

# IMAGINING AHEAD

## Defence Innovation Guidance Document

2019



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# Editorial

## A new impetus for defence innovation

Humanoid robots rescuing soldiers on the battlefield, aircraft able to interact with drones and software programs capable of analysing thousands of satellite images instantaneously - these examples are not drawn from a new George Orwell novel set in "2089". All these applications are currently entering the real world: we have seen them at the Le Bourget Air Show, on the stands of the French Ministry of the Armed Forces (Ministère des Armées) at Vivaltech or again at the experimentation centres of the French armed forces. There can be no doubt: innovation is currently in vogue.

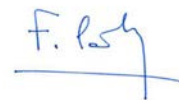
However, the fact that innovation is fashionable does not mean that it is merely a fad. Innovation is a substantive trend, and its motivations and necessities are rooted in the disruptive transformations faced by our societies today. In the defence sector, innovation has become an operational and strategic necessity, even more than it already was in the past. Innovation is now even a vital factor to national sovereignty: at a time when threats and hotbeds of tension are proliferating, we need to have our own way of innovating, in France and in Europe. For example, the innovation capability of our national and European defence industry will enable us to draw on the support of strong, competitive and enduring companies for the benefit of our armed forces and, more generally, of society as a whole.

For the first time, central government is not the predominant instigator of defence innovation. Leading the field in the technological race that we are running, the civilian and commercial domain now permeates every major sector and all the forces involved. Whereas, a few years ago, communication on the battlefield was the exclusive preserve of the armed forces, the irruption of the smartphone into our daily lives has led to major transformations of established practises. This is particularly visible in the context of counter-terrorism. Similarly, the democratisation of access to space has enabled organisations and states that were previously excluded from this field to lay claim to their own space capability. The biggest Silicon Valley corporations challenge and rival the world's top laboratories dedicated to artificial intelligence or big data.

This race for innovation is rich in opportunities for the defence sector: certain technological disruptions are likely to generate strategic disruptions. Endowing equipment with decision-making aids based on artificial intelligence or developing hypersonic missiles capable of travelling thousands of kilometres in less than an hour confer a strategic advantage that will be all the more potent because it can remain concealed.

These developments are unavoidable. They force us to rethink the way we envisage innovation in defence. They impel us to deepen European defence cooperation, which is so necessary to the development of a European strategic culture and to our autonomy. France has every advantage in this race: we have the strength of a robust scientific tradition, excellence in engineering and a real creativity recognised at international level. Defence innovation is now readying itself for a new boost, with the single aim of providing complete and rapid assistance to the men and women who serve our country and protect her population.

Florence Parly



## 1. INTRODUCTION

This document is the first edition of the Defence Innovation Guideline Document (“DOIG”). It defines the essential objectives of the French Ministry of the Armed Forces (“Ministère des Armées”), in cohesion with the ambition defined in the new Defence and National Security Strategic Review published at the end of 2017 and implemented in the Military Planning Law (“LPM”) for 2019-2025.

### 1.1 THE CHALLENGES OF INNOVATION FOR THE FRENCH MINISTRY OF THE ARMED FORCES

The 2017 Strategic Review of Defence and National Security states the following observation: “in the international context [...], it is clear that the demand on France’s armed forces and defence can only grow”. Our country, which is already exposed to proven threats and is operationally engaged at a high level, is now also confronted by an unstable and uncertain strategic environment. Possible new areas of conflict are appearing, with potential adversaries that are better armed due to massive investment. Moreover, the pace of technological development is increasing and should impel us to “maintain high ambitions in every area - technology, industry, capability or on the operational front – supported by a rigorous innovation policy”. So, innovation primarily responds to an **operational challenge**, namely to guarantee to our armed forces, **both reactively and in the long term**, the operational superiority that will enable them to defend our vital interests and ensure the safety of the French people, both on our own territory and outside our borders, while preserving our place in the group of military powers that have a real say in the world.

This challenge is heavily dependent on **capability**: maintaining operational superiority under all conditions of current and foreseeable engagement will require mastery of the full domain of capability and capability (doctrine, organisation, human and trained resources, equipment and support services), so that we are able to take action, both today and in the future, through the mobilisation of key skills (knowledge, understanding and command, first entry, influence, combat and protection, support and endurance) in all potential theatres of conflict, including, of course, ground air and sea, but also exoatmospheric space and cyberspace..

In terms of **technology**, operational superiority requires sovereign access to the technologies needed for the production of the defence systems that France intends to preserve as part of its autonomous capability, either at strictly national level or in cooperation with partners in the context of mutually agreed interdependence.

Finally, this aim of strategic autonomy is necessarily reflected in **industrial** issues, in order to establish and develop a defence technological and industrial base (DTIB<sup>1</sup>) that is competitive and provides consistent high performance over the long term.

Also, we will have to maintain a process of constant technology intelligence, exploration and development, in particular in the case of emerging technologies, and more specifically technologies with disruptive potential, without necessarily waiting for any prior expression of capability requirements by the government. These

new technologies are indeed the bedrock of future capabilities that are challenging to design today.

Finally, innovation, especially in the digital domain, is a **lever of transformation, to assist the performance of the Ministry**.

For example, in the support and/or administration functions innovation aims to improve quality of service to the defence community and its users, while also increasing efficiency and simplifying the daily work of personnel.

Every sector is concerned -finance and procurement, human resources and training, legal affairs, environment, assets, property and infrastructure, shared support and the Ministry’s relations with those serving under it and with their families and the entire French population.



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1. The “defence technological industrial base” consists of major industrial contractors (most important are Airbus, ArianeGroup, Dassault, MBDA, Naval Group, Nexter, SAFRAN and THALES), their subcontractor chain and other component suppliers, including numerous mid-market and small and medium-sized companies.



## 1.2 THE CHALLENGES OF FLEXIBILITY AND DARING

« *Innovation and audacity must be the keywords of our defence strategy, because both are fundamental to our efficiency and our sovereignty* »

Florence Parly,

Foreword to the Strategic Review of Defence and National Security.

In a context of uncertainty regarding the strategic environment and of permanently evolving threats from agile and inventive adversaries, it is essential for us to increase our reactivity in order to detect, acquire and integrate innovation wherever we find it. This will mean directing certain projects on a deadline basis as well as on criteria of performance, assigning priority to simplicity and adaptability of procedures and accepting greater levels of risk-taking, even though risks must still be kept under control. Also, it may even be necessary to undertake an in-depth review of development cycles, in order to adopt new incremental and adaptive approaches and to develop subsidiarity in decision-making and funding.

## 1.3 SCOPE OF DEFENCE INNOVATION

So, defence innovation concerns the full spectrum of the Ministry's activities and covers the operational and organic functions as well as the administrative and support functions.

With regard to these functions (human resources, finance etc.), issues are shared with all public administrations and companies, and the Ministry will make every effort to deploy the current best practises.

## 1.4 ORGANISATION AND GOVERNANCE

Defence innovation is directed by the Defence Innovation Steering Committee, which is chaired by the "Délégué Général pour l'Armement" (Chief Executive of the Armament General Directorate) and brings together representatives of the armed forces and the departments and services of the Ministry. Qualified external personalities also sit on this steering committee, which defines the overall direction of innovation policy and determines its implementation.

The Defence Innovation Agency (AID) has the role of executive manager, coordinating the definition and implementation of the Ministry's innovation policy. This Agency maintains and nurtures the network of key players in defence innovation, in a spirit of coordination, cohesion and subsidiarity.

The Ministerial Instruction on Defence Innovation defines the detailed roles of the Ministry's main entities and individuals responsible for innovation, pursuant to the outline provisions of Decree 2018-764 dated 30 August 2010 concerning the Defence Innovation Agency.

In particular, this Instruction introduces the role of the "innovation correspondents", who are individuals identified in the armed forces, departments and services (ADS) and tasked with promoting the flow of ideas and nurturing the emergence of the most promising of these ideas. These innovation correspondents contribute to defining the broad directions of defence innovation, while also ensuring its communication and implementation.

The Ministry also relies heavily on the expertise of the Technical Department of the DGA, which has more than 6,000 engineers and high-level technicians distributed between 10 test centres equipped with exceptional scientific equipment that is in some cases unique in Europe.

In terms of budget, defence innovation is not considered to be an "action" in the budgetary sense of the term but as a lever mobilised for the benefit of the policies pursued by the Ministry of the Armed Forces.

Naturally, defence innovation is at the heart of the activities of preparation for the future stipulated in Programme 144 of the State Budget ("defence policy environment and future prospects") and in Programme 191 ("dual research"). Nevertheless, innovation can also solicit every budget programme of the Defence mission, in particular to ensure scale-up and deployment of the innovations judged to be appropriate.



## THE DEFENCE INNOVATION AGENCY (AID) A DRIVING FORCE FOR DEFENCE INNOVATION

The Defence Innovation Agency ["Agence d'Innovation Défense" - AID], created on 1 September 2018, brings together all the key players of the French Ministry of the Armed Forces and all the actions that contribute to defence innovation.

### Missions

- implement the Ministry's innovation policies and put forward proposals to help further define this policy;
- direct the strategies defined in this domain by the "ADS" (armed forces and Ministry departments and services) and participate in the corresponding budgeting work;
- coordinate and oversee implementation of the innovation projects and scientific and technical research work of the ADS and ensure their overall cohesion;
- conduct the innovation programmes entrusted to it;
- develop and implement the necessary international partnerships and cooperation agreements with the relevant public and private bodies;

The Agency will enhance the Ministry's reactivity in detecting and appropriating advances and disruptions, in particular from the civilian domain. Its ambition is to transform the results of innovation projects into products and services that benefit the armed forces and the users of the Ministry.

## 1.5 ACTIVITÉS

The Strategic Review emphasises that the "objectives [of defence and security policy] cannot be attained unless they are accompanied by a global policy that supports innovation and an overall transformation of the ecosystem".

Consequently, this document aims to provide guideline directions for defence innovation and to anchor innovation permanently in the Ministry through the effect of generalised cultural transformation. The overall process of innovation, from conception to implementation of a capability, comprises the following main activities:



• **detecting and capturing:** numerous innovations originate outside the Ministry, in many different ecosystems, sometimes without any initial link to defence activities. Consequently, a strategy must be developed to improve detection and appropriation for the purposes of defence innovation;



• **initiating and guiding:** the Ministry directs efforts by clearly stating its key interests and major needs. It funds promising projects by means of thematic calls for tenders or public research contracts. The Ministry must also be able to initiate and support innovations proposed internally, as the outcome of the creativity and operational expertise of its personnel;



• **accelerating and scaling-up:** to implement innovation for the benefit of users, various stages of technological and operational development must be completed, while maintaining greater tolerance for failure, which is indissociable from the audacity required to reach ambitious aims. In this manoeuvre, speed and agility are essential;



• **sharing:** On its own, the Ministry of the Armed Forces does not have all the resources necessary to meet all its needs and ambitions with regard to innovation. For this reason, a policy of partnerships with other national public and private organisations is indispensable. Furthermore, a policy of international - and especially European - cooperation will also enable the Ministry to attain the objectives unattainable at national level;



• **evaluating and valuing:** here, the main aim is to make innovation projects more widely known, in order to assist their funding and operational adoption by user entities. The Ministry will also endeavour to endorse internal innovation initiatives and to assist innovators in obtaining due recognition of their intellectual property. Also, as with every public policy, the Ministry's innovation policy shall be subject to evaluation, mainly via its results, effects and impacts, in order to generate an experience feedback loop and to enhance organisational learning. On the other hand, this evaluation must not act as a brake on risk-taking and acceptance of failure, which are indispensable to the spirit of innovation;



• **nurturing:** a cultural transformation is indispensable to anchor innovation durably in the practises of the Ministry. The spirit of innovation must infuse the entire Ministry, its organisation and working practises, in order to impel a cultural shift and the acceptance of the inevitable higher risk levels.

The main body of this document is structured according to these six main activities to provide an overview of the global innovation policy required by the Strategic Review and the Military Planning Law.

## 2. DETECTING, CAPTURING



To acquire the innovations produced by the civilian sector, the Ministry must give itself the means to detect them and classify their maturity level. This intelligence work relies both on the processing of data from documentary databases and on an efficient network of “sensors” that provide detailed territorial and thematic coverage. This innovation intelligence network comprises in particular:

### Open innovation officers

in the various entities of the Ministry;

- the various digital Labs and Factories of the Ministry, constituted in a network around the **Defence Innovation Lab**;
- innovation clusters established around the test centres of the DGA;
- the **network of correspondents** of the DGA in the “DIRRECTE” Regional Business Development Agencies, which act as regional relays to the industrial sector;
- business clusters, competitiveness centres, operators of start-up seeding and acceleration programmes and capital investment funds, with which the Ministry maintains long-term relations.

### ESTABLISHING A NETWORK OF INNOVATION “SENSORS”

In the initial phase, the Agency will seek to federate and equip its network of intelligence monitors and organise information feedback and distribution.

In the second phase, the Agency will further develop this network by establishing or reinforcing partnerships with other players, especially state operators (such as the ONERA National Aerospace Lab, the CEA Commission for Atomic Energy and Alternative Energies, the CNES National Centre for Space Studies, the ANR National Research Agency, the ISL Franco-German Defence Research Institute, universities, etc.) and the relevant industrial ecosystems. Finally, the Agency will establish partnerships with the various operators responsible for seed-funding and accelerating national and European start-up.

To supplement this network, defence companies have organised a similar activity of intelligence and opportunity identification at their own level, and synergies with this network are both possible and desirable.

Finally, the acquisition system is completed by the Ministry’s participation in roughly a dozen major international trade shows, and in the selection juries for incubators, accelerators and investment funds,

# INNOVATION



### GOING BEYOND THE TRL MODEL (TECHNOLOGY READINESS LEVELS)

In the defence sector, “maturity” or “readiness” has traditionally been measured on the TRL scale (Technology Readiness Level), conceived by NASA in 1974 and formally defined in 1989. Although this scale is useful, since it constitutes a universal standard, it is insufficient to measure the maturity of an innovation, still less of an economic player.

This is because an innovation arises from the combination of a technology, a market and a source of finance, whereas the TRL only measures the first aspect. That is why the French Defence Innovation Agency (AID) proposes enriching this measurement scale by evaluating not only technological readiness but also the market readiness of an innovative project. This is done by assessing the maturity level of the economic player on its target market: how does the start-up finance its activity, and what are its sources of revenue? Will it be able to serve its priority target market? Within what time-scale, and with what investment?

Finally, a third dimension must be measured, namely user readiness. Is the user currently exploring a technology and investigating a concept or specific application? Is the user already prepared for experimentation and deployment?

The AID will take care to consider all these three maturity levels - technology readiness, the readiness of the economic player in relation to its initial and priority target and, finally, the readiness of the (internal) end-user. The acceleration logic for open innovation projects, promoted by the Open Innovation Division of The Agency, is in harmony with this vision, since it aims to finance maturation in all three aspects, not simply in the technological domain, in order to deploy the detected innovation as soon as possible.

### 3. INITIATING AND PLANNING



Defence innovation sometimes originates without the intervention of the Ministry of the Armed Forces. However, in many domains, this intervention is necessary, because the needs of the Ministry are highly specific and represent a significant entry barrier to innovators

.The Ministry's method of intervention can range from the relatively non-directive - "open innovation" method - to a highly directive mode - with a precise definition of needs leading to clearly programmed actions defined by public contract, or projects conducted in public bodies under the authority of the Ministry, i.e. a "planned innovation" action mode.

So, this document combines a "top-down" analysis of the foreseeable military requirements - in terms of capability, industrial partnership and technology, - with a "bottom-up" approach, impelled by advances in technologies, products or services that can bring disruption to standard practises, performance or costs. The target domains described in the remainder of this section are derived from analysis of the strategic context and of the foreseeable military requirements for 2030 - 2035.

These studies converge to affirm that over the next fifteen years, military action will often retain its decisive place in achieving the final effect of enforcement over an adversary. Military action will always be preceded, facilitated or extended by a full set of non-military actions, with which it must be coordinated.

Operations will have an increasingly joint dimension, and so efforts will be conducted simultaneously in all conflict environments (ground, sea, air, digital, exoatmospheric space, information environment, electromagnetic environment etc.). In particular, the Ministry will devote additional efforts to the new confrontation areas of exoatmospheric space and cyberspace.

#### BRINGING GREATER CLARITY TO THE CAPABILITY DIMENSION TO IMPROVE COMMAND AND CONTROL

Planned innovation has up to now been organised into "sectoral aggregate". These are defined on the basis of a dominant logic of product families. Their main role is to provide visibility to the efforts made, as a necessary guide to the economic players in each of the sectors covered.

Modifications to this classification will be proposed for implementation in the 2020 edition of this Guideline Document (DOIC) These changes will favour the emergence of new solutions based on an approach of "reinforced capability", while preserving a high level of technological ambition in the preparation of future capabilities.

The modifications are designed to introduce a cross-disciplinary approach for the future direction of shared technologies and the development of emerging technologies. Finally, the new approach will enable us to welcome "newcomers" or small and medium-sized companies and mid-market companies that propose innovative technologies. This openness was difficult to achieve with a narrowly sectoral approach.

The environment of these operations must also be readied and improved. So, naturally, the Ministry's priorities also include cross-disciplinary fields of innovation, such as human support, the maintenance of equipment in operational condition and support services, including administrative support.

Finally, artificial intelligence, due to its potential contributions to a very large proportion of the Ministry's fields of action, is an area of particular interest, to which the Ministry will be devoting special attention.

#### 3.1 EFFORT AXIS: FUTURE STRUCTURAL CAPABILITIES IN THE DOMAIN OF GROUND FORCES

The evolving context requires that the modern air-ground force must be able to fight at high intensity in more dangerous and more multi-dimensional confrontations. To do so, it must cultivate its warrior spirit and resilience and arm itself with innovative and interconnected equipment capable of genuinely collaborative combat. Technological research will enable us to pursue the **efforts of transformation of air-land close combat**, in particular by preparing the next increments to the SCORPION programme and air combat programmes, and, in cooperation with Germany, the future structural programmes in the domain of ground combat, such as the Main Ground Combat System (MGCS), in preparation for the replacement of the Leclerc MBTs. The Ministry will especially focus efforts on:

- **collaborative combat**: the SCORPION programme has introduced the networking of combat actions. Work will continue, especially on enabling situational knowledge-sharing between platforms, to assist rapid decision-making. The level of integration between ground platforms, drones and helicopters will be the key to the success of collaborative combat. Collaborative combat must of course be extended to the French joint forces and combined Allied joint forces levels.;



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- **the development of automated systems** should help to focus the attention of combatants on high value-added tasks and spare them the more dangerous or repetitive and excessively fastidious tasks that are frequent sources of error.. For example, robotics will enable dangerous itineraries to be reconnoitred, and the use of AI in detection-reconnaissance tasks (see section 3.8) will lead to rapid exploitation of complex tactical situations.



- **platform protection:** the vehicles will have innovative equipment to deal with diverse threats in CBRN environment while increasing their stealth;
- **increased mobility and availability of platforms:** high-performance mobility will be sought in every environment, even under destructured conditions, especially in urban zones. Also, the platforms will benefit from the latest civilian technologies in the field of maintenance.
- **improved aggressive capabilities of systems:** studies will be conducted into weapon systems (cannon, rocket, missile, etc.) that provide high-speed short-distance reaction capability. These studies will also include Beyond Line Of Sight (BLOS) strike capabilities; The work on directed energy weapons will complete this capability, in particular to counter the new drone-type threats..



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Guidance and miniaturisation technologies will enhance the precision of tank, artillery and mortar munitions and further increase the BLOS capability. In combination with improvements to propellant charges, these technologies will also contribute to the Common Indirect Fire System (CIFS), the future artillery system. These research studies are further intended to support technological innovation in the munitions sector, especially for guided munitions.

Finally, **dismounted combatants** will also benefit from marked improvements in every field of action, with enhanced observation equipment, friend/enemy identification, energy systems, innovative fabrics, mobility aids, indoor/outdoor continuity, on-board/off-board continuity, health monitoring etc.

### 3.2 EFFORT AXIS: FUTURE STRUCTURAL CAPABILITY IN THE NAVAL FIELD

The return of strategic naval competition, both in approaches and in French zones of interest, compels us to remain proactive in the development of our capabilities. Consequently, innovation work is required to control maritime airspace and to intervene in a joint-forces and combined allied framework, from low intensity interventions up to high-intensity confrontation.

In terms of capability, studies and research will enable us to anticipate the evolutions of multi-purpose frigates (FREMM), defence and intervention frigates (FDI) and Sulfren-class nuclear attack submarines (SNA). These studies will also



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enable us to renovate the Horizon air defence frigates (FDA) in order to meet the changing threats and deployment contexts.

Additionally, these studies will identify the further research necessary for preparing the future aircraft carrier contingent and renewing our maritime airspace patrolling capability. In technological terms, our efforts will focus on the following seven domains:

- **sensor performance** [in particular sonar devices, including in the form of sonobuoys], and electronic warfare equipment;
- **application of robotics to the naval domain:** mine warfare, aircraft carrier battle group protection, countering asymmetric threats, etc.
- commanding of units at sea and their capability to endure in **more demanding sea conditions** [stability, operation of ship's boats and towed sonar systems]
- definition of a **future generation of long-range anti-ship and cruise missiles** and future standards of the "MdcN" naval cruise missile;
- collaborative combat: advanced multistatic sonar for anti-submarine warfare, conception of a more highly automated submarine detection system, collaborative air-sea monitoring and engagement, increased connectivity etc.;
- **big data and AI: information superiority** will be sought through capabilities for the automated collection and processing of large volumes of data at multiple levels of confidentiality. The control of air-sea environment and the targeting of intervention zones will also be improved;
- **new on-board weapon systems:** exploration of disruptive technologies, such as railguns and directed energy weapons. The combination of these weapons with innovations in energy (electrical architecture, massive high-intensity storage etc.) shall also be researched, with a view to developing future weapon systems specially adapted to the new threats of anti-missile or anti-drone combat at sea.



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### 3.3 EFFORT AXIS: FUTURE STRUCTURING CAPABILITIES IN THE AERONAUTICAL FIELD

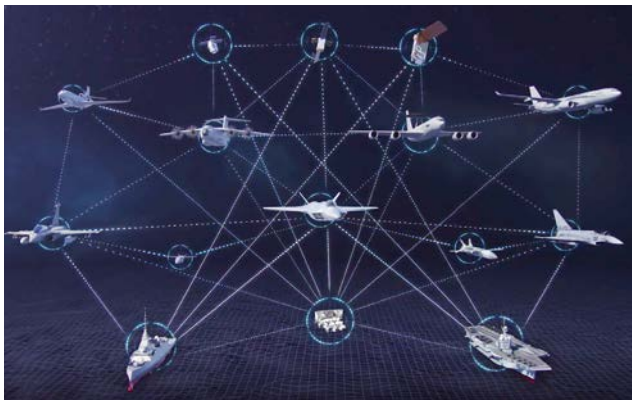
The development of new threats acting simultaneously from the air, space and surface (stealth, hypervelocity, highly coordinated air defence systems) compels our air forces to increase their information and action capabilities.

To help maintain air superiority, this focus of effort will utilise the **benefits of digital technology** (technologies designed to develop connectivity, artificial intelligence [see 3.8 below] and big data) and the improvements in intrinsic performance of the various weapon systems, designed to make them more effective in their missions [robustness, precision, persistence, capabilities, reactivity, availability and resilience]..

#### 3.3.1 Fighter planes

In this domain, the aim is to **prepare the further developments of the Rafale system and the "future combat air system"**, by concentrating especially on networked collaborative operation and the ability to integrate innovations in electronic warfare, radar, optoelectronics, connectivity and stealth.

The goal here, with the aid of technology demonstrators [aircraft,



engine, remote effectors etc.], is to **impel the emergence of a modern air combat capability** able, among other things, to deliver weapons from the internal weapons bay at supersonic speeds, to obtain detections and designations via multistatic systems, to carry out complex cooperative strikes or to coordinate a set of remote effectors in combat missions.

Research will also focus on maturing the technologies necessary for man-machine interfaces. Enhanced ergonomics and ease of use will be introduced for better and faster understanding of situations. Virtual assistants and decision-aid systems will free human operators from tasks without added value, leaving them available for the high value-added actions inaccessible to information technology tools.

These studies will also lead to the establishment of effective industrial cooperation, in particular via a Franco-German hub, in order to implement the future systems under affordable economic conditions.

To prepare for the Future Combat Air Systems (FCAS, known in France as SCAF), the Connect@éro<sup>1</sup> initiative will incrementally integrate new collaborative combat capabilities, by



drawing on the mature technologies derived from the FCAS studies and on the use of endorsed data accessible in a Combat Cloud. This initiative is intended to guarantee interconnection with the other environments (ground and sea).

The planned technological developments will help to advance the concepts and technologies required for a **future generation of long-range missiles**. This new generation will replace the SCALP-EG and Exocet missiles, advance the development of the METEOR missile and contribute to preserving air defence capabilities (both surface-to-air and air-to-air) in the context of the evolving threats.

At the same time, to counter the most highly integrated surface-to-air defence systems, and with the support of a close-knit, multilayer network of research centres, studies must be conducted on the development of effector technologies and saturation tactics. Also, with a short development cycle, **technological research into hypersonic vectors** will be initiated. These new weapons will enable fighter planes to preserve their capabilities for air defence, first entry in non-permissive theatres and deep strikes.

Finally, this research will contribute to Franco-British industrial rationalisation in the domain of missiles. The ambition is to maintain a complete and competitive European missile sector.

#### 3.3.2 Helicopters and transport aircraft

For this domain, research will focus in priority on the following themes:

- the **safety of operations on all helicopter platforms**, with a project preparing the development of pilot aid systems for degraded visibility conditions.



<sup>1</sup> Project conducted by the French army with the aim of establishing global consistency in connectivity between different weapon systems

- **platform survivability**, via self-protection solutions for the aircraft most suited to the evolving threat.

This subject is the focus of a project preparing the future cross-disciplinary programme for a self-protection system for helicopters and mission aircraft.

- **helicopter/drone cooperation** with the aid of a demonstrator aiming to develop modular components that will be reusable on all platforms.

- enhanced persistence capabilities of **aeronautical systems**, through the application of civilian sector research in the domain of energy (production and storage). These studies will help to increase the quantity and power of the on-board equipment in the aircraft.



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### 3.4.1 Communications and networks domain

In this domain, the technological research work is aimed at preserving national sovereignty over a "controlled core" of communication media, in particular by preparing technological modules specifically for the military in the domains of tactical broadband and discrete data links.

To attain a greater degree of interoperability for networked and coalition operations, studies are planned to adapt, where necessary, the key technologies essential for interconnection of the heterogeneous joint forces networks of the future. The aim is to achieve efficient and secured networking by taking advantage of civilian and dual military/civilian investment in research and development.



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### 3.3.3 Intelligence and surveillance

Innovation in the field of intelligence and surveillance aims to accelerate the decision-making loop for the benefit of operations. For this purpose, the Ministry will develop **operating systems** capable of fusing information of different types and classification from multiple sources at high speed.

**Technological research will also help to attenuate the risks associated with the future increments to France's air command and control system (SCCOA) and the renewal of the capabilities of the Airborne Warning And Control System (AWACS).**

### 3.3.4 Surface-to-air defence

To protect the forces, systems and installations deployed in operations and on national territory, the improvement of the expanded surface-to-air defence and anti-drone systems will require longer-range sensors and increased computing power to accelerate the process of identification and classification of the threat, together with decision-aid tools that are both reactive and effective. Research in this field must result in the capability to identify, in time of crisis or war, the new threats, which can combine hypervelocity, stealth and high-saturation.

## 3.4 EFFORT AXIS: FUTURE STRUCTURING CAPABILITIES IN C4I AND CYBER FIELDS

This effort focus will involve research in the technological domains of communications and networks, information systems and command and control (C2) systems.

### 3.4.2 Information and C2 systems:

In this domain, the main challenge is to integrate the innovations originating mainly in the civilian sector, especially in the fields of big data and artificial intelligence. The aims are to develop:

- the information systems of the armed forces (in particular their architectures);
- the means of data production (apart from sensors), hosting and processing, by seeking to establish, through cooperation, standards designed to reinforce interoperability. In particular, this work will help to increase the volume of data processed from intelligence sensors and collection sources.
- the geophysical environment services (geography, hydrography, oceanography and meteorology). In this sector, the Ministry will draw on the competences of the competent public institutions in the domain of data and on the geophysical environment departments.

<sup>1</sup> operations providing the necessary guarantees for autonomy of appreciation and action

### 3.4.3 Cyberdefence

Control of cyberspace is at the heart of the twin goal of defending the state's critical sovereign infrastructure and preserving the operational efficiency of our forces. In this domain, where threats proliferate and constantly improve in quality, the aims of research are as follows:

- maintaining France's national capability at a high technological level, with the capability for autonomous creation of security products able to resist the most advanced cyber threats;
- identifying the most effective solutions for protecting weapon systems, including solutions from the civilian world, at a particularly rapid rate of development;
- identifying the potential contributions of artificial intelligence for cyberdefence and handling the specific cybernetic threats associated with this technology, and now also integrating the possibility of offensive actions in cyberspace.

Cross-disciplinary research across the full C4I and cyber domain must be devoted to studying alternative methods of preserving our freedom of action in the event of partial or total denial of space, whether of physical or cyber origin. This concerns long-distance C4I capability and the capabilities for rapid positioning and time reference, which are now vital to the coordination of our operations.

### 3.5 EFFORT AXIS: FUTURE STRUCTURING CAPABILITIES IN THE SPACE DOMAIN



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The domain of space has witnessed major disruptions that have highlighted new vulnerabilities, with the emergence of new players, the multiplication of civilian mini-satellites, potentially aggressive actions in space and space debris. To take these factors into account, the Ministry has established a space defence strategy and will focus efforts in priority on the following themes:

- new sovereign capabilities for military communication by satellite;
- development of a national radio navigation solution combining the GPS and Galileo constellations. At the same time, alternative solutions to

satellites will also be explored for positioning and navigation;

- renewal of the CSD and CERES intelligence satellites;
- improvement of space surveillance from both ground and space;
- protection of our satellites and our means of action in space to counter a threat.

To attain these aims, the Ministry shall draw on the expertise of the French space agency (CNES) and shall support the emergence of a national public/private "New Space" sector to focus on the goals of miniaturisation and cost reduction.



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### 3.6 EFFORT AXIS: HUMAN SUPPORT AND LOGISTICS

The activities relating to personnel support and logistics in peacetime are in many ways comparable to the private-sector support functions in the fields of transport, catering, logistics and clothing. **The Ministry must therefore draw on the digital innovations available to private enterprise and ensure that the innovations that can be adapted are adapted to the reality of military operations, by seeking partnerships with the key economic players of these sectors.**

Among the technological domains of particular interest, we can name:

- **the connected devices**, firstly to improve logistic efficiency and secondly to guarantee traceability and continuity of support in the fields of facility management (for example waste treatment), food safety and clothing;
- **predictive maintenance** of the most sensitive equipment, in order to facilitate its use in operating theatres and increase its operational availability. The 4-year target is to have a predictive maintenance module for the SCORPION, FREMM, BARRACUDA and A4DDM programmes. This will be followed by modules for the Rafale F4 and the future joint light helicopter ("HIL Guépard").
- **additive manufacturing** and its potential implications for the organisation of support;
- **augmented reality**, which also offers opportunities in the fields of simulation, training and maintenance: These potential benefits must also be examined by the Ministry;
- **smart textiles**: connected fibres, stealth camouflage etc..
- **optimised management of water and energy resources**, where AI may be able to provide a predictive approach;
- **reduction of waste in operations.**

### 3.7 EFFORT AXIS: HEALTH OF COMBATANTS

The aim of innovation in this domain is to guarantee and restore the health of military personnel and improve their operational ability.

In the field of **prevention**, research will primarily focus on identifying and characterising the health risks of the environments in which the armed forces are deployed. Progress in methods of hygiene and protection against infectious agents and innovations in weapon system ergonomics and mission safety will also play a part in this safety mission.

**In the domain of health care**, the researched innovations will concern **diagnosis and care provision** :

- **in isolated situations**, using robust and easily deployable techniques, with possible recourse to remote networked personnel, telemedicine and robotics;



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- **in crisis situations**, with a massive inflow of wounded, disorganisation of resources and increased uncertainty on future development;
- **in response to attacks linked to the working environment (ballistic, infectious, psychological, CBRN).**

Innovations in tissue reconstruction and rehabilitation in the post-critical phase will also be researched.

**Evaluation of the physical and cognitive performance** of military personnel and assessment of the risks to which they are exposed in the course of their career will also be a focus of research, to determine fitness for work, to adapt to exercise conditions and to document the fitness decision (whether initial or following a pathological episode).

### 3.8 EFFORT AXIS: ARTIFICIAL INTELLIGENCE

Artificial intelligence, which is a highly "dual" domain (i.e. both military and civilian), can only be advanced in the Ministry through close interaction with the civilian world, both in industry and academia. Appropriate management of this interaction should stimulate innovation and research into specific subjects while also detecting the developments that can be used in the systems of the armed forces and Ministry departments and services.

The AI strategy of the French Ministry of the Armed Forces is in synergy with the research section of the government's strategy, which is operated by the National Research Agency (ANR). For example, the Ministry of the Armed Forces will join in the development of the AI interdisciplinary institutions ("3IA") responsible for defence subjects. It will also co-finance calls for additional projects issued by the ANR.

Moreover, structural academic partnerships will be established in 2019 with education establishments selected on the basis of both their academic excellence and their ability to bring their research projects to pre-industrial readiness and transfer them to industry for full-scale implementation. I

However, the uses of AI for the Ministry of the Armed Forces involve characteristics and demands that are not necessarily identical to those of the applications currently developed for the commercial sector. These differences reveal real technical challenges that are still far from being resolved.

The main challenges to be met are as follows:

- robustness
- simplicity of learning processes (frugality);
- adaptability to new situations;
- embeddability;
- man-AI interfaces. This involves the development of new methods of interaction between man and machine;
- enhancement of performance by hybrid approaches combining statistical and rules-based approaches.

In many ways, these challenges are similar to those that every critical system integrating AI will have to meet, whether self-driving cars or energy distribution systems. So, the Ministry of the Armed Forces will focus on guiding and supporting academic and industrial research in the domain of AI for critical systems



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### 3.9 EFFORT AXIS: EMERGING AND DISRUPTIVE TECHNOLOGIES

Our positioning on tomorrow's battlefield will depend, in part, on our ability to identify and cultivate technological disruptions. In addition to **artificial intelligence** as described above, together with its corollaries in the domain of robotics, we can cite the following subject areas in particular:

- **hypersonic glider**: initially propelled by a rocket with a speed exceeding 6000 km/h, the hypersonic glide missile uses the atmosphere to manoeuvre with a high load factor. Its main attraction is the unpredictability of its trajectory, giving it the ability to evade interception. The demonstrator programme dedicated to developing the related technologies to production readiness was launched in 2018. In particular, this programme includes the test flight of an experimental manoeuvring vehicle, which is planned to take place by the end of 2021.
- **quantum technologies (see box)**;
- **directed energy weapons (DEWs)** (electromagnetic weapons, laser weapons etc.) These technologies are capable of disrupting current approaches to the auto-protection of ships and aircraft and anti-drone combat. Cross-disciplinary investigation of these technologies is therefore necessary to meet the requirements identified in the various combat environments;
- in addition to quantum technologies, numerous **sensor technologies** merit sustained efforts. This particularly applies to the domains of radars (coloured transmission radar, cognitive radar etc.) and optoelectronics (multispectral sensors).

### QUANTUM PROSPECTS

Quantum mechanics is engendering new technological revolutions. The properties of quantum bodies, allied to photonics and nanotechnologies, confer unprecedented capabilities. This potential disruption is impacting several key domains for defence.

**Sensors and metrology.** This is the top priority and the main short-term challenge for the Ministry of the Armed Forces. The aim is to plan innovation efforts with a view to identifying the possibilities of the new inertial sensors for navigation and geolocation applications;

**Security of communications networks and encryption.** Since the development of computing capabilities could render all or some of the encryption methods currently used obsolete, this domain must be closely monitored.

With regard to computing power (the "quantum computer") the time-scales are increasingly long term, and the entry barriers are very high: this domain requires civilian investment and, almost certainly, multinational cooperation; open innovation tools will be prioritised to take advantage of the advances made.

The Ministry of the Armed Forces will therefore also take part in the coming inter-ministerial work on quantum technologies. Defence innovation will benefit from France's advantages in this domain – a world-class academic community, with proven industrial competences, including via major corporations with international scope.



### 3.10 EFFORT AXIS: FORWARD PLANNING AND STRATEGIC RESEARCH

In an uncertain and complex strategic context, the defence community has an even greater need than in the past to analyse and understand the major international strategic stakes and the new forms of conflict. For this purpose, the Ministry of the Armed Forces is supporting French strategic research in the domain of Humanities and Social Sciences (HSS). With the "Higher Education Pact" ("Pacte Enseignement Supérieur") launched in 2015, the Ministry of the Armed Forces:

- is contributing to the emergence of a new academic branch of French "war studies";
- is encouraging the logic of hybridisation between the HSS and technological approaches, especially big data;
- is promoting the employability of young researchers in strategic research.

In this domain, the Ministry is using both the existing system for outsourcing research contracts (forward and strategic studies ["EPS"], observatories, framework contracts etc.) and IRSEM, the Strategic Research Institute of the Ecole Militaire (Institut de Recherche Stratégique de l'Ecole Militaire), both of which have recently been reformed.

### 3.11 EFFORT AXIS: ADMINISTRATION AND SUPPORT:

In the domain of administration and support, the Ministry of the Armed Forces wishes to improve its capability for organisational and managerial innovation. The aim here is to distribute and adopt new, intuitive procedures, tools and operating methods centred on user experience

For the administrative professions, solutions will especially be researched to:

- **develop the capabilities for real-time data sharing and collaborative design;**
- **ensure traceability** of exchanges, in particular using blockchain technologies ;
- **develop capabilities in predictive analysis, correlation and data processing to facilitate aids to decision-making;**
- design and implement **smart buildings;**
- **automate repetitive and time-consuming tasks** for professional processes having a highly transactional workflow (HR, account closing audits, procurements, invoice processing etc.);
- **automate document production on the basis of existing content** [parliamentary questions, budget execution memos etc.] with the aid of data copying robots;
- **accelerate and automate the research and identification of "correct" information;**
- **simplify working environments by personalising** and fluidising the interfaces (questions in plain language), by offering a complete and integrated "digitised office" and by enabling workplace mobility and "augmenting" agents by means of virtual personal assistants;
- establish new models for continuous learning, using simulation game formats [serious games, augmented reality and simulation] to accelerate the learning process;
- **rethink recruitment models**, by developing talent acquisition programmes and drawing on the techniques of behavioural and cognitive science.



## 4 ACCELERATING, SCALING-UP

### 4.1 TODAY: A DISPERSED TOOLBOX



The creation of the Defence Innovation Agency has brought together a set of innovation support tools that were previously scattered between different entities of the Ministry and enriched them through the establishment of the Open Innovation Cell and the Defence Innovation Lab.

Some of these tools are deployed jointly with the civilian operators of reference. This is the case of the RAPID system in partnership with the Directorate General of Enterprise (DGE), and the ASTRID and ASTRID Maturation systems with the National Research Agency (ANR), and it also applies to the support given to our doctoral and post-doctoral studies, mainly in cooperation with the French National Centre for Scientific Research (CNRS).

At this stage, each of these tools has its own rules of eligibility and its own governance and is intended for a specific type of economic player.

This situation has its limits, in particular insufficient clarity for innovators, a lack of tools tailored to start-ups and difficulty of experimentation.

Moreover, frequent recourse to subsidies, which cannot be accounted as turnover, prevents the supported businesses from reassuring their investors.

The Defence Innovation Agency aims to bring cohesion to these disparate systems and to establish a clear portfolio of projects

The projects selected for support by these schemes must meet two key criteria: they must be of innovative character and of interest to defence. Depending on the specific schemes, and especially on the beneficiary entities (labs, small and medium-sized companies, mid-market companies, universities etc.) other aspects are considered, such as the dual military/civilian nature of the innovation or its level of maturity, regardless whether these aspects concern the technology, the users or the market.

### 4.2 TOMORROW: AN END-TO-END ACCELERATION PROCESS

The process of bringing cohesive organisation to the various innovation support schemes will continue beyond simply bringing them together under a single roof. In the short term, thanks to this one-stop "single agency" structure, the new cohesion will help innovators to find the appropriate programme for their project more rapidly. An evaluation of the various schemes and programmes will be conducted in 2019 to identify the areas not covered and any possible improvements.

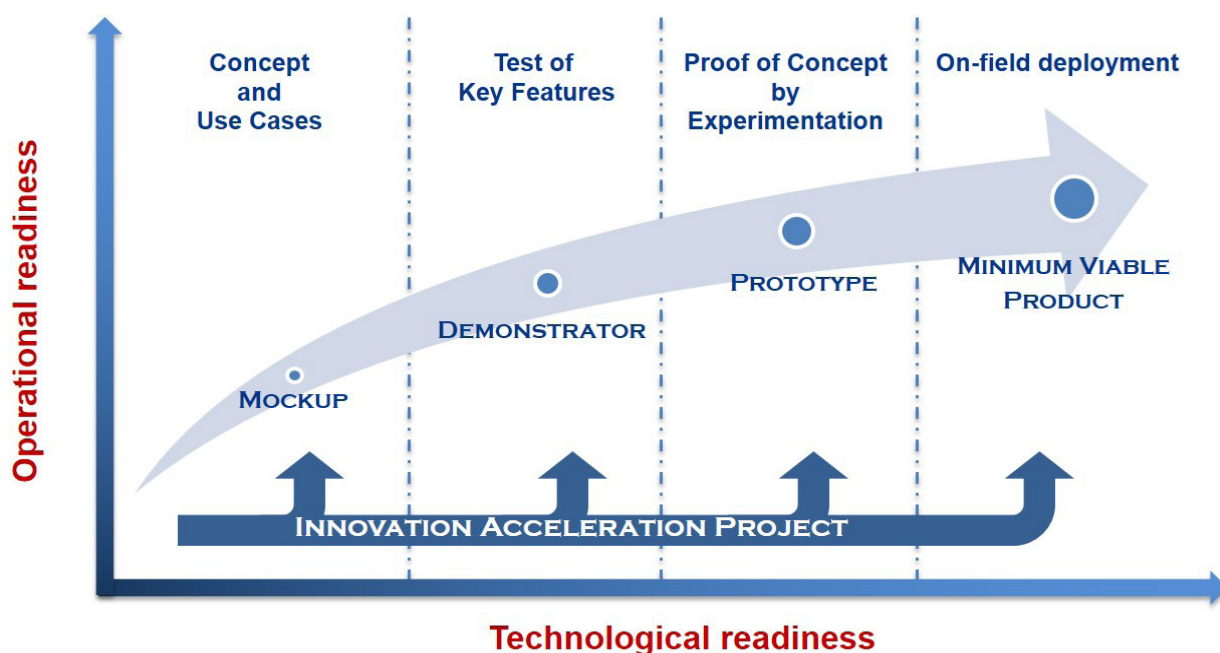
For example, the "ASTRID Maturation" programme can be modified to limit the interruptions of support for a project. The programme for experimentation operations must also be revised to provide a significant increase in reactivity.

In the future, the process of accelerating innovation will be inspired by the entrepreneurial model and its financing methods. The acceleration of open innovation projects will function along the lines of an investment committee that is able to "gamble" on projects, in the form of funding or the provision of support skills, and to support them until they reach a maturity level close to pre-industrial production, possibly in cooperation with private or para-public financial institutions.

The path of an accelerated project will be characterised by the increased readiness of the product or service in the three dimensions mentioned above - technology, user and market. This development is envisaged as an end-to-end process, i.e from the initial concept phase to deployment in the Ministry of the Armed Forces.

This approach has several advantages:

- decompartmentalising the various "dealflows" of innovative projects and prevention of duplicates;
- bringing together all relevant stakeholders at each stage and promoting sponsoring;
- facilitating the transition to full-scale implementation, especially in defence equipment project, by considering not only technology readiness but also market readiness;





- implicating internal innovators;
- increasing the clarity and accessibility of the programme;
- conferring responsibility on the (internal or external) project sponsors/developers by helping them to identify the stakeholders at each phase of technological development;
- developing an appropriate culture for innovation in terms of risk taking and the acceptance of failure.

### EXPERIMENTATION WEEK

The availability of test and experimentation equipment is often a barrier to deployment of an innovation.

The Defence Innovation Agency is proposing to create periodic sessions reserved for experimentation ("the experimentation week"), to facilitate access to the numerous and sometimes unique test systems and experiment grounds.

This initiative will structure calls for projects with the prospect of more easily organising experimentations with the DGA experts and operational users.

Moreover, it will provide small and medium-sized companies and mid-market companies with access to the technical and human resources of the Ministry of the Armed Forces, in order to consolidate their products or services and, where applicable, adapt them specifically to military use.

### 4.3 PROCURING INNOVATION, INNOVATING IN PROCUREMENT

The major proportion of defence innovation funding today (more than 80%) takes the form of public contracts. The public procurement order is a very rich toolbox that can be used both to purchase Innovations and to innovate by purchasing.

However, as is emphasised by the Ministry's procurement policy, several factors impel a more progressive use of this toolbox, in particular:

- acceleration in the evolution of technologies and requirements;
- rapid changes in the environment of the economic players in certain domains;
- the increasing level of uncertainty resulting from the above factors and the reduced ability of the public purchaser to master all the information necessary to adopt a procurement approach based on a detailed technical specification and the search for the all-inclusive contract.
- The increased expectations of reactivity and flexibility for the development and scaling up of innovations to full-scale implementation.

So, the aim is to increase the reactivity of the procurement process and the flexibility of the public contracts placed by the Ministry, in order to provide better satisfaction of these expectations. The key challenge is to ensure better management of the uncertainties inherent to innovation and to consider the lead time as an integral part of the expected performance.

### MORE DYNAMIC ACQUISITION OF OPEN INNOVATION

To respond to the tempo of open innovation, the DGA has established a procurement cell in the Defence Innovation Agency, specialising in the acquisition of innovation. Its role is to explore new approaches by making extensive use of the provisions of the French Public Procurement Code ("Code de la Commande Publique") that stimulate innovation and by seeking flexibility and reactivity. This cell will especially undertake the following experimental initiatives:

- The establishment of a contract factory", as a veritable accelerator of purchase orders, based on use of systematised General Terms and Conditions of Purchase.
- One-off experimenting of an innovation to confirm its suitability for users (first contracts announced for March 2019);
- A challenge scheme, resulting in the award of a contract to the winner;
- A thematic call for proposals (the first will be in June 2019).

In each of these cases, the targeted average performance is 3 weeks from the choice of partner operator(s) to the notification of the contracts.

The Defence Innovation Agency will also take advantage of procedures for accelerating the scale-up to full-scale implementation, in particular competitive dialogues or innovation partnerships, with selection of the best offer based on evaluation of the demonstrations. Financial incentives are planned to encourage small and medium-sized companies and micro-enterprises to submit bids. All these "end-to-end" contractual initiatives shall be conducted in association with the entities responsible for scale-up (for example the teams responsible for managing weapons operations).

New approaches to innovation procurement have been experimented over the last few years, mainly by the DGA. In particular, these approaches include the use of framework contracts aimed at bringing integrators closer to innovators, while preserving the intellectual property rights of each party.

These experiments, in combination with the lessons learned from non-arms purchases, from benchmarking with other French and foreign public contracts and from a body of already published recommendations on R&T innovation procurement, constitute a rich base that the Ministry must use to full advantage.

### 4.4 TOWARDS WEAPONS PROGRAMMES THAT ARE MORE FLEXIBLE AND MORE RECEPTIVE TO INNOVATION

To meet the challenges of integrating innovation in already deployed capabilities, the key players in the management of the defence equipment plans will take advantage of the new, more flexible provisions introduced by the recently revised Ministerial instruction relative to the conduct of defence equipment programmes. Open technical architecture, early identification of opportunities and project management methods specifically adapted to the management of uncertainty will be preferred. The process of configuration management will be employed to integrate innovative developments.

The “reinforced capability-based” approach will also open up innovation opportunities through a more global consideration of capability requirements that are not based solely on major weapons systems.

#### 4.5 support for innovative companies

The Ministry of the Armed Forces must be able to draw on a high-performing and sustainable national industrial base that is also endowed with a strong capability for innovation. In addition to the big names of the defence industry, this industrial base consists of several hundred small and medium-sized companies and start-up that the Ministry supports in their innovation projects and long-term development. For example the “Action PME”<sup>1</sup> plan reaffirms the intent of the Ministry to direct its programmes in priority to these innovative small and medium-sized companies. However, beyond financial support, the Ministry of the Armed Forces has other powerful cards for the support of innovative French companies:

- **practical case studies:** the Ministry of the Armed Forces is able to offer these companies a selection of demanding and endorsable practical applications to enable them to open themselves to the national and international defences markets. For example, we can cite the mapping of a building without GPS, the protection of a position held by the military, the use of exoskeletons in operation etc. These subjects can give rise to joint reflection workshops between companies and the Ministry of the Armed Forces, organised by the Defence Innovation Lab.
- **technical and managerial competence, test and experimentation equipment:** open innovation can put these companies into contact with representatives of the Ministry to assist them in their development and enable the Ministry to benefit from the innovations that they bring. For example, the establishment of the RAPID-Expé programme in 2017 enabled military personnel in the field to appropriate the technologies of a prototype and stimulated discussion of the prototype between users and companies.
- **future markets:** the Ministry of the Armed Forces is the largest buyer of the French state. After a phase of successful innovation, the innovating companies will therefore be able to position themselves on the defence markets.
- **levers** to assist the consolidation of the supported companies.

#### THE DEFENCE INNOVATION AGENCY AS TRUSTED THIRD PARTY BETWEEN ECONOMIC PLAYERS

The Defence Innovation Agency proposes to act as “trusted third party”, putting the key players of innovation into contact with one another. For this purpose, the Agency will endeavour to establish:

- clear and jointly agreed intellectual property rules respecting the ideas and know-how of each party;
- programmes enabling smaller partners to remain in control of their governance;
- a protective legal framework.

<sup>1</sup> Ministerial Instruction No. 5871/ARM/CAB dated 3 September 2018 concerning the SME Action Plan of the Ministry of the Armed Forces in support of small and medium-sized companies and mid-market companies

## 5. SHARING



At national level, the innovation policy of the Ministry of the Armed Forces is fully in accord with the national innovation support policy. In particular, the Ministry is developing close partnerships with the Ministry of Higher Education, Research and Innovation, to promote academic research in defence-related subjects and the transfer of this research to industry, and with the Ministry of the Economy to coordinate efforts in support of French industry.

At international level, the European Union, even more than in the past, remains a major framework for cooperation, as witnessed in the recent common initiatives on defence, in particular the creation of the European Defence Fund. France is also turning to partners of reference via bilateral cooperation programmes, in particular with Germany and the United Kingdom.

### 5.1 THE MINISTRY CONTRIBUTES TO THE NATIONAL RESEARCH AND INNOVATION STRATEGY

The Ministry of the Armed Forces intends to play its full part in the national innovation ecosystem. This determination is reflected in the Ministry’s major implication in the Innovation Advisory Committee (“Conseil de l’Innovation”) and in its close relations with the ministries in charge of innovation policy in the civilian domain. So, the Ministry of the Armed Forces contributes to the national strategy for research and innovation.

On a daily basis, the Defence Innovation Agency works closely with the Directorate General of Enterprises (DGE) and the Directorate General for Research and Innovation (DGRI). Programmes operated jointly with these entities are already in progress.

The Ministry of the Armed Forces also participates in the work of the Strategic Committees of the relevant branches (in particular aviation, naval and security), in the policy of “competitiveness clusters” for business and research and in the selection of “major challenges” financed by the Fund for Innovation and Industry.

The Defence Innovation Agency and the DGA also maintain close relations with several other key players, including the French National Research Agency (ANR) and French Public Investment Bank.

Since 2018, relations between the DGA and ANR have been governed by a general cooperation agreement. In particular, this agreement enables the Defence Innovation Agency to enlist the aid of the ANR as operator in the implementation of the ASTRID and ASTRID Maturation programmes. This partnership also provides the Defence Innovation Agency with easier access to the full range of public civilian research, thereby helping it to identify potential disruptions more efficiently.

### 5.2 SOLID PARTNERSHIPS WITH ACADEMIC RESEARCH

Often, in the run-up to major technological disruptions, academic research constructs an extensive foundation of knowledge and know-how essential for innovation, especially for defence innovation. In France, academic research is driven by a vast network of high-level laboratories, with researchers from universities, research institutes and specialised higher education centres. For several years, the Ministry of the Armed Forces has been establishing solid partnerships with academic research, with the constant aim of putting the

results of research to profitable use and consolidating links with the socio-economic world via tools such as shared laboratories, spin-offs, industrial colleges and programmes such as the “Carnot Label”, CIFRE Defence doctoral scheme...

The particular aims of the Ministry of the Armed Forces are to:

- **maintain a balanced portfolio of scientific and technical research**, including in particular studies of very low TRL (Technology Readiness Level) on potentially disruptive subjects to prepare the future beyond the current formally defined military requirements;
- **reinforce the effectiveness of the instruments of support for academic research**, for example by encouraging synergy between programmes to promote acceleration and utilisation, or by introducing greater flexibility in budget allocations to these programmes, in order to scale up the TRL and provide more effective support to the best projects (while maintaining a balance between different TRLs in the portfolio).

The attainment of these objectives particularly depends on the Ministry's ability to mobilise the solid scientific and technical expertise of the DGA, which has 6 000 experts in 10 technical test centres, enabling the Ministry to

- **develop an in-depth knowledge of the laboratories** and of their activities, to discuss our respective effort focuses with them and to arouse interest in the studies corresponding to the priorities of the Ministry;
- **detect the studies having a high potential** for application in defence and, among these, the studies most capable of providing a decisive advantage in the domains of operation, support or management;
- **experiment the results of research studies** on real examples of practical application.

### *5.2.1 Public research institutions under the authority of the Ministry*

The Ministry of the Armed Forces is the main supervisory authority of the ONERA National Aerospace Lab, the French-German Research Institute of St-Louis and its associate supervisory authority of the CNES National Centre for Space Studies. It is also in charge of directing the dual military/civilian research conducted by the

Commission for Atomic Energy and Alternative Energies (CEA). These public establishments conduct research activities of interest to defence and provide expert assistance to the Ministry of the Armed Forces (project management assistance or provision of experts of reference in certain domains).

*By drawing on these establishments, defence innovation contributes to developing centres of excellence and to sustaining the skills and resources considered indispensable for future defence systems.*

The appearance of new strategic challenges in space will reinforce the role of ONERA as a key player in the efforts in the aerospace domain. In this framework, a modification of ONERA's 2017-2021 aims and performance contract is currently being studied.

The Frencho-German Defence Research Institute of Saint-Louis (ISL) will be reinforced in its domains of excellence in the control of energy effects. These domains will especially cover studies of laser-based weapon systems, the railgun and research into guided projectiles and combatant protection. More generally, the competencies of the ISL will support efforts in the domain of ground forces, by nurturing the development of certain technologies to full readiness and their transfer to industry.

In the domain of space, at the request of the President of the Republic, a space working group has proposed an ambitious space strategy for our defence. The conclusions of this working group, defining the broad outlines of space policy for defence, will be incorporated in the update of the contract stipulating the aims and performance of the CNES and ONERA in 2020.

Finally, the dual research conducted by CEA - in addition to the CBRN-E activities (chemical, biological, radiological, nuclear and explosive), which represent almost half of the subsidy allocated to this body under Programme 191 - covers six domains of research: life sciences, cybersecurity, communication sensor components, photonics, on-board energy systems and artificial intelligence. **Particular effort will be devoted to artificial intelligence.**

### *5.2.2 The other major public research bodies*

In addition to the institutions under the direct authority of the Ministry, defence innovation strategy draws on the expertise of major national research organisations in order to cover the various necessary scientific and technological domains and to assist in maintaining the knowledge and competence levels of the Ministry of the Armed forces in the scientific and technological branches relevant to defence.

In particular, the CNRS, France's National Centre for Scientific Research, is a vital partner, and the vast majority of doctoral papers co-funded by the DGA are conducted in “mixed research units” (UMRs). A framework agreement with the CNRS signed in 2005 enables the Defence Innovation Agency to co-finance doctoral theses with the CNRS and also ensures the support of the CNRS for various scientific committees (selection of doctoral and post-doctoral theses, R&T project evaluations etc.). This agreement aims to develop a network of recognised experts as drivers of defence innovation.

INRIA, the French National Institute for Research in Computer Science and Automation, is designated as the national coordinator of France's artificial intelligence programme “AI for humanity” and is the key organisation in France for research in the digital sciences. The Defence community works in close collaboration with the INRIA teams responsible for major innovations for future defence systems, in the framework of a partnership agreement first signed in 2007 and regularly renewed.

### *5.2.3 The Schools of the Ministry of the Armed Forces*

The Ministry of the Armed Forces is also the main supervisory authority responsible for several higher education establishments that contribute to defence innovation, both through their training activities and their research work. These establishments include École Polytechnique, ISAE-SUPAERO (Institut Supérieur de l'Aéronautique

et de l'Espace - National Higher French Institute of Aeronautics and Space), ENSTA ParisTech (École Nationale Supérieure de Techniques Avancées - Superior National School of Advanced Techniques) and l'ENSTA Bretagne. These schools are public establishments with a permanent autonomous legal identity and are integrated in France's higher education landscape.

They receive a public service grant for their role in the training of high-level engineers meeting the requirements of the French state and of the defence industry and for the research activities that they conduct in the field of defence. They also receive support for research projects of interest to defence conducted in their laboratories.

To reinforce cohesion between the innovation policy of the Ministry and the specific policies of these establishments, a strategic plan has been developed with their respective supervisory authorities. This plan will be deployed as from 2019 by the Defence Innovation Agency.

#### A STRATEGY FOR OBTAINING MORE FROM THE POTENTIAL OF THE GRADUATE ENGINEERING SCHOOLS OF THE MINISTRY OF THE ARMED FORCES

The strategy of reinforcing synergies between the innovation policy of the Ministry and the specific policies of the graduate engineering schools is based on four main principles:

- development of defence research in the schools;
- development of innovation expertise in the Ministry;
- maturing and incubation of innovative projects and entrepreneurship;
- interconnection of school networks with the networks of the Agency.

In addition, the three officer schools train the future officers of the armed forces. Of these the air force and navy academies (École de l'Air and École Navale) have recently obtained the status of public establishments in the scientific, cultural and professional fields. This status offers many opportunities for reinforcing and developing research and innovation activities, and these opportunities will be explored by focusing in particular on the research institutes integrated in these schools.

The Saint-Cyr Coëtquidan schools are also geared to innovation and possess an internal research centre, while defence school of joint supply corps officers, like the military health service schools, include innovation studies in the training that they provide to future officers.

#### 5.2.4 Defence industry

Finally, the defence innovation policy cannot be conceived without also maintaining a partnership-type relationship with the defence industry, albeit structured by public contracts.

**The input of the defence industry for defining the directions of the Ministerial innovation policy shall therefore be sought, in particular via professional associations.** These exchanges already involve shared road maps, the implementation of a joint approach of open innovation, developments aimed at making weapons programmes more agile and receptive to innovation, innovative procurement, joint experimentation and, finally, the endorsement and utilisation of upstream projects.

The key to these synergies is to maintain a shared vision of the challenges and capability priorities of the state and of its armed forces. On this basis, industrial companies are able to work with the state to establish a shared vision of the essential technological developments required to meet the aims of defence innovation. They can also contribute to the definition of "composite" deployment strategies that combine upstream research with experimentation.

#### 5.3 INTERNATIONAL COOPERATION IN INNOVATION

In a strategic environment that is more unstable and unpredictable than anticipated, cooperation agreements can contribute to reinforcing the bonds that unite us to our partners throughout the world, in both multilateral - especially European - and bilateral frameworks. This observation also applies to defence innovation, where **cooperation enables the sharing of risks and investments between several partners. Cooperation permits the attainment of objectives that could not be attained alone.**

Moreover, France's aim of strategic autonomy is now integrated in a strong European ambition in matters of defence. **In this respect, France intends to contribute to the development of a cohesive, innovative and competitive European defence industry, in particular via its participation in the EDF and Horizon Europe**, highlighting and utilising the full potential of French industry's centres of excellence.

A proactive European and international policy requires the conception of a renewed framework of action, conforming to the recommendations of the 2017 Strategic Review. Cooperation agreements must be carefully managed and result only in dependencies that are mutually agreed.

Cooperation in R&T is conducted in the framework of bilateral agreements (for example with the UK, Germany, USA and Singapore) and multilateral agreements (EDA and NATO) or forums (under the "Letter of Intent" format). International cooperation is also conducted in the framework of the new initiatives of the European Commission, in particular the European Defence Fund (EDF).

Besides the activities of "traditional" R&T, these cooperation agreements can cover engineer exchanges, common doctoral programmes and joint calls for projects in the domain of open innovation.

At present, France devotes about 10% of its total R&T budget to studies conducted in the framework of international cooperation, essentially under bilateral agreements. This figure is expected to increase over the period of the Military Planning Law, due to the cooperation projects retained.

#### 5.3.1 European cooperation

The creation of the EDF will have a structural impact on the European defence technological and industrial base (DTIB), since the funding requested by the European Commission totals €13 billion for the period 2021-2027, including €4.1 billion for research and innovation. Feedback from the first two years of preparatory action for this research window is positive. It demonstrates the capability of French players to contribute to projects serving the strategic autonomy of the EU.

This dynamic impetus must be maintained in defining the European technological road maps in the working parties of the European Defence Agency. By summer 2019, this process will contribute to

the proposal of the broad outlines for the content of the EDF's work schedule, in cohesion with the French strategy for capability and strategic autonomy. The framework offered by permanent structured cooperation will also enable the envisaged projects to be endorsed with a view to obtaining funding from the EDF.

Priority must be accorded to the development of technological demonstrators to experiment new cooperation concepts (such as stratospheric platforms), prepare the subsystems essential to the success of European programmes (e.g. the engines of future aircraft) or to invest in critical cross-disciplinary domains (such as electronic and photonic components, materials etc.). Unnecessary duplication of industrial competencies will be avoided.

We will also have recourse to civilian innovation funding instruments (in particular Horizon 2020 and Horizon Europe) for dual-interest projects.

### 5.3.2 Bilateral and multilateral cooperation

In these domains, France's strategy consists in reinforcing cooperation with Germany, maintaining a solid bilateral link with the United Kingdom and extending existing cooperation agreements to the European countries having both the capability and the desire for such cooperation.

In the future, the armed forces of some European states may be able to obtain equipment originating from the high-level structural programmes identified in the current Military Planning Law and developed in cooperation. These ambitious programmes demand prior investment in scientific and technological research and innovation. In particular, these programmes aim to:

- initiate studies for the replacement of the Leclerc MBT by new combat systems (MGCS), in the framework of European - and especially Franco-German - cooperation;
- research the architecture of the air combat system of the future, in the framework of a cooperation programme that includes Germany and Spain, and then launch the programmes for certain components of this system; European cooperation will help to accelerate the consolidation of a European DTIB for combat aviation, in which French industry will play a fundamental role.
- define the architecture of the possible future Maritime Airborne Warfare System (MAWS), on which France and Germany are currently cooperating;
- conduct trials of prototypes and system demonstrators of unmanned Maritime Mine Counter Measures (MMCM) in partnership with the United Kingdom;
- modernise the low-orbit surveillance systems (GRAVES and SATAM) in the domain of exoatmospheric and endoatmospheric surveillance, by seizing the opportunities of European cooperation in this domain.

Since innovation is one of the areas of excellence of the United States, reinforcement of relations with the innovation drivers in the Pentagon, especially DARPA, is of key importance to France. The US-led Multinational Capability Development Campaign brings together states and organisations (NATO / ACT, EDA etc.) and constitutes a forum of innovation that offers many opportunities.

Singapore will also remain a strategic partner with which France has developed relations of trust based on cooperation projects in defence research and technology, together with close operational links.

Finally, defence R&T cooperation with Australia will be reinforced in the context of cooperation in the Future Submarine Programme.

Additionally, **the Defence Innovation Agency will join the network established by the NATO Innovation Hub**, which already includes several hubs, incubators and accelerators from Europe (the UK's DASA Defence and Security Accelerator, Germany's Cyber Innovation Hub), and America (e.g. AFWerx for the Air Force and SQFWerx for Special Ops) Similarly, the Labs of the French armed forces and Ministry departments and services will also be able to develop partnerships with their foreign counterparts.

## 6. EVALUATING, VALUING



The Ministry will evaluate the results of innovation projects and their operational effects. Qualitative and quantitative evaluation is an essential tool for decision-making and project management, for determining the most rational distribution of resources between the various players and for improving execution. Evaluation provides accountability for investment and contributes to the endorsement and optimal utilisation of the top-performing projects, uniting stakeholders in a convergent view of the effectiveness of the innovation concerned.

The evaluation of defence innovation will aim to:

- assess and quantify the results and effects of projects;
- improve the efficiency of the innovation policy ("feedback loop"), in particular by drawing up suggestions and recommendations concerning the programmes, operating procedures and other factors to enhance their effectiveness;
- ensure due proportionality between the aims of the innovation policy and the means devoted to them.

Finally, evaluation will guarantee the communication of organisational best practises, in order to establish, as a permanent feature of the Ministry, an environment conducive to the development of innovation in all the domains concerned (technological, capability, administrative and human).

The most promising projects must also be met by a **proactive valuation** strategy, both internally and externally, to promote the rapid utilisation of their results. To help establish the development of a culture of innovation, this endorsement strategy must be applied not only to the projects but also to the innovators themselves. The aims of endorsement are as follows:

- **improve the innovation integration rate** by arousing interest in the project as early as possible from "user" stakeholders;
- **protect the state's possibilities for subsequent utilisation** of the projects supported by the Agency;
- **assist innovators in the protection of their intellectual property rights covering the innovation;**

- stimulate innovation in the Ministry by highlighting the Ministry's internal innovators and encouraging their sharing in the profits derived from the innovation by a suitably **adapted "intrapreneurial" approach**;
- **highlight** the results and successes of the Ministry;
- **obtain a more systematic return on the Ministry's investment** in innovation projects.

Endorsement must be integrated from the outset in the project selection, implementation and evaluation process. For this purpose, shared tools will be provided to **evaluate the readiness** of an innovation and assess its global performance. The Ministry of the Armed Forces will also undertake to endorse innovators by awarding bonuses, including innovation capabilities as criteria in staff evaluation and advancement and by internal and external communication campaigns on the most noteworthy and audacious initiatives.

## 7. NURTURING



Although defence innovation requires the mobilisation of physical and financial resources, we must not neglect the cultural and organisational resources that it will need in order to develop. In fact, ideas that nurture innovation (from the most complex - strategic forward planning - to the simplest - irritants observed at individual agent level) and the collective and individual innovation capabilities of Ministry personnel will be decisive in establishing a permanent culture conducive to new ways of working together.

### 7.1 INSPIRING DEFENCE INNOVATION WITH NEW IDEAS

#### 7.1.1 Forward planning and anticipation

The definition of a cohesive French defence policy first requires an updated and prospective analysis of the strategic environment in which France operates, the nature and form of future threats and new vulnerability factors.

This exercise of forward planning and anticipation, which must take into account the technological disruptions of the future, in turn constitutes an input in determining the priorities of defence orientation.

**Consequently, it is vital to reinforce the synergies between the ministerial functions dedicated to forward planning / strategic research and those dedicated to innovation. This is the aim of the "Red Team" that will be set up by the Agency and the DGRIS to challenge the institutional forward planning exercise (see box opposite).**

### A "RED TEAM" OF FUTUROLOGISTS AND SCIENCE FICTION WRITERS TO "IMAGINE AHEAD"

The Agency 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 mission of this Red Team will be to transform difficulty into opportunity!

The task of the cell will be to construct valid strategic hypotheses that are liable to disrupt current capability plans. This cell will be established by the Defence Innovation Agency and the Directorate General for International Relations and Strategy (DGRIS) and will be composed of futurists and science fiction writers. The expected "deliverables" from this cell are:

- disruptive future scenarios that can aid in reflecting on the strategic consequences of the emergence of "disruptive technologies";
- possible asymmetric utilisations of technologies (e.g. artificial intelligence) by malicious state or non-state actors attaining readiness, in particular in non-defence (and non-cyber) contexts.

Although the existence of the "Red Team" is public, its work will be confidential, in view of the sensitivity of this research and to prevent giving inspiration to potential adversaries. The deliverables can also include summary memos to the various armed forces and Ministry departments and services, outlining threat scenarios and recommendations to aid in decision-making.

#### 7.1.2 Identifying "irritants"

Another source of innovations is the identification of "irritants", i.e. any points of dissatisfaction in any of the Ministry's domains of activity. These dissatisfactions can reveal inefficiencies, dysfunctions or missed opportunities.

Provisions for registering these dissatisfactions exist, for example via process reviews in the SGA and DGA, experience feedback loops in the armed forces, "labs", analyses of the quality of provided services in the Joint Forces Coordination and Support Centre (CICOS) or in the general ministerial simplification system. These provisions will be consolidated and extended in order to channel the subjects selected for examination and processing to the appropriation innovation units.

### 7.2 MORE AGILE ORGANISATIONS

Today, the cultural obstacles to innovation in the defence sector, as in many large organisations, are well known - high aversion to risk and failure, way of thinking based on extreme planning, allowing no place for uncertainty and the quest for the illusory "one best way".

The Ministry's innovation policy must be designed to remove these obstacles in the domains of human resources, personnel and organisation management, communication and the monitoring of legal standards. These long-term tasks will require strong and durable commitment by the managers of each entity of the Ministry, in conjunction with investment in helping staff to adapt to transformations.

### 7.2.1 Developing skills conducive to innovation

**The armed forces and the departments and services of the Ministry will introduce modifications, especially in their human resources policies,** to reinforce the practical and objective incorporation of innovation and creativity in the following processes:

- risk management and skills management;
- individual assessment of executives and senior managers, revised to include real inclinations towards innovations and to highlight the ability to simplify.

At the macroscopic level, a better balance between cultural cohesion and creative originality will be sought. Diversity in the profiles of agents and executives will especially contribute to stimulating original thought, which is a key factor in generating and/or integrating of innovation.

For its part, **the Defence Innovation Agency, in liaison with the HR officers of the Ministry, will conduct studies to establish a training and cultural assimilation programme for innovation,** specifically adapted to each level of management and command, including the highest levels, in order to support and assist the development of the skills required by the Ministry (knowledge, technical know-how, and social skills).

Participative innovation is also a key instrument in propagating a culture of innovation and will also be mobilised for this purpose. Finally, as in the case of strategic forward planning, these studies can be enriched by input from research in the human and social sciences.

### 7.2.2 Stimulating organisational and managerial innovation

Organisational and managerial innovation consists in impelling the adoption of more flexible, fluid and collaborative working methods, yielding greater value for agents and their entities. **In this context, it is vital, and the responsibility of management and command, to see innovation not as an additional constraint, on top of the performance requirements already demanded, but, on the contrary, as an opportunity to improve job satisfaction.**

The entities of the Ministry will pursue rational exploration along several lines:

- **greater assumption of autonomy by middle management, with a more readily granted right to test and experiment;**
- **new conception process in project mode,** with multi-disciplinary teams working under the same roof;
- **new collaborative working methods based on “design thinking”,** integrating progressive stages in order to understand a problem, generate and explore ideas and implement a solution by means of prototype production, experimenting and iteration in direct contact with the applications and users in the field;
- **increased cooperation and cross-disciplinary working between agents,** in a logic of “co-worker experience”, which stimulates the commitment of personnel and the generation of new ideas.

**This innovation in the organisational and managerial domains also applies to the new combat methods,** through which the armed forces aim to obtain improved fluidity of procedures and greater reactivity and effectiveness in operational engagement.

As essential aids to organisational and managerial innovation, **the new digital technologies constitute powerful levers,** but only if

their potentialities and possible applications are known. However, the contribution of digital technologies to these processes should not be limited only to the “digitisation” of these processes but should comprise a complete analysis of the possibilities brought by digital tools. For greater effectiveness and resilience, a genuine renunciation of old models must be initiated, so that processes are replaced and not simply added.

### 7.2.3 Removing obstacles and adapting to rules and controls

Innovation can also be hampered by regulatory obstacles. One part of this problem is the exposure of innovators or decision-makers to personal risks beyond their control.

Where relevant, the Ministry will endeavour to undertake a legal review of the standards and regulations that constitute obstructions to innovation, in order to make use of derogations (for example for experimentation) or to attempt to introduce modifications.

For the Ministry’s supervisory and inspection bodies, the aim is also to develop supervisory approaches that are appropriate, in their demands and means, to the characteristics of innovation, and in particular to the uncertainty inevitably accompanying innovation.

Finally, the Ministry will initiate an analysis of possible rule changes in order to provide better protection to the drivers of innovative initiatives when they take risks corresponding to the needs of the Ministry, for example by transferring the penal risk to a collective level.

### 7.2.4 Developing participative innovation and “intrapreneurship”

*The level of participative innovation in an entity is a good indicator of its morale<sup>1</sup>*

On the strength of thirty years of experience acquired by the Mission for the Development of Participative Innovation (MIP), in combination with the incentive schemes specific to certain of the armed forces and Ministry departments and services, **participative innovation contributes to the spread of a culture of innovation by encouraging the emergence of innovators within the Ministry** (and Gendarmerie Nationale), by offering them a framework that integrates both risk-taking and the right to fail.

**This “human-scale” approach to innovation** contributes to functional or capability improvements, by drawing on the experience acquired from operations or day-to-day work. This approach favours the rapid and low-cost emergence of equipment and procedures and integrates the endorsement of innovators and innovations.

In some cases, the scale-up of project readiness can be conducted on the basis of an “**intrapreneurship**” model entrusted to the innovator or to a third party. This is because certain projects initiated by the innovators require acceleration of development in order to ensure their rapid deployment. This “intrapreneurship” approach relies on the firm support of the innovator’s local line management. Studies are now in progress to determine whether the status of “intrapreneur” should be created to establish the optimal conditions for the success of this approach.

<sup>1</sup> Major General of the Gendarmerie Nationale, during the awards ceremony for the 2019 Excellence Workshops.

### 7.2.5 Anchoring innovation in Ministerial culture

**The durable establishment of a culture of innovation in the Ministry of the Armed Forces will be based on a learning process involving communication, capitalisation, implementation and the sharing of feedback from experience.** It will also employ reinforcement mechanisms, such as the valuing of innovators and benchmarking with other entities in broader networks (other ministries, major industrial groups both in and outside the domain of defence etc.). Particular attention will be paid to positive analysis of the failures that are likely to provide useful lessons.

Through its “federating” role in the Ministry of the Armed Forces, the Defence Innovation Agency is tasked with coordinating this approach, albeit without replacing any initiatives that may be taken by the armed forces and relevant departments and services, for which it can act as echo chamber.

**New systems of knowledge management will be experimented,** with the aim of transforming tacit individual knowledge into collective skills, or continuously creating new knowledge (augmented learning, learning networks etc..).

**The innovation correspondents’ network** is an indispensable intermediary for sharing innovative ideas or new practises and for relaying information to the agents in the entities, with the final aim of establishing innovation as a natural practise, so that the number of “top-down” interventions will be constantly reduced.

## 8. GENERAL FINANCIAL FACTORS

The breakdown of financial efforts between the major domains of defence innovation is as follows:

DOMAIN	AMOUNT 2019-25 [M€]
<b>R&amp;T INNOVATION</b>	
Aviation and missiles	1716
Information and intelligence	1575
Innovation detection and routine innovation	793
Naval	317
Ground, CBRN and health	506
Cross-disciplinary technologies	350
Operational innovation	135
<b>RESEARCH OPERATORS</b>	
ONERA and ISL subsidy	897
Subsidies to P191 operators (CNES, GEA)	1280

### NURTURING A COMMUNITY OF DEFENCE INNOVATORS

Internally, the Defence Innovation Agency will conduct an in-house experiment consisting in the trial establishment of a community of practises structured by:

- an internal social network enabling the ideas of innovators to ripen and their projects to be developed through the exchange and confrontation of different points of view and the sharing of feedback;
- events that bring together innovators from the Ministry of the Armed forces to exchange thoughts on their experience.

Externally, the Defence Innovation Agency will set up a defence innovation “club” tasked with nurturing the ecosystem: organisation of events and conferences, creation of a newsletter, establishment of discussion and influence networks to ensure that the “defence” dimension” is included in the global innovation ecosystem.

This club, which can come together for quarterly dinners or meetings, will comprise key players from all parts of the ecosystem - labs, companies and private groups, centres and institutes, journalists, science experts, investors and state bodies. It will be an influencing force for defence innovation in France and will be able enter direct contact with its international counterparts.



## ABBREVIATIONS AND ACRONYMS

- ACT:** Allied Command for Transformation (NATO)
- ADS:** Armed forces, Departments and Services
- AID:** French Defence Innovation Agency
- ANR:** French National Research Agency
- ASTRID:** Accompagnement Spécifique de Travaux de Recherches d'intérêt Défense  
(Specific assistance for research work of interest to defence)
- BLOS:** Beyond Line of Sight
- BRL:** Business Readiness Level
- C2:** Command & Control
- CBRN:** Chemical, Biological, Radiological, Nuclear
- CEA:** Commissariat à l'Energie Atomique et aux Energies Alternatives  
(French Alternative Energy and Atomic Energy Commission)
- CERES:** Capacité de REenseignement Electromagnétique Spatial  
(Space-based electronic signals intelligence programme)
- CNES:** Centre National d'Études Spatiales  
(National Centre for Space Studies)
- CNRS:** Centre National de la Recherche Scientifique  
(National Centre for Scientific Research)
- CSO:** Composante Spatiale Optique  
(Optical Space Component)
- DARPA:** Defense Advanced Research Projects Agency (USA)
- DASA:** Defence and Science Accelerator (UK)
- DGA:** Direction Générale de l'Armement  
(Armament General Directorate)
- DGE:** Direction Générale des Entreprises  
(Directorate General of Enterprise)
- DGRIS:** Direction Générale des Relations Internationales et de la Stratégie  
(Directorate General for International Relations and Strategy)
- DTIB:** Defence Technological and Industrial Base
- EDA:** European Defence Agency
- EDF:** European Defence Fund:
- EMA:** État-Major des Armées  
(French Joint Forces Command)
- ENSTA:** École Nationale Supérieure de Techniques Avancées  
(Superior National School of Advanced Techniques)
- FDA:** Frégate de Défense Aérienne  
(Air Defence Frigate)
- FDI:** Frégate de Défense et d'intervention  
(Defence and Intervention Frigate)
- FREMM:** Frégate Multi-Missions (Multi-purpose frigate)
- HSS:** Humanities and Social Sciences
- INRIA:** Institut National de Recherche en Informatique et en Automatique  
(National Institute for Research in Computer Science and Automation)
- ISL:** Institut franco-allemand de recherches de Saint-Louis  
(Franco-German Research Institute)
- ISR:** Intelligence, surveillance, reconnaissance
- LPM:** Loi de Programmation Militaire  
(Military Planning Law)
- MGCS:** Main Ground Combat System
- NATO:** North Atlantic Treaty Organisation
- ONERA:** Office National d'Études et Recherches Aérospatiales  
(French Aerospace Lab)
- R&T:** Research and Technology
- RAPID:** Régime d'Appui à l'innovation Duale  
(Support programme for dual military/civilian innovation)
- SCALP-EG:** Système de Croisière Conventionnel à Longue Portée - Emploi Général  
(General Purpose Long Range Cruise Missile)
- SGA:** Secrétariat Général pour l'Administration  
(Secretary General for Administration)
- SME:** Small and Medium-sized Enterprise
- TRL:** Technology Readiness Level





