates on the defence and security priorities of his country's current EU Presidency and shares his views on other defence-related topics.

One of the EU's objectives is to ensure a safe and peaceful environment for its citizens. By participating in the EU's Common Security and Defence Policy (CSDP), we are safer and stronger, although facing challenges in different areas.

In the past two years, we have been confronted with the COVID-19 pandemic which showed us the need for joint coordinated activities. The recent events in Afghanistan also caught us by surprise. We have all been witnessing the devastating effects of climate change for years now. Such global events or new facts have also made it clear that Europe has to step up and do more for its own security and protection. The EU countries have to make Europe more capable of acting on its own when necessary.

The important role of EDA

The CSDP is an integral part of the EU's common foreign and security policy, with a focus on military and civilian crisis management, conflict prevention and support for security sector reform. It has made significant progress in recent years also with the abundant help of the European Defence Agency (EDA). EDA is of utmost importance because it supports the development of defence capabilities and military cooperation, promotes defence research , the strengthening of the European defence industry and collaborations, launches new initiatives and introduces solutions to improve defence capabilities. In my view, EDA's most important role is to connect the participating countries, to nourish this bond among us and motivate us in achieving results. I believe we are heading in the right direction.

Slovenian EU Presidency

Slovenia is more than halfway through its EU Presidency. We have been leading the EU family of 27 Member States in close cooperation with the EU High Representative through these challenging times. The two other members of our Presidency 'trio', Germany and Portugal, as well as the other Member States, particularly France, who takes over the next Presidency soon, have been supportive of our efforts. I am confident that we will be able to bring to the table even more deliverables before the end of our Presidency. We have also been working closely with other partner countries and organisations on many topical issues and our priorities, and I believe that our cooperation has been more than successful and efficient.

"Together. Resilient. Europe." is the official slogan of the Slovenian EU Presidency. Our priorities in the field of defence are also in line with this message. We hope that our activities can contribute to the CSDP implementation and strengthen the solidarity, cohesion and resilience of the Union.

Close cooperation with US and NATO

The Slovenian EU Presidency, supporting the work of the High Representative for Foreign Affairs and Security Policy, will take all the necessary steps to strengthen the transatlantic relations. Close cooperation with the United States and NATO based on common principles, values and interests is the best guarantee for strengthening the position of the EU in the international community and for facilitating the pursuit of common interests by the Member States.

The EU should continue to work together with NATO when it comes to our common security and defence issues, and future challenges. We must make this a strategic partnership and deepen the EU-NATO cooperation. Closer cooperation is more important than ever in pursuing our joint strategic goal – preservation and strengthening of rules based on the international order; shared democratic principles when building defence and resilience, especially when dealing with terrorism; climate security and cyber security.

In this respect, we have been fully supporting the idea to sign the third EU-NATO Declaration, which will define the future of our strategic partnership. Enhancing resilience is another important common area where we should look for synergies between the US, the EU and NATO. The strengthening of our transatlantic bond is therefore crucial for our security and defence on both sides of the Atlantic.

Focus on the Western Balkans

We have to face some challenges together with our partners outside the EU. Our focus here is on the Western Balkans region, which is not only geographically close, but is also the area where most of the Slovenian Armed Forces participating in missions and operations are deployed. By contributing to EU missions and operations, the countries of the Western Balkans have demonstrated their commitment to the CSDP, and together we will work to further develop their capabilities, in particular through the European Peace Instrument. In this direction, talks and efforts are underway within the

MoD for the possibility of EU support for the Balkan Medical Task Forces (BMTF) project.

Energy efficiency in the defence sector

Finally, we must all do our share to protect the environment and reduce the negative effects of climate change. This affects our lives as citizens whether we are in uniform or not. Climate change is one of the most urgent global challenges. Its destabilising impacts make it a threat multiplier.

Armed forces will have to face this challenge and become more resilient to be able to carry out military tasks and to complete missions and operations. That is why the energy efficiency of the defence sector is our third priority.

We organised a military and defence seminar on new energy supply models for sustainable and resilient military engagement. We are also involved in several international EDA projects that develop green defence technologies, and we are renovating our barracks and introducing renewable energy sources.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All our electricity is obtained from green sources. We are one of the leading countries in introducing hydrogen as the fuel of the future. Soldiers must complete an environmental protection course as part of their individual-skill programme. Those are all activities that contributes to our safer and better future.

Strategic Compass

The Strategic Compass is the most important on-going EU security and defence topic and therefore at the heart of our endeavours. We have been actively participating in the Strategic Compass process, addressing all four pillars: crisis management, capability development, partnerships, and resilience. We see our role in seeking consensus between EU Member States, together with the EU High Representative on what the final content of the Compass should be. Throughout our Presidency we have facilitated and contributed to this exchange so the first draft of the document could be presented in November. Our successful coordination will be a good starting point to conclude the process in March 2022, during the French EU Presidency.

The EU's CSDP should continue to tackle new challenges

We have seen significant progress in recent years in the CSDP domain; however, there is still a lot of room for improvement, especially in areas such as military mobility, impacts of climate change on the defence, countering hybrid and cyber threats, and improving civil-military cooperation in crises. The EU's CSDP should continue to address new challenges, such as pandemics, natural disasters, terrorism, and cyber threats. We should support the role of EDA and strive to jointly make the most visible and concrete impact on the quality of life of our citizens. Member States' overall engagement in drafting the Strategic Compass as a guidance document that will direct us towards better and safer Europe is very promising. I believe that their engagement shows a willingness to become even more committed to the activities within the EU's CSDP.


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"The EU needs stronger common military tools"

General Claudio Graziano's mandate as Chairman of the EU Military Committee (EUMC), the EU's highest military body, will end in May 2022 after more than three years which saw important defence achievements, such as the first full Coordinated Annual Review on Defence (CARD), the launch of new PESCO projects and the start of the European Defence Fund (EDF). Legacy interview with a front row actor of the Europe of Defence in the making.

With the required prioritisation and implementation tools now in place (CDP, CARD, PESCO, EDF), is European Defence on the right track?

The world I found when I arrived at the EUMC in November 2018 has been heavily shaken during my mandate. The pandemic hit hard, amplified existing threats, brought new challenges and displayed a new geopolitical situation.

Furthermore, the growing competition between the US and China and the new role of some international actors, prove the merits of a stronger EU in the global arena. Undoubtedly, if the EU wants to play this role, the role of a global security provider, it needs stronger common military tools.

We are working on a lot of these issues and I think that we are on the right track. We clearly know that it's a long path that needs to be run together, because the result of individual egoisms is a common failure.

There are a lot of defence initiatives. I am talking mainly about CARD, PESCO and the EDF, not just mechanisms to identify opportunities and support cooperation in developing capabilities, but also substantial funding for EU research and development.

Despite these efforts, we continue to witness the anachronistic fragmentation of the EU defence capability landscape. It is clear that if we want to avoid duplications and waste of resources, we need to spend better together.

On top of this duplication and fragmentation, we continue to face some major critical shortfalls: readiness of forces, logistic infrastructure and support for deployment, transport helicopters, C2, intelligence, surveillance and reconnaissance capabilities, enablers for special operations forces and medical support. These are the areas on which we have to focus our efforts.

The 2020 CARD report concluded that Member States' general commitment to CSDP missions and operations is low with strong disparities between countries in terms of their engagement and operational effort. How concerned are you, and what could be done to change that?

The EU must absolutely count on a full spectrum force package for all potential crisis scenarios, with a proper EU Central Command and Control capacity, secure lines of communications, the necessary military mobility and strategic enablers. But the EU's credibility will also depend on the availability and rapid deployability of a joint and multi-domain reaction toolbox: about 5-6,000 personnel, properly equipped and sustained by all indispensable enablers, for which a revised EU Battlegroup could be the core.

To support these objectives, the EU still relies almost entirely on Member States' contributions, personnel and capabilities. In this regard, we have two problems.

First, a lack of political commitment by Member States to provide the necessary personnel and assets. Secondly, the afore-mentioned fragmentation of the EU defence capability landscape.

To address these problems, the EU has done a lot, providing Member States with different tools. Now we need to work together coherently and concretely knowing that the EU defence initiatives are too recent to have already produced a significant and positive

effect on the fragmentation. Remember: Rome wasn't built in a day!

Close interaction between the political and military actors is crucial for the EU's security and defence policy. With your experience, did we succeed in establishing the civil-military synergies or what can and should be improved in this regard?

Nowadays, more than ever before, the border between the civil and military is imperceptible. The battlefield is where the competition for technological edge will potentially see the most severe confrontation: technological sovereignty.

History teaches us that military innovations have changed the shape of wars and, subsequently, the societies. Nowadays the opposite is happening. The main innovation drivers come from the private, corporate domain – often small and innovative startups – and we as military are trying to integrate these new disruptive technologies in our platforms.

This will require our utmost attention, because there is neither time nor money to waste, and a real urgency to focus on innovative technologies.

This is also the reason why the European Commission recently released its Action Plan on synergies between civil, defence and space industries.

Facilitating civilian-space- defence cross-fertilisation is not only possible but indispensable. It will address the current fragmentation of the civil-defence innovation landscape, strengthen innovation and lead to European economic growth.

If you look ahead to 2030-2040: what will Europe's security and defence clout be in the world and also in the context of EU-NATO cooperation?

Unlike anytime before, after the end of WWII, we Europeans are living in an era of uncertainty where even fundamental institutions like NATO and the UN, are rethinking their roles. This doesn't mean that the EU of defence is an alternative to NATO. On the contrary, based on 'the single set of forces' principle, a stronger EU of defence makes NATO stronger. We have to continue to work together and, at the same time, demonstrate the EU's capacity to tackle its own security challenges effectively and timely, thanks to a new and concrete strategic autonomy.

2030 seems far away, but it is not. We are already working within a wider time horizon and the EDF is a clear sign of this forward-looking approach. With this financial tool, the EU is providing the right means to develop the military capabilities that will be operational in the decades to come. This is the reason why we are called to make huge efforts of imagination and innovation. We are called to take the right initiatives now to face the threats in 30-40 years.

A final word on the EUMC's cooperation with the European Defence Agency (EDA). As the highest military body in the EU, the EUMC's operational view on capability related projects is crucial. To pursue this coherent approach, what would be your advice for the future?

The end-user, by definition, is the ultimate consumer of a final product, which in the military domain, can be a weapon, a system, or even a policy. But the role of the end user, especially in complex systems like the EU defence, is not limited to 'consuming' a product, but it goes further.

Military inputs and expertise coming from the field are essential factors for coming to the best possible definition of the end products needed. Of course, to optimise the outcome of the whole process, it's important to continue to work shoulder by shoulder with EDA.

Our common effort is to provide the militaries with the right toolbox to drive the changes and to accomplish their tasks, which, in the case of the EU, means to fulfil the Level of Ambition defined at political level, namely to be able to defend Europe's interests and citizens.

In defence of dual-use

In a world where the lines between civil and military technologies are increasingly blurred, it is strategically important to ensure that Europe's dual-use industry - a large part of which is made up of young and small start-ups - has adequate access to finance so that they can fully play their role in providing the security and defence systems Europe needs, argues **Kris Peeters**, Vice-President of the European Investment Bank (EIB), in the following Opinion Editorial.

Technological developments are redefining the nature and rules of our physical and economic security. Our economies, infrastructure and militaries can be threatened and attacked without a single shot being fired. With their enormous potential for both military application and economic competitiveness, the disruptive potential of emerging technologies such as artificial intelligence and quantum computing completely blurs the distinctions between economic and security issues.

At the same time, the COVID-19 pandemic has exposed the risks associated with global supply chains and political developments in major trading partners have shown the fragility of the peace that the interdependence associated with globalisation is supposed to maintain. In this new era, the EU needs a holistic conception of security that can discern and defend against the sharp threats hiding in a world of blurred lines.

Cyberattacks on the rise

Last May, hackers effectively shut down Ireland's national healthcare system. Critical services on which lives depend, from coronavirus testing, to maternal care and cancer treatments were disrupted by hackers holding the lives of millions to ransom. Similar attacks have also taken place against healthcare providers in France and Finland, while in the US, critical infrastructure such as the Colonial oil pipeline have also been hit. Across Europe, the number of serious cyberattacks is on the rise, jumping from 432 in 2019 to 756 in 2020. According to the Center for Strategic and International Studies, cybercrime now costs the global economy nearly 1% of global GDP.

Cybersecurity perfectly exemplifies the blurring of the lines between civilian and military concerns and the strategic importance of dual-use technology, i.e. technology with both civilian and military applications. It is a strategically important industry vital to Europe's digital transition and therefore also its decarbonisation efforts and economic competitiveness. Unfortunately, it is also an industry in which European start-ups struggle to access finance. Limited access to finance stifles their growth and holds them back from developing into industry leaders. This is the European Investment Bank's area of expertise and how we have been helping to protect, secure and defend Europe through our European Security Initiative since 2017.

European Cybersecurity Investment Platform

Our investment in the Dutch cybersecurity company EclecticIQ this summer is a good example. The company, an innovative, growth-stage business has developed a cutting-edge threat intelligence platform that allows clients to analyse threats and develop a tailored, proactive approach to cyber defence. Like far too many start-ups in Europe, however, EclecticIQ faced a challenging market for mid-to-long-term financing that threatened to constrain its growth prospects. With the backing of the European Commission through the European Fund for Strategic Investments, the EIB was able to provide the company with a €15 million venture debt loan to expand its research and development activities and fund its international expansion plans.

To help many more companies like EclecticIQ, the European Investment Bank is now working together with the European Cyber Security Organisation and the European Investment Advisory Hub on the creation of a new platform to attract large international investors to the European cybersecurity industry called the European Cybersecurity Investment Platform. Together we will also study ways to encourage private investment in the sector by providing access to and simplifying information about the EU's cybersecurity market and the potential for dedicated technical assistance programmes for investors and clients. In this way, we will develop the tools we need to support start-ups and create a vibrant ecosystem for this strategically important sector in Europe.

Opening Space for start-ups

Space is another example of an area where military and civilian technologies overlap. Technological developments have dramatically changed the economics of the space sector such that start-ups are now driving innovation in what was once the exclusive preserve of state-linked actors. Strategically important from a security perspective, space-related technologies are also vital in the fight against climate change and a source of competitive advantage in industries ranging from energy, to transport and agriculture. Our partnerships with the European Space Agency and the EU Agency for the Space Programme, responsible for the Galileo programme, have helped us to expand our presence in the space sector and our recent investments in innovative satellite makers such as Spire (Luxembourg), D-Orbit (Italy), and EnduroSat (Bulgaria) show the potential that EU space companies have to offer.

The aircraft industry, radar systems, microelectronics and even vaccines are all areas that contribute to Europe's security, resilience and autonomy and in which the European Investment Bank is active. The EIB fully supports the EU's determination to strengthen the security and defence of its members and its ability to contribute to NATO. But like other multilateral development banks, our commitment to not finance projects that give rise to conflicts or intensify existing conflicts means that we won't finance investments in core defence assets, like weapons or ammunition.

Creating synergies

Significant funding from the EU budget has been allocated to defence for the first time in the current long-term EU budget (2021-2027). Through our advisory work, the European Investment Bank is working to create synergies and explore complementarities between EU programmes such as the European Defence Fund, the EU Space programme, Horizon Europe, Digital Europe, the Connecting Europe Facility, the European Innovation Council and InvestEU. The Bank is also working with industry, the European Defence Agency (EDA), the European Commission and national ministries of defence to guide Member States on how to blend the various sources of EU funding with financial instruments for their defence sectors.

Cooperative Financial Mechanism

Our work with EDA on the Cooperative Financial Mechanism (CFM) is a core part of this strategy. Conceived at the end of 2019, the CFM is designed to help facilitate the launch of collaborative defence research and capability projects between Member States, where budgets are often unsynchronised.

With more and more governments confirming their willingness to participate, the CFM should soon be ready to begin operation. And not a moment too soon. Defence spending across Europe has been rising in recent years but the percentage dedicated to research and technology remains lower than it was in 2007. Moreover, the level of public sector cooperation in defence procurement and research in Europe is very low. Over 80% of defence procurement and 90% of defence research is run on a purely national basis. Greater cooperation between Member States has the potential to boost investment and improve the efficiency of individual projects as well as the competitiveness of Europe's defence industries.

Taking IED threats by the horns, together

It is the largest multinational Counter-Improvised Explosive Devices (C-IED) exercise in Europe, and still going from strength to strength: after two successful rounds in the Netherlands (2013) and Sweden (2016), BISON COUNTER 21 set a new benchmark for joint C-IED training with its third exercise recently hosted by the Italian Armed Forces in Southern Sardinia. Further improvements can be expected: as of 2022, BISON COUNTER will become a fully fledged EDA project!

Supported by the European Defence Agency (EDA), the exercise (18 Oct-9 Nov) gathered some 650 staff from 10 EU Member States – Austria, Belgium, Czech Republic, France, Germany, Hungary, Italy, Slovenia, Spain, Sweden – as well as Norway and the United States.

The objective of this extraordinary come-together of C-IED experts, an organisational and logistical challenge brilliantly mastered by the Italian host, was to exchange and train technical skills, to integrate and use available technical enablers and to implement the full C-IED cycle. The wider purpose being to improve interoperability and resilience among European and allied C-IED capabilities in the fight against evolving IED threats, both in military and counter-terrorism operations.

Live exercise, real conditions

The live part of the exercise saw the multination expert teams plan, decide and perform all types of C-IED activities on the ground, based on a fictive but realistic scenario featuring all the ingredients and challenges any national or multinational military operation (EU, NATO, UN, etc.) faces today under real circumstances. "The exercise scenario is actually a previously used one that we adapted in such a way that it fits the conditions and reality of an EU CSDP operation outside Europe, with a specific and realistic C-IED sub-scenario encompassing all challenges, including fighting multiple, →

asymmetric IED attacks, from the simplest improvised devices to the most sophisticated ones", explains Lieutenant Colonel Alessandro Ortolani from the Italian Army, one of the main exercise scenario planners. This exercise naturally raised ambitions following the two previous operations "in the sense that this time, we also used specific intelligence to analyse the perpetrators of IED attacks. We want to know how they think and work, who is behind, what tactics and materials they use, so to be able to better understand and prevent their attacks in the future", he stresses.

All C-IED actors involved

All C-IED aspects were involved and represented, from planning in joint task force headquarters, military search, route clearance and weapons intelligence, to combat engineering, Explosive Ordnance Disposal/Improvised Explosive Device Disposal (EOD/IEDD), manual neutralisation techniques and technical exploitation. They were all organised inside one specific multinational C-IED taskforce, a first in a BISON COUNTER exercise.

EDA-grown initiatives, such as the Joint Deployable Exploitation and Analysis Laboratory (JDEAL) now permanently established in Soesterberg (The Netherlands) and the Vienna-based European Centre for Manual Neutralisation Capabilities (ECMAN) were also present in Sardinia, playing key roles in the C-IED chain trained on the ground. The operational benefits of participating in BISON COUNTER are immense, says Major Marco Pennisi (Italian Armed Forces) who is Training Branch Chief at JDEAL: "During the exercise, we have the possibility to test together what we have trained together at the JDEAL in Soesterberg. There, we just don't have such realistic field conditions to do that. Here, our labs are constantly fed with evidence of all sorts coming from the live exercise. It means that we have to work under very challenging conditions, including time pressure, that are very close to the reality of multinational military missions out there. This allows us to test what is going well, but also what is missing or should be improved". The cooperation done at JDEAL is already having effects on how crews from different countries operate together on the ground, he stresses: "We can clearly see this during exercises like BISON COUNTER. I can see progress everywhere!".

Similar positive feedback comes from an ECMAN crew member participating in the exercise: "In the manual neutralisation techniques (MNT) domain, this BISON COUNTER 21 exercise has broken new ground because, for the first time, participating Member States have sent their national assets to be used on the ground. This allowed us to actually test our respective capabilities on the ground, under real conditions. We know that each Member States has top-notch MNT teams, but to make them work together seamlessly and efficiently is a much bigger challenge".

Lessons to be learned

Even though it is too early to draw final operational conclusions from BISON COUNTER 21 – this important follow-on part of the exercise will only be completed by February 2022 – the overall initial assessment of the achievements is more than positive. In other words: the exercise clearly delivered on its main objectives. "We were happy and proud to act as the host nation of this important exercise for the entire European military community. I think we were successful in delivering a realistic scenario and am confident that the lessons we will identify from BISON COUNTER 21 will be useful in planning and conducting future similar events", concludes General Filippo Gabriele, the Italian General overseeing and directing the exercise.

Immediate reactions from participants were overwhelmingly positive. "Exercises

such as BISON COUNTER are the only way for Member States' C-IED teams to work and train together on the ground, exchange their best practices, merge their capabilities and develop joint standards. At home, we don't have the possibility to do that in a multinational context", said Captain Christian Berger, Austrian C-IED Commander.

Which does not mean that some aspects could not be further improved in the future. "I think that the coordination between the different working levels involved in the exercise – strategic, tactical, operational – could be further improved to better take into account the specific challenges, needs and requirements of the people that actually do the job on the ground. This is particularly important because those boots on the ground are highly specialised. Therefore, they need to be heard", explains Captain Berger.

"There is always room for improvement", adds Corporal Julian Tellez Mutis, Commander of the Spanish K9 (dog) team at BISON COUNTER 21. "For instance, during our training sessions with the dogs, we could try to have even more samples of explosives available and tested during the exercise. It would be good if we could further broaden up the range of materials that we use in training, including new types of samples not yet known to everyone. The more we use and train, the better".

EDA to play a leading role in future

As was the case in the two previous exercises, EDA was closely involved in the organisation and running of BISON COUNTER 21 which had integrated several Agency projects such as the afore-mentioned JDEAL and ECMAN, but also the Military Search Capability Building (MSCB). Going forward, EDA's role will be even bigger as it is the Agency's ambition to pursue the series of BISON COUNTER exercises beyond the 2021 edition in a more structured, comprehensive and coherent manner.

An important step in that direction will be the launch, beginning of 2022 by 13 Member States, of a new EDA project ('Cat B') which foresees at least three additional BISON COUNTER events in 2023, 2025 and 2027. The project will also establish a permanent expert team in charge of the planning of the exercises and its subsidiary activities, both at the conceptual and technical level.

"This means that the joint planning and organisation of future BISON COUNTER exercises will become more centralised and structured under EDA's auspices in close cooperation, of course, with the future host countries. As a result, this should further enhance the coordination and coherence among all participating C-IED actors at all different levels, from strategy to tactics to operations", says Pedro Basto, EDA's C-IED Project Officer.

Having the exercise prepared and organised under EDA auspices "will help to even further streamline our work and move towards common standards", anticipates Major Pennisi from JDEAL. It should also help mitigate minor communication issues between the different working levels operating in multination C-IED missions, as previously mentioned by Austrian Captain Berger. "The fact that BISON COUNTER is going to be a proper EDA project, and therefore become more structured and centralised, can certainly help to improve communication with the operational people on the ground", he says.

Finally, the envisaged more structured approach should also help to better analyse the exercise results and implement a consolidated lessons learned cycle which is essential for moving towards even more sophisticated and interoperable C-IED capabilities in Europe.


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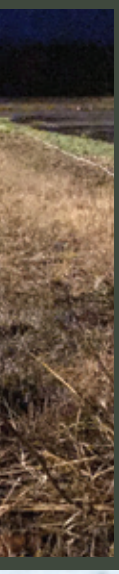


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