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INFORMATION REPORT

DRAWN UP

*on behalf of the Foreign Affairs, Defence and Armed Forces Committee (1) on
the Future Combat Air System (FCAS),*

By Mr Ronan LE GLEUT and Ms H el ene CONWAY-MOURET,

Senators

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SUMMARY

The Future Combat Air System (FCAS) programme is essential to the renewal of combat aviation in France, Germany and Spain by 2040 (the end-of-service date for the Rafale and Eurofighter Typhoon). It is also essential to **preserving Europe's strategic autonomy and its defence technological and industrial base.**

Building a next-gen air combat system with our German and Spanish partners will allow us to have the best technology and address all threats in the coming decades.

At the end of its work, the mission identified **four main challenges** for the FCAS programme: reach a new milestone in early 2021 to make the programme irreversible, rise to the challenges of 2040-2080 (the FCAS's probable lifespan), make industrial cooperation as efficient as possible while avoiding the pitfalls encountered by some of the previous cooperation programmes, and take into account the European aspect as well as the existence of a competing programme, the Tempest. For each of these challenges, the mission presents concrete proposals.

I Make the FCAS programme irreversible by mid-2021

The FCAS is **essential and will structure** the upcoming decades. The current financial commitment, with an initial contract of €65 million for the study of the joint concept and then a second contract of €155 million for phase 1A to develop the demonstrator, nevertheless remains too limited to prevent any turning back. The negotiations, which resulted in the Franco-German agreement on the first stage of the programme, were laborious. **Vigilance is required to make sure the programme does not encounter a definitive blockage or too significant a delay.** In this context, the next twelve months will be crucial to finding a new agreement, particularly on the issue of industrial property and on the "stealth" pillar and speeding up the programme's implementation.

Proposal 1: Prioritise signing an overall framework agreement at the start of 2021 to continue developing the FCAS demonstrator through 2025/2026 rather than a succession of contracts requiring repeated political approval.

Proposal 2: Improve reciprocal understanding between the three partners; identify and publish a "joint industrial defence strategy" that includes a provisional schedule of the joint projects.

Proposal 3: Encourage the three partners to accelerate the FCAS schedule so that it is part of the post-coronavirus economic stimulus plans. Plan for the programme to be completed by 2040.

Proposal 4: Invite our German partners to sign an agreement with Spain regarding arms exports similar to the one signed with France

II Develop the technology needed to make the FCAS truly revolutionary in 2040

The FCAS must replace the current air combat systems (Rafale and Eurofighter) by 2040 and remain in service until 2080 and, perhaps, beyond. The speed at which technology changes, in terms of not only combat aviation, but artificial intelligence, data exchanges, combat cloud, electronic war or hyper-speed missiles as well as the efforts made by our main adversaries and allies to develop ever-more effective systems, requires us to look beyond 2040. The goal is **to avoid developing a combat system that will be obsolete as soon as it is commissioned**. The ethical and legal aspect of artificial intelligence must also be taken into account within the programme's framework.

Proposal 5: Consider artificial intelligence as a "transversal pillar" of the FCAS that must be developed with the broadest possible scope of application. Resume international discussions on lethal autonomous weapons (LAW) to arrive at a clear legal framework that is consistent with ethics and the principles of international humanitarian law.

Proposal 6: Make the "combat cloud" pillar as much of a priority as the plane and the engine. Begin preparing the integration of the FCAS's combat cloud with the Scorpion Command Information System (CIS) immediately.

Proposal 7: Make the investments necessary to equip the demonstrator planned for 2026 with the M88 engine (the Rafale engine) or a new version of it.

Proposal 8: Include environmental concerns from the start of the FCAS programme while seeking the best performance possible.

III For balanced and effective industrial cooperation

The experience of certain international defence cooperation programmes such as the A400M has led to the implementation of a **highly structured industrial organisation** for the FCAS. This system is thus organised around seven pillars: the aircraft, the engine, remote carriers, combat cloud, simulation/coherence, and, soon, stealth and sensors. A prime contractor and a main partner have been appointed for each of these pillars. While France can count on its first-rate defence manufacturers, who have already demonstrated their know-how in the principal fields concerned by the programme, **the position of sub-contractors must not be neglected** to maintain an overall industrial balance. It is also necessary to **resolve the issue of industrial property in accordance with the main principles already approved by the Franco-German agreement of December 2019.**

Proposal 9: Support the "Best Athlete" principle (the one who has demonstrated competency is the prime contractor) throughout the duration of the FCAS programme to avoid the errors of the A400M programme, while ensuring that French small and medium defence companies participate in the programme.

Proposal 10: Strengthen Spain's position on the "sensors" pillar.

Proposal 11: Protect manufacturers' background in terms of intellectual property. Provide for balanced use of the foreground (the technologies that emerge during development): ensure that each of the participating countries can maintain or make changes to the FCAS after it is commissioned and ensure an adequate protection of innovations.

Proposal 12: Integrate ONERA into the FCAS programme at a fair level given its eminent expertise in combat aviation. Encourage manufacturers to rely on ONERA for sub-contracting.

IV Give the FCAS programme a European dimension

While the FCAS programme is currently a French, German and Spanish project, the opportunity of finding synergies with European instruments of defence as well as the goal of exportation must lead us to consider **enlarging cooperation when the moment is right.** Furthermore, it would be imprudent not to take **the Tempest programme** into account.

Proposal 13: Work to enlarge the FCAS programme to new European countries in future stages (post-2026). Synergies should then be developed with European instruments of defence (EDIDP, PESCO, EDF),

in particular with a view to implementing European interoperability standards.

Proposal 14: Take into account the Tempest's simultaneous existence as a competitor to the FCAS; the coexistence of the two programmes makes it more difficult to build the European defence technological and industrial base (EDTIB).

LIST OF PROPOSALS

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I. FCAS, A COOPERATION PROGRAMME NECESSARY FOR EUROPE'S STRATEGIC AUTONOMY

The FCAS is a highly ambitious programme that includes three aspects: a **political project** linked to Franco-German friendship, later joined by Spain, a response to a **need for capabilities**, and an initiative essential to preserving **France's strategic autonomy** and helping to create **Europe's strategic autonomy**. With its nature as a "system of systems", it seeks to provide an innovative response to the threats that the armed forces will face in 2040.

A. A NEED FOR CAPABILITIES SHARED BY FRANCE, GERMANY AND SPAIN FOR 2040

1. Replacing the Rafale and the Eurofighter Typhoon

a) The need for capabilities

The first reason for launching the FCAS programme is to **meet the French, German and Spanish air forces' need for capabilities in 2040**.

The three countries share a relatively coincidental need to renew their combat aircraft equipment:

- **for France**, the need to find a successor to the Rafale, in service in the Navy since 1998/99 and in the Air Force since 2006, and which is planned to be retired around 2060. The FCAS will progressively relieve the

Rafale F3R,¹ qualified by the DGA in July 2018, then the upcoming Rafale F4, which will improve the aircraft's connectivity, electronic war capabilities and the radar's effectiveness, constituting a first step toward the FCAS. The FCAS must also be able to **fulfil the mission of nuclear dissuasion**.

- **for Germany**, the need to plan for a successor to the Eurofighter, in service in the Luftwaffe since 2004 and which is set to be retired roughly at the same time as the Rafale, after being improved in the meantime. The new system should allow Germany to **continue to fulfil its nuclear missions for NATO** (B61 gravity bombs carried by P200 Tornados).

- **for Spain**, replace the Eurofighter, which was ordered in 2010, 2014 and 2017. Note that the F/A-18A Hornet of the Spanish ALA 46, based in the Canary Islands and taken from US stocks in the 1980s, will expire in 2025. Later, it will be the same for the sixty aircraft of the same type acquired by the Spanish air force. The Spanish navy also uses around a dozen AV-8 Harrier IIs on the Juan Carlos I aircraft carrier. To meet its renewal needs, Spain could be tempted to acquire some F35Bs, the only aircraft on the market that can take off vertically from the aircraft carrier. However, until now, this solution has not been adopted because of Spain's "European preference" on the one hand and the very high cost of the F35Bs on the other. Even if the F35B were chosen, it would no doubt not be a choice that definitively turns Spain in favour of the American aircraft manufacturer.

The new air weapons system that will succeed the Rafale and the Eurofighter must be a **system with multiple roles**² suited to the context of 2040 and the following decades until it is retired, likely around 2080. The general opinion is that this context will be characterised by a **greater dispute of airspace by our adversaries** through "Anti-Access/Area Denial" (A2/AD) strategies implemented using highly effective detection systems (broadband radar) and anti-missile systems (such as the Russian S400 and its successors). This will result in a risk of it being impossible to penetrate enemy areas even though controlling the third dimension remains essential to any military action, including on the ground.

Additionally, the new combat aircraft must be able to carry both French nuclear weapons and the NATO nuclear weapons used by Germany, which will have an impact on its characteristics that remains to be determined.

¹ This new standard will allow the Rafale to carry the METEOR long-range air-to-air missile along with the RBE2 AESA radar with an active antenna that allows flying targets to be engaged at around a hundred kilometres. It will also be able to implement the TALIOS targeting pod. This new version of the Rafale is also equipped with a mode 5/mode S-compatible IFF interrogator and an AGCAS (Automatic Ground Collision Avoidance System). The link 16, the RBE2 AESA radar and the SPECTRA electronic war system have been improved. In addition to the METEOR missile, it will be able to carry GBU-16 laser-guided bombs and Block 3 air-to-ground modular weapons.

² Currently, the Rafale is a multi-role aircraft by design (even omni-role, as presented by Dassault Aviation), while the Eurofighter is an air superiority aircraft that was only recently adapted to air-ground missions.

b) Consequences for the future aircraft carrier

The size and weight of the new combat aircraft will have **consequences for the size of any future French aircraft carrier** and for the size of the missiles that may be used and developed in the future.

Currently, the Rafale Marine has a wingspan of 10.90 metres, a length of 15.27 metres, empty weight of 10 tonnes and a maximum weight of 24 tonnes with the weapons. The NGF will be heavier for at least three reasons: it must be able to carry more effectors, have a greater flight range, and its stealth will no doubt require a hold of a certain size for the missiles.

As a comparison, the American F22 stealth fighter has a wingspan of 13.56 metres, is 18.9-metres long, weighs 20 tonnes when empty and up to 35 tonnes with all its cargo. The NGF model presented at Le Bourget was 18-metres long. Admiral Christophe Prazuck, Chief of Staff of the French Navy, also spoke of **a weight of around 30 tonnes for the NGF** and dimensions greater than the Rafale at a Senate hearing on 23 October 2019, implying a much bigger and heavier aircraft carrier than the Charles de Gaulle. Thus, the order of magnitude being considered would be 70,000 tonnes for an aircraft carrier 280- to 300-metres long, compared with 42,000 tonnes and 261 metres for the current aircraft carrier.

2. Keeping a "sovereign" aircraft, maintaining cutting-edge skills

If the aircraft's development is not launched now, France and Germany will no doubt have to adopt a non-sovereign solution in 2040. It will probably be the F35, which should remain in activity until around 2080, or one of its American successors.

France would then renounce its strategic autonomy. It would also renounce part of its defence technological and industrial base. Remember that France is one of the three countries, alongside the United States and Russia, that can manufacture an entire combat aircraft.

It would be the same for Germany. Despite its traditionally more favourable attitude towards the United States in the matter, Germany decided in April 2020 to buy 93 Eurofighter (BAE systems, Airbus and Leonardo) and 45 American F-18 (Boeing) combat aircraft to renew its fleet of Tornados capable of carrying the American nuclear bomb **and not F35s** as the Americans were encouraging, arguing that only an American aircraft could carry this bomb (although the Tornado, the current carrier within the German forces, is indeed a European aircraft).

Furthermore, **the abandonment of strategic autonomy that would result from the lack or the delayed launch of a new air combat system would no doubt be permanent.** It would be very difficult for European manufacturers, particularly aircraft and engine manufacturers, to skip a generation of aircraft. The cutting-edge skills needed in this field can only be

maintained by **effectively participating in industrial programmes**. In particular, for the two main French manufacturers participating in the NGF project,¹ Dassault and Safran, the last military programme dates back to the Rafale in the 1980s. The aircraft manufacturer has not developed a new combat aircraft since this period, just as the engine-maker has not made a complete engine (hot and cold parts) since the M88 on the Rafale. Therefore, it is urgent that these two manufacturers work on a new major-scale project that mobilises all the skills needed to make a complete aircraft.

Representatives from Safran and the CEO of Dassault, who gave testimony to the rapporteurs, considered the FCAS, as a new programme for an air combat system, to be an "existential project". It's this existential character for Europe's strategic autonomy that ultimately fully justifies not meeting the need by an aircraft purchased "off-the-shelf". Conversely, the A400M may not have had the same "existential" character for Airbus (as the Court of Auditors underscored in its 2010 report on the steering of arms programmes).²

Also, it should be noted that, in terms of combat aircraft, the international "trend" is towards sovereign programmes. **Many regional powers have decided to develop their own combat aircraft**, particularly in Asia, to support their sovereignty and develop a local manufacturing network. This is the case in China with the Chengdu J-20, a stealth twin-engine, in South Korea, which is developing a combat aircraft in cooperation with Indonesia, the KF-X, India, which is developing the HAL AMCA via national manufacturer Hindustan Aeronautics, Japan, which is also developing a stealth aircraft (since they were unable to acquire the F22s that the Americans refused to export), Turkey and Iran. FCAS member countries' attachment to their strategic autonomy is thus widely shared.

B. A PROJECT TO DEEPEN FRANCO-GERMAN COOPERATION

In addition to its role as a project for capability and operations, the FCAS is foremost a **Franco-German political project** desired by the French President and announced during the Franco-German Defence and Security Council on 13 July 2017.

The FCAS is an additional opportunity to strengthen and nurture the Franco-German partnership as part of the desire to revitalise this relationship, as was strongly manifested in the Aachen Treaty on 22 January 2019. While the project now includes Spain and may be joined by other countries, it was first the product of France and Germany's efforts towards cooperation in recent years, particularly in terms of defence. By

¹ *The Next Generation Fighter which comprises one of the elements, along with the remote carriers (drones) and the tactical cloud, of the NGWS (New Generation Weapon System), itself at the heart of the FCAS: see page and following.*

² https://www.ccomptes.fr/sites/default/files/EzPublish/1_conduite-des-programmes-armement.pdf

committing the two countries to a partnership likely to last more than 20 years (and even 50 years if we add the likely lifespan of the weapon systems), the FCAS programme assures very dense discussions throughout this period on a political and industrial level, as does the future MGCS combat tank project for land programmes.

1. The impetus created by the Aachen Treaty

More than half a century after the Elysée Treaty was signed as a sign of reconciliation (22 January 1963), the signature of the Treaty on Franco-German Cooperation and Integration by President Emmanuel Macron and Chancellor Angela Merkel on 22 January 2019 in Aachen **confirmed the two countries' desire to deepen the Franco-German partnership.**

In particular, chapter 2 of the treaty is entitled "**Peace, Security and Development**" and affirms **the need to strengthen the Franco-German bilateral defence relationship** with a view to creating a stronger Europe in the light of new international threats and turmoil (Brexit, terrorism, the rise of populism, the questioning of the multilateral order by world powers, etc.). This chapter also includes a mutual assistance clause based on Articles 5 (NATO) and 42.7 (EU). It also makes provision for the development of a **joint strategic culture** that seeks to strengthen Franco-German operational cooperation through joint deployments, which recalls the European Intervention Initiative (EI2) and confirms Germany's desire to play a more important role on the international scene.

Furthermore, in terms of capability and industrial cooperation, the two parties to this treaty commit to "*[intensify] the development of common defence programmes and their expansion to include partners*" (Article 4.3) and "*[develop] a common approach*" in terms of arms exports for these projects.

Finally, the Aachen Treaty reaffirms the role of the Franco-German Defence and Security Council (CFADS - *Conseil franco-allemand de défense et de sécurité*) as a political body for steering these reciprocal commitments. Co-chaired by the French President and German Chancellor, the CFADS brings together the two countries' foreign and defence ministers and was last held formally on 13 July 2017 in Paris.

2. Perspectives for strengthening Franco-German operational cooperation to be confirmed

The FCAS project came about in a context of **new perspectives of operational cooperation** between France and Germany. The Aachen Treaty confirms much of the progress seen in recent years in this field. The desire to act jointly "*whenever possible...with a view to maintaining peace and security.*" (Article 4.2) shows a desire to reinforce the trend seen in recent years of German deployments in French zones of interest (the Sahel and the Levant).

It also seems essential to work to capitalise on Germany's increased commitment to these theatres, particularly in the Sahel, where **German support could be increased should some or all of the United States' capabilities be removed** (air-to-air refuelling, tactical and strategic transport, intelligence).

Germany's participation in the European Intervention Initiative (EI2), launched by ten countries in June 2018 and which now counts 13 participating countries,¹ could also help to bring together France and Germany's shared strategic cultures with a view to facilitating joint deployments of their military forces. EI2 has resulted in working groups created at the chief-of-staff level in the fields of strategic anticipation, scenario development and planning, operational support, and feedback and doctrine sharing.

France also announced that **it was returning to Lithuania alongside Germany in 2020 as part of the advanced reinforced presence of NATO**. France's participation translates to sending 300 soldiers, 4 Leclerc tanks and 13 armoured infantry fighting vehicles.

However, Germany's desire to be more involved on the international stage, which is explained in the 2016 white paper and in the 2018 coalition contract, has not yet had a major effect on Franco-German operational cooperation. The Franco-German brigade deployed in Mali (November 2018 - March 2019) saw German units join MINUSMA and EUTM Mali, while French soldiers were integrated into the Barkhane Force. Cooperation on joint engagement in hard fighting is not conceivable in the foreseeable future: Germany does not intend to take part in the Takuba Task Force and should limit itself to political support for the European Maritime Awareness in the Straits of Hormuz mission (EMASoH).

More generally, French initiatives do not always receive the desired reaction. **Furthermore, the mission observed this during its visit to Berlin:** concerning the Sahel, German members of parliament questioned the methods of the military intervention in Mali and regretted the lack of coordination between the various initiatives in support of the G5 Sahel. Nevertheless, Germany should involve itself more in the international Coalition for the Sahel by steering the pillar on "*support for the return of the state and administrations*".

¹ Belgium, Denmark, Estonia, France, Finland, Germany, Italy, the Netherlands, Portugal, Spain, Sweden, the United Kingdom, Norway and Italy.

The gradual evolution of Germany's position on defence issues

1. Germany's traditionally prudent stance on defence and foreign relations

In its report in 2012 on the government bill to ratify the agreement on the Franco-German Brigade, our colleague Jean Marie Bockel underscored the tensions in defence matters between the two countries, particularly on the issue of the intervention in Libya (2011). Among the topics of discussion, he cited the disagreements within NATO, particularly on the role of nuclear dissuasion, disarmament and joint financing. He also discussed the conclusion of the Franco-British defence agreements in 2010 (the Lancaster House Treaties) which raised certain questions in Germany.

The report also highlighted that, due to the budget context, the time was hardly right for deepening Franco-German cooperation in defence. Germany was in the midst of a deep reform of its defence apparatus, with the end of conscription and the closure of a number of garrisons. In France, the defence apparatus underwent a significant transformation, with a reduction in personnel and a reform of support.

Finally, the Senate report underscored that, while Germany's military and political leaders had undertaken a study of the need for their country to play a more significant role on issues of defence and security and, even if the German army was engaged in several theatres such as Afghanistan, German public opinion was still reticent about foreign operations, particularly when these interventions were combat operations.

2. A move towards a more active stance after the Libya crisis

a) A gradual evolution of Germany's doctrine

After the abstention on the intervention in Libya (resolution 1973 of the United Nations Security Council in March 2011), the Merkel III government (2013-2018) began to study Germany taking on more responsibility on the international stage. During the 2014 Munich Security Conference, federal President J. Gauck, Defence Minister U. von der Leyen (CDU) and Foreign Minister F.-W. Steinmeier (SPD) affirmed in three speeches that Germany was ready to take on international responsibilities and make greater commitments. This call for more international involvement was called the "Munich consensus". Germany's strong involvement in Ukraine in 2014, particularly in the Normandy format, was a concrete reflection of this stronger commitment.

The study of this reorientation was also extended to the realm of defence. In the 2013 coalition contract, the government had already stated that the Bundeswehr was an "army in deployment" (*Militär im Einsatz*), which was a break with the tradition of restraint and the pacifist position of a large share of public opinion and certain parties. This approach was confirmed in the 2016 white paper. This change also came with a budgetary effort: ahead of the NATO summit in July 2018, the Chancellor promised to reach defence spending of 1.5% GDP in 2024. While NATO's target is still 2%, Mr Nikolaus Meyer-Landrut, Germany's ambassador in France, highlighted in his hearing before the committee that the German defence budget had already increased by 40% over the five preceding years.

b) Persistent reluctance and growing opposition to arms exports

The Bundeswehr remains a parliamentary army: approval from the Bundestag is a prerequisite to any foreign intervention. Furthermore, German parties and administrations are still very divided on these questions, even if public opinion is progressively moving towards greater approval of more significant foreign engagement. Germany is often criticised by civil society and certain political parties about its status as the world's 5th largest arms exporter. The new coalition contract plans to prohibit delivering arms to countries directly engaged in the war in Yemen.

After the murder of Saudi journalist Jamal Khashoggi on 2 October 2018, Germany announced that it was suspending arms exports to Saudi Arabia. Foreign Minister Heiko Maas called for the international regulation of cruise missiles. While, the Chancellor called for the development of a "*shared European culture in arms exports*" in February 2019, the SPD opposed increasing exports in this domain and recommended prohibiting all exports to countries at war or crisis hotspots outside NATO. It also opposes any large increases to the defence budget.

c) Multiple German commitments in foreign theatres

Despite this continuing reluctance, the Bundeswehr now operates in multiple theatres of operation. After the 2014 decision to deliver arms to the Iraqi peshmergas in their fight against Islamic State, lifting the taboo on exporting arms to zones of conflict (to a non-state actor, no less), Berlin's support for French operations after the Paris attacks illustrates Germany's turnaround towards a more active foreign engagement.

Furthermore, shaken by the migration crisis and the risk of terrorism, Berlin has been more engaged in Africa in recent years, in particular in the Sahel (Mali: MINUSMA, EUTM Mali, EUCAP Sahel Niger – it stopped participating in operations in Somalia in early 2018, however), to support the G5 and its joint force.

d) A renewed commitment from Germany to multilateralism and for a reform of the United Nations Security Council

Germany is also seeking to strengthen its role within the United Nations, and Foreign Minister H. Maas agreed with Mr Le Drian to undertake an "Initiative in favour of multilateralism". Berlin is also showing a desire to increase Germany's voluntary contributions to the UN and to continue its engagement in peacekeeping operations.

Germany also wants to obtain a permanent seat on the Security Council, as well as for the other G4 members (Brazil, India and Japan). The coalition contract also sets out the more long-term objective of creating a permanent seat for the European Union. France is opposed to this. The Chancellor reiterated this proposal in June 2018, and Vice Chancellor O. Scholz even recently proposed (on 28 November 2018) transforming France's seat into an EU seat in the "medium term". However, the *Auswärtiges Amt* quickly distanced itself from this proposal, which has not been repeated since. But it resurfaces regularly, such as in the recent op-ed from CDU leader Annegret Kramp-Karrenbauer published on 10 February in *Die Welt am Sonntag*.

3. A rebalancing of Germany's position towards the European defence policy?

When she returned from the G7 in Taormina (May 2017), the Chancellor stated that "*we Europeans must really take our destiny into our own hands*" because "*the time when we could totally rely on others has, in part, passed*". Trade and defence issues were at the heart of bilateral difficulties between Germany and the United States in the summer of 2018. For Berlin, NATO and the American nuclear umbrella remain the pillars of German and European security (the "irreplaceable guarantor" according to the coalition contract). However, the German Chancellor now advocates maintaining a multilateral approach in the face of US unilateralism in security or trade matters. Vice Chancellor O. Scholz (SPD) has also come out in favour of a greater Europeanisation of the arms industry.

Source: the committee report from the Senate Foreign Affairs and Defence Committee on the Aachen Treaty.

3. Recent progress on Franco-German cooperation on capability

Since the implementation of the roadmap dedicated to monitoring the projects confirmed as part of the CFADS on 13 July 2017, **Franco-German cooperation has seen significant progress in the domain of capability.**

After signing letters of intent on the FCAS and the future tank (MGCS) at the Meseberg summit on 19 June 2018, **the ministers specified how the leadership of these programmes would be distributed in Brussels on 19 November 2018: Germany will be the leader on MGCS and France on the FCAS.**

Furthermore, the signature of a **global EUROMALE contract** is desired for the second half of 2020, subject to financial competitiveness. Finally, 2020 will also see the launch of feasibility studies for the **Maritime Airborne Warfare System (MAWS)** after a ministerial letter of intent was signed on 26 April 2018.

In general, France and Germany are seeking to leverage the potential offered by new European tools in capability (Permanent Structured Cooperation (PESCO), the European Defence Fund (EDF)) by presenting many projects in the European framework (the MALE drone, the ESSOR software radio and the modernisation of the Tiger standard III).

C. SPAIN, A PARTNER HIGHLY MOTIVATED BY THE PROJECT

1. A solid bilateral defence and security relationship

France and Spain have long had a good bilateral relationship in defence and security. This relationship was institutionalised in 2005 by the creation of the Franco-Spanish Defence and Security Council (CFEDS - *Conseil franco-espagnol de défense et de sécurité*). It has also been reflected in defence cooperation agreements. In particular, the final declaration of the

Brest CFEDS in 2013 was a roadmap that laid out France and Spain's strong commitment to reinforcing the Common Security and Defence Policy (CSDP) in its strategic, operational, capability and industrial aspects as well as a convergence of operational capabilities **in areas of common interest**: the Mediterranean, the Sahel, the Gulf of Guinea and the Horn of Africa. Madrid also joined the European Intervention Initiative (EI2) on 25 June 2018.

On the operational side, Spain and France are cooperating in the framework of several European missions: EUTM-Somalia, EUTM-Mali, EUTM-RCA, EUNAVFOR MED IRINI. Both countries are also taking a joint initiative in support of security forces in Sahel countries as part of the G5 and through the "5+5 Defence" initiative, a multilateral forum of cooperation on both sides of the Western Mediterranean, including Morocco, Algeria, Tunisia, Libya, Mauritania, France, Italy, Malta, Spain, and Portugal.

Concerning defence industry cooperation, Spain's participation in major military programmes started in the 1980s with the Eurofighter programme and continued through multilateral cooperation, notably through its membership of OCCAr. France and Spain are participating in several defence industry cooperation programmes: Tiger, A400M, the European MALE drone, and now FCAS. In general, Spain is **highly favourable to European cooperation in defence**: the country is the leading contributor to EU operations, and it is now more oriented towards Europe than the United States in the matter and highly supports PESCO.

2. A precious contribution to the FCAS

After a phase that was no doubt too exclusively Franco-German, Spain's inclusion is **excellent news for the FCAS**.

French authorities initially gave priority to the Franco-German relationship to establish the basis for the industrial and research partnership. Spain was only able to join the project slightly after. However, **Spain's political will to participate in the FCAS project is very strong**: initiated by the Rajoy Government, this participation was confirmed as soon as the Sanchez Government took over in mid-2018.

The relationship between France and Germany, sometimes characterised by misunderstandings, is turning into a three-sided relationship that reflects the diversity of European cultures in defence, where France, as a central country in Europe, can no doubt act as a mediator if needed between its northern and southern neighbours.

D. A PROJECT IN COOPERATION TO SHARE COSTS AND WORK TOWARDS STRATEGIC AUTONOMY

While the political benefits of Franco-German cooperation are obvious, it is undeniably more complex to develop a project with international cooperation than it is to develop it entirely internally. **The mission's interlocutors have all reiterated the multiple difficulties encountered by European programmes such as the A400M.** Similarly, the precedent of France's withdrawal from the Eurofighter programme in 1985, just one and a half years after the project started and followed by the launch of the competing Rafale project, is on everyone's minds. Technologically, and not to minimise the challenge it would represent, French industry would no doubt be able to realise the entirety of the FCAS. However, it would be a very costly operation. **Finally, cooperation between France, Germany and Spain will allow France to preserve its strategic autonomy while betting on a promising European strategic autonomy.**

1. A project that would no doubt be too costly for a single country

Most of the mission's interlocutors took it for granted that a programme such as FCAS would be unthinkable for a single country since the development costs for such a complex programme would place it out of reach of just one nation's budget. **Developing a combat aircraft is indeed more expensive today than it was in the past, let alone developing an airborne system of systems such as the FCAS.**

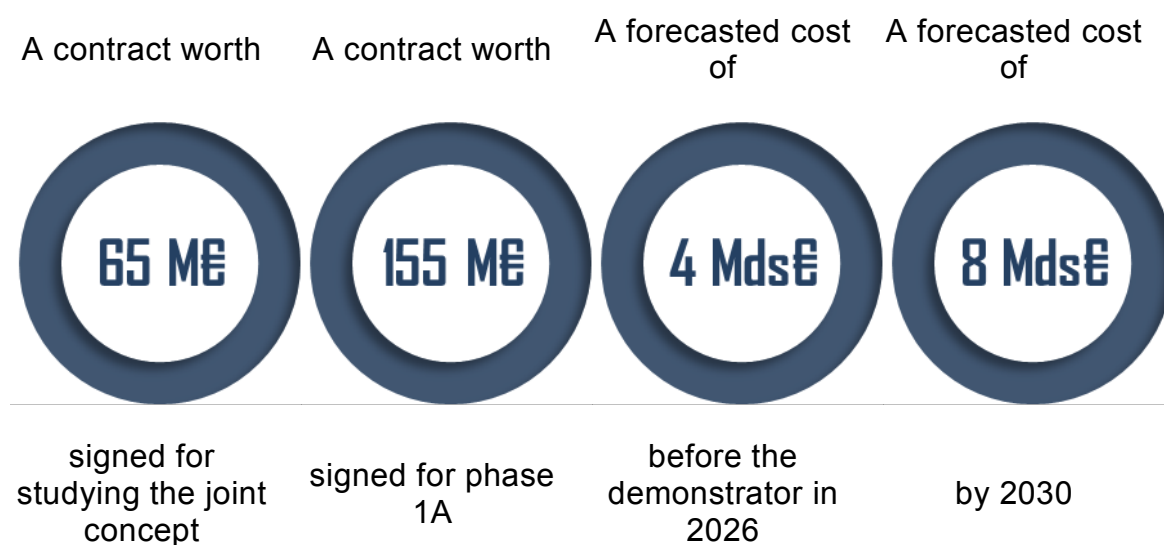
As an example, the engine manufacturers chosen for the project (Safran and MTU) recalled during their hearing that the United States had paid more than \$1 billion over the last two years to each of their two engine manufacturers (Pratt & Whitney and General Electric) to maintain their lead in hot engine parts, compared for example with the €115 million "Turenne 2" upstream study programme (PEA), awarded by the DGA to Safran to consolidate its skills. More globally, the simultaneous development of a new combat aircraft platform, a new engine, several types of drones and a specific combat cloud **represents an extremely high investment that seems very burdensome for a single country.**

So, while international cooperation in defence increases the amount of non-recurring expenses (research and development) slightly, it also allows **the partners to share** them, reducing the total expenses each country must pay. Also, given the amount of the orders, it also allows for **lower unit costs** (production costs can be brought down by a greater industrialisation of processes made possible by the volume of the production ordered. Finally, as

the Court of Auditors highlighted in its 2018 report,¹ savings can also be made during the operations phase by pooling support and, in particular, during the industrial phase of maintaining materials in operational condition.

Sharing costs is thus very much a necessity to be able to preserve the strategic autonomy of the air combat systems of each of the programme's member states.

Remember that the 2020 Finance Act has allocated €1.4 billion in commitment authorisations to cover the launch of the initial development activities of the demonstration programme. At the moment, the planned investment in the FCAS, equally shared by Paris and Berlin,² is around €4 billion by 2025-2026 (demonstrator), and €8 billion by 2030, after which industrialisation expenses will begin. For certain analysts, the total cost of the programme is estimated at between €50 and €80 billion.



2. A project guided by an imperative of national and European strategic autonomy

In addition to the financial aspect already covered, the convergence of interests between France, Germany and Spain in terms of combat aviation allows us to think that **the three countries will preserve their strategic autonomy more effectively by cooperating together**. It is also a bet on the

¹ European cooperation in arms, a necessary reinforcement, subject to demanding conditions, 2018.

² The amount of funding provided by Spain is not yet set, but Spain intends to contribute the same amounts as its partners

future: that the programme will encourage a greater European strategic autonomy beyond the three countries currently participating.

a) Becoming export-competitive once again

(1) Aiming for "exportability" from the start of the programme

Cooperating to build the FCAS ensures that, at the least, **the project's participants will buy this instead of competing American products**, in this case the F35 and any future versions.

Additionally, as Airbus's representatives highlighted during their hearing, beyond the project's participants, "exportability" has been taken into account right from the specifications: the aircraft and its "remote carriers" must be attractive for export to reduce production costs and spread European standards.

While the three current-gen European fighters (Rafale, Eurofighter, Gripen) have seen some export success, **we can nonetheless speak of a global weakening of export capability due to this division**. There is no doubt that this has cost us against the F35 which, despite all the criticisms on the technical aspects, has had particularly good export success until now. **Cooperatively completing an NGWS in Europe will be an asset for its exportation**. In this regard, the competition with the British Tempest project would be a significant drawback (see below page).

(2) A necessary "dis-ITAR-isation"

Strengthening strategic autonomy largely addresses **the "dis-ITAR-isation" problem**, i.e. the slightest exposure to ITAR (International Traffic in Arms Regulations), which allows the United States to block the export of equipment with American components. ITAR weighs on many French export projects like a sword of Damocles. In recent years, we can cite the export of SCALP missiles in Egypt or threats (carried through or not) to various export projects to India, Qatar, and the United Arab Emirates. Many pieces of equipment include American-origin electronic components, and most French aircraft in particular in some way fall under the ITAR regime. **Germany and Spain also share this problem. Thus, from the start, the FCAS project integrates the need to be less dependent on ITAR in the future.**¹

b) A cooperative project encouraged by changes in the international environment

All the parties the mission heard agreed that the need for greater strategic autonomy is also the result of **changes to the international environment that are impacting the three countries in the programme in**

¹ We should note that, for example, the MICA missile, the next generation of MBDA, is already designed to exclude any ITAR components.

the same way, encouraging them to "close ranks" to face threats from "world powers".

Brexit raises questions about the United Kingdom's future position and on the continuation of arms projects shared with this country.

Also, **the change in the United States' attitude** towards Europe's defence since the election of D. Trump as U.S. president has helped to move Germany to a more favourable position on European defence. This change was reflected in the Chancellor's statement upon her return from the Taormina G7 summit in May 2017 that "*we Europeans must really take our destiny into our own hands because the time when we could totally rely on others has, in part, passed*". (see box above).

c) Towards European strategic autonomy?

(1) A structural project for European industry

Given its exceptional magnitude (between €50 and €80 billion according to estimates), according to Joël Barre, Chief Executive of the DGA, FCAS can **structure the overall defence system at the European level and become a driver of European industry alongside many potential spill-overs into the civilian field.**

According to Dirk Hoke, CEO of Airbus Defence and Space (ADS), who gave testimony to the mission in Berlin, the FCAS is a unique opportunity to rely on Europe's key strength: **its great diversity that drives creativity and emulation.** For him, this results in better projects for less financial investment than those made in the United States for the same type of programme.

(2) A long-term bet on Europe's strategic autonomy, which involves the issue of interoperability

Going from French, German and Spanish strategic autonomy to European strategic autonomy is undoubtedly not self-evident. **Above all, it is a bet that other European countries will join the project and buy the new system of systems.**

A project with three partners is already highly complex. As Dassault Aviation's CEO highlighted during his hearing, this three-partner core must be strong first for it to be reasonable to consider expanding it to other European countries.

The future link between the FCAS project and the European Union can go through the new European defence instruments, such as: Permanent Structured Cooperation (PESCO), the European Defence Industrial Development Programme (EDIDP), and the European Defence Fund (EDF):

- Concerning **PESCO**, projects have been selected in three stages since 2017, the last selection having taken place in November 2019, bringing the total number of these projects to 47. **One of these projects is called "EU Collaborative Warfare Capabilities (ECoWAR)" and brings together France, Belgium, Spain, Hungary, Romania, Spain and Sweden.** This project's definition centred around collaborative combat and connected platforms concerns all environments, not just the air. It is a forum where countries' representatives can identify needs for capabilities and future doctrines of use as well as the bricks needed to build collaborative combat.

The ECoWar programme has a certain significance to the perspectives for building interoperability with France's European partners who chose the F35, **interoperability that can make up for the lack of the native interoperability of the American aircraft.** Several countries, such as Belgium and Italy, who have seen that they cannot make the F35 interoperable with their other combat aircraft, are turning to this programme. More globally, the ECoWar project's goal is to review all NATO (FMN)¹ and European (ESSOR)² interoperability works to further a **European vision of interoperability. Thus, other European countries could come to the FCAS programme through this issue of interoperability.**

- **Concerning EDIDP**, which includes €500 million of funding with two tranches of €200 million for calls for bids in 2019 and 2020, France is also carrying out cooperation projects in air combat (equipment, training resources) to build networks with manufacturers in other European countries on these issues **on the margins of the FCAS.**

- Finally, and above all, a series of meetings will be held through the end of 2020 to reach a structure for the **EDF**. The issue of the next-generation combat aircraft will necessarily be a part of the discussions, as most likely will be the way in which the EDF could have "points of adherence" with the FCAS, in one way or another. Once again, the goal will be to have a wide-ranging cooperative approach to the bricks of the system beyond just the FCAS programme's initial members.

In total, the challenge is **to find convergences between multilateral approaches and a Community approach.** As part of these Community instruments, the European Commission will probably also want to move forward on issues of defence, including collaborative combat, specifically to give them a more Community aspect. It will then be necessary to work to maintain FCAS's solidity and consistency while surfing on the momentum from the Commission. Such a situation is already being trialled with the Euromale drone, supported by the EDIDP to the tune of €90 million.³

¹ Federated Mission Networking

² European Secure Software defined Radio

³ in spite of a certain reluctance from countries who are not members of the programme.

d) FCAS and NATO

For now, NATO is not discussing the issue of the FCAS directly. However, the organisation is drawing up and standardising rules of interoperability (STANAGs related to data links) that apply to the air combat cloud of its member countries to which the FCAS's data links must be able to integrate.

NATO is also developing a replacement programme for the AWACS entitled "*Alliance Future Surveillance and Control*" (AFSC) with €120 million of funding from allies as a control and communication system. This will not be a single platform but a system of systems that will **intersect with the FCAS architecture in that future platforms will need to be able to connect to it**. The risk would be that this future NATO system will be directly derived from American standards. Thus, it is essential to take this aspect into account from the start of the FCAS programme.

Furthermore, the FCAS is considered within NATO as an opportunity to modernise member countries' aircraft fleets. A review will have to be carried out on how the NATO missions taken over by Germany and France will be carried out with the FCAS and what added value they will bring to the situation at hand: deep strikes, air superiority, etc.

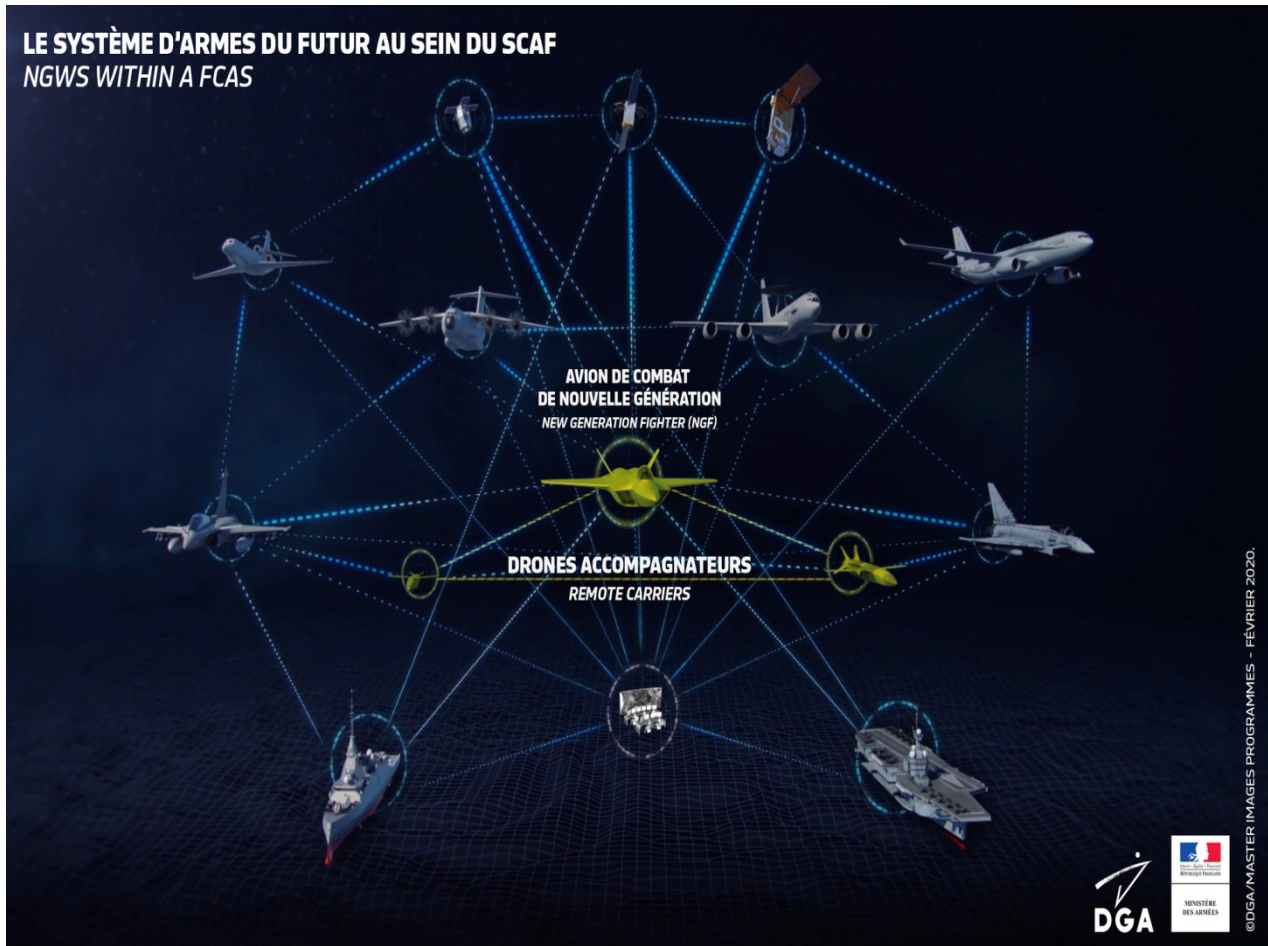
II. FCAS: FROM A SYSTEM TO A "SYSTEM OF SYSTEMS"

All of the mission's witnesses emphasised one essential aspect of the FCAS programme: this project will be a complete innovation over previous combat aircraft projects. **This innovation is reflected in the expression "system of systems"**. The FCAS will not just be another Rafale or Eurofighter, but an aviation "system of systems".

This "system of systems" consists of three concentric circles. In the centre, the combat aircraft called the NGF (next generation fighter). Then, around this circle and including, in addition to the NGF, remote carriers and the combat cloud, the NGWS (new generation weapon system). Then, the FCAS itself encompassing all the previous circles and adding other pre-existing national capabilities (Rafale and Eurofighter) as well as refuellers, reconnaissance aircraft and command systems, right up to satellites.

So, we should talk about several FCASs, all interoperable but each specific to one country. The three countries of the programme will cooperate to build the core of each national FCAS: the NGWS (NGF + Remote Carriers in a combat cloud). This NGWS will be able to act independently or in a network with other aviation, naval, land or space command or combat systems (we speak of an "NGWS within a FCAS") then, beyond that, interoperate with NATO and EU resources. The other national aviation combat resources that will network with NGWS system components (current airborne platforms, in particular Rafale and its future versions,

future cruise missiles developed with the United Kingdom, current weapons and drones) are part of the equation from the start of the programme.



A. A NEED DEFINED TOGETHER

To have a chance of succeeding, an international project must be founded on a **shared analysis of the needs**. It was imperative that the programme's two, then three, member countries put their operational needs in a common envelope, and not a list that juxtaposed national needs, otherwise they would face the same difficulties as the A400M programme.

As the Court of Auditors highlighted in the 2010 report, discussed above and dedicated to weapons programme steering, a usual characteristic of cooperative programmes is an **inflation of technical specifications** which leads to very costly production conditions. For the A400M, Germany required particularly high performance standards for the navigation system. Similarly, NH90 helicopters are equipped with different engines for the French and Italian versions and are produced in 27 separate versions for all

the participating countries. Another example: there are three production and assembly lines for the Tiger (France, Germany and Spain).

France and Germany undertook an analysis of shared needs in future combat aviation. All the desired specifications were the subject of a document co-signed on 26 April 2018 by General André Lanate, Chief of Staff of the Air Force, and General Bühler, Director General for Planning: the **HLCORD** (High Level Common Requirement), which Spain approved the following year. The HLCORD gives a relatively precise description of the requirements that the NGWS must meet as the core of the national FCAS of each of the programme's participating countries.

To obtain these shared specifications of the military needs, the two countries needed to agree on the missions to be carried out. The system must be **versatile**, incorporating France's request to **be able to land on an aircraft carrier** (whereas Germany does not have an aircraft carrier) and Germany's need to carry out the NATO missions taken on by the German air force. So the goal will be to build a system with Germany and Spain that meets the widest range of needs (which essentially matches the needs of the French army since it takes on the broadest missions). This future aircraft's "survivability" is underscored, as well as its ability to interoperate with NATO and EU resources. It must be able to conduct operations in contested airspace and engage all types of air defence. **Above all, the HLCORD specifies that the FCAS's performance will be collective and derive from the ability of each of its components to interact with the others.**

B. THINKING IN TERMS OF A "SYSTEM OF SYSTEMS": A NEW REQUIREMENT

1. The FCAS's architecture

In 2040, threats will have evolved a great deal. Long-range air defences and access denial systems, currently expanding with the export of Russian systems (S400 and later), will become more widespread. Aircraft stealth will be generalised, and the enemy will systematically use cyber defence resources, drones in swarms or otherwise, and high-velocity missiles. The integration of land/sea/air/space defences and cyber capabilities will itself be much more developed. Thus, the stakes for future combat aviation will be to be capable of establishing and maintaining air superiority to be able to act in the third dimension, on land and at sea.

Building the FCAS thus requires a **paradigm shift**. **System-based threats must be responded to by an FCAS itself built as a system to conduct "collaborative combat"**. Thus, the FCAS must include several components themselves laid out in several circles.

- The first circle is the NGWS (next generation weapon system) which encompasses:

- **a combat aircraft (expected to be manned at this stage)**, the NGF, capable of completing interception and air-to-air defence missions, as well as dissuasion missions for France. Thus, it seems necessary to maintain a piloted aircraft, in particular in cases where the decision to intervene includes a significant political aspect. Also, non-piloted systems are more exposed to jamming or the destruction of their long-range data link (satellite). However, this aspect is no doubt subject to change (see Part III);

- **remote carriers** that can weigh anywhere from a kilogram to a tonne; unmanned machines with capabilities of saturation (sending swarms to saturate enemy defences), decoying, intelligence (before and during the mission), or to strike against highly defended targets. Some of them can be retrieved by returning directly or retrieval on the field; others will be consumables similar to munitions. They will be equipped with a certain amount of **autonomous capabilities** (artificial intelligence) to face the threats that they might encounter ahead of combat aircraft.

Remote carriers: versatile tools of combat in the future

There are many possible applications for remote carriers, which can weigh from a few kilograms to several tonnes: penetrating enemy defences by saturating them through sheer numbers, decoying enemy aircraft, carrying out electronic warfare missions (jamming), designating targets for other aircraft, carrying out reconnaissance missions, launching missiles instead of combat aircraft, etc.

In particular, MBDA is looking at smaller remote carriers, which would be "consumables", i.e. they would not be retrievable. They may be equipped with an explosive charge so that they can be destroyed in case of loss, so that the enemy does not benefit from their technology. These small remote carriers will also need to be inexpensive as they will have to be used in large numbers.

Airbus is working on larger remote carriers, potentially weighing several tonnes, which would be jettisoned from large aircraft (A400M). They could be retrieved on the ground or in the air while the larger ones could be equipped with landing gear. Accompanying manned aircraft, they would be "loyal wingmen" capable of carrying out combat operations, defending manned aircraft and gathering intelligence.

- all within an **"air combat cloud"** that connects all the platforms to allow for collaborative combat.

- For France, the second circle will include future versions of Rafale, satellites, refuelling aircraft, radar planes, navy ships, resources of allied forces, etc.

All the elements that make up the two circles must be able to communicate with each other constantly so as to constitute a team directed by the pilots of combat aircraft. Thus, interoperability, connection and

dialogue between platforms **within a "combat cloud"** will be essential. **Military capabilities will lie less in the unitary performance of its individual components (platforms, sensors, carriers) than in the way they are combined.** In particular, this system could decide which platform will attack (drone, missile) and which platform will stay behind according to the threat or how the situation evolves.

In any event, **attack formations should comprise fewer combat aircraft than at present**, numbers being provided by the various remote carriers whose attrition is more acceptable since they will be unmanned and potentially cheaper, taken individually, than a combat aircraft.

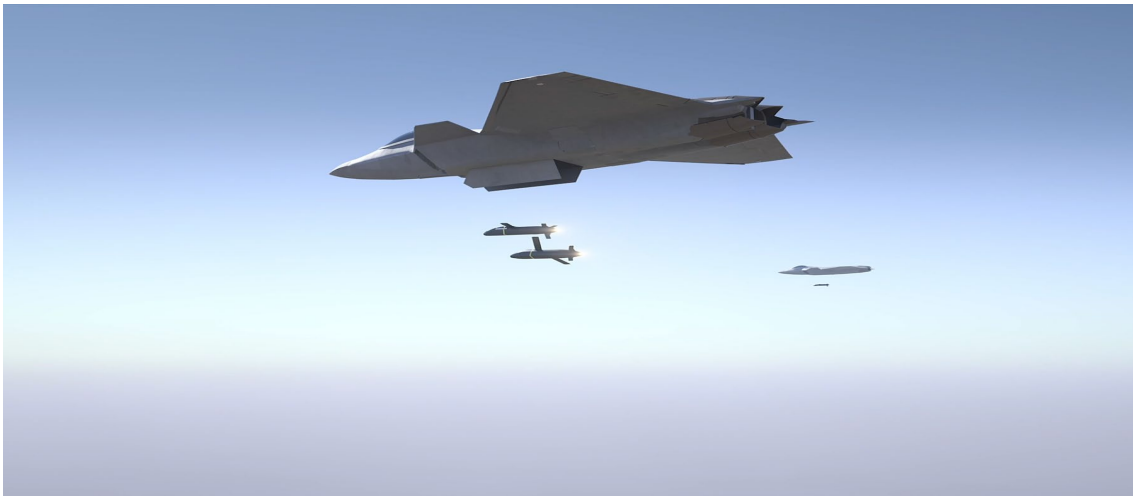


Illustration: MBDA

2. Necessary innovations

To meet the needs in 2040 and remain competitive through 2080, **the FCAS must be highly innovative.** The goal is not just to maintain effective combat superiority in the face of the means adversaries may deploy **but to be attractive for exports.** Only a system **including one or more totally exclusive and innovative bricks** will be competitive against competitors who are very experienced in arms exports.

The new "system of systems" organisation provides essential innovations in the following sectors:

- **aircraft technology:** better propulsion thanks to a hotter engine (see below) and variable-cycle technology, better stealth, and better manoeuvrability. The combat aircraft, which will be optionally "dronified", remains at the heart of the FCAS. The programme's directors clearly intend to regain the lead in 2040 over current and future adversaries and competitors with a combat aircraft equipped with the best capabilities possible at that time.

- **sensor technology** with the development of antennae that combine radar, listening, communication and electronic war.

- **remote carrier technology**, with breakthroughs needed especially in terms of cost reduction for consumable drones, miniaturisation and swarm flight.

Three domains of technological innovation call for special development: connectivity and combat cloud, artificial intelligence, and the new engine.

3. The challenges of connectivity and the combat cloud

The aspects related to connectivity will be essential. This is likely to include a high-speed intra-patrol link, a high-speed satellite link and, possibly, optical links (see box below). Cyber security will also be a key issue for the system as a whole. The FCAS must also be able to function without connectivity in case of a total loss of connection. On all these aspects, the Air Force is currently developing the Connect@aéro¹ project taking into account existing systems, be it the Syracuse 4 satellite, the Omega navigation system, or the Rafale F4 for which the connectivity brick will be central.

Correspondingly, data management will be an essential aspect of the FCAS. The extreme amount of data produced by the many aircraft that will make up the FCAS must be sorted, processed and analysed to provide the best information possible to the operators.

Currently, the Rafale is already networked, but the pilot mainly uses their own sensors and, to a lesser extent, information provided by the network. Many data from the aircraft's sensors are not shared. The new generation of air combat will go hand in hand with better sensor capabilities, better use of the electromagnetic spectrum, increased storage capacity, artificial intelligence to extract and process data, heterogeneous data fusion tools and architectures, integrating raw data from on-board or remote sensors which are already used in isolation by 5th generation aircraft (F22 and F35), and, finally, better diversity and speed of application development. Thus, on the FCAS the network must manage the data transfers independently of the pilot, who will only see the merged data. They will supervise the overall process. Ultimately, it will be a paradigm shift: **a switch from a data exchange dictated by the network's format to data being at the heart of the system.**²

The end goal of the tactical cloud is to **speed up decision making and execution** to obtain tactical superiority.

¹ For the French Air Force, Connect@aéro is a step-by-step approach to digitisation beginning now, ensuring the gradual and then enhanced connectivity of air resources, command centres and air bases. Connect@aéro will guarantee this digital transformation to deploy airborne and ground communication architectures and structure data and operational services gradually and coherently.

² See "The 'tactical cloud', a key element of the future combat air system", FRS, 19 June 2019.

One of the crucial aspects of the cloud and the data links will also be their resilience to cyber-electronic threats: the NGWS will probably function in a highly constrained and scrambled electromagnetic environment, which will require the ability to operate without connections.

The key issue of satellite communications

The FCAS will rely a great deal of data being exchanged via a network of all actors. Control of these exchanges is fundamental and represents a real issue of sovereignty without jeopardising the search for very high interoperability(...).

Today, combat aviation is at the beginning of the system of systems concept. Connectivity between the various vectors is already a reality, but it is still somewhat partial and limited: the Rafale's F4 standard that foreshadows the ultra-connected combat aircraft is the first to implement satellite communications as standard.

The space aspect will play a predominant role in the FCAS's operational capabilities by providing the essential bricks to building the "system of systems", considering the reactivity, length and speed of travel that characterise airborne vectors. Conversely, the FCAS could also contribute to the space domain.

Exoatmospheric space has become an essential link to each step in the cycle of operations, from knowledge about our centres of interest to evaluating our actions on our enemies through the planning and execution of our operations. Space provides many services such as satellite communications, positioning, navigation, time synchronisation, early warnings, meteorology, and space surveillance and listening. These capabilities provide a major distinguishing advantage by reducing uncertainty in combat situations. They allow us to access areas that cannot be reached by land, sea, or air. Monitoring areas of interest from space, by observing and listening, contributes to planning and conducting operations as well as national autonomy in assessing situations, by allowing us to gain information about enemy provisions and intentions or to carry out general early surveillance. It aids in tracking, targeting and engaging the adversary and is a way to assess battle damage. ISR (intelligence, surveillance, and reconnaissance) support provides a better understanding of the situation, in particular for alerting units and appreciating how friendly forces disrupt the adversary. In the field of permanent strategic surveillance, it contributes to finding and anticipating potential risks and threats.

Nevertheless, space's support requires changes for future operations. The precision required for operations requires data that is reliable, calibrated, current, and distributed in near-real time. Satellite images allow an objective to be identified, but its constraints make it incompatible with on-board real-time operations: the revisit frequency will be an essential parameter to approaching permanence.

Protection against new threats such as high-velocity missiles will rely on early warnings. It will be necessary to detect and characterise launches, provide early warning, assess impacts and identify potential countermeasures for FCAS objects requiring them.

In addition to the extension of the new vectors and their very high connectivity, FCAS will be characterised by the integration of remotely controlled and/or automated vectors. Satellite communications allow for remote piloting and communications independent of geographical constraints. For vectors using Satcom, operational mobility becomes vital, as does overcoming coverage constraints around the globe and accessing frequencies (Ka, Ku, X, or using laser communications). The availability of Satcom resources becomes critical. It must be the subject of precise planning and will require great robustness (particularly cyber) and resilience. Operating with a wide variety of objects requires these objects to be highly coordinated. Position, navigation, and time (PNT) data are already essential; they will be more so in the future. The aim will be to guarantee forces the use of reliable and accurate location information to better train, plan and conduct their operations (for better accuracy and to limit the risk of collateral damage). In addition to coordinating operations, controlling time allows the information networks and systems to function in terms of synchronisation and security.

Finally, Navigation Warfare (NavWar) will continue to spread, coordinating defensive and offensive actions to guarantee the use of PNT data for friendly forces and deny it to their adversaries. FCAS objects must not only be protected against this but may potentially play an offensive role in this field. Finally, FCAS systems could provide tactical support capability to space operations. The most futuristic approaches imagine the NGF fighter plane contributing to the FCAS to put small short-life satellites into orbit by carrying a rocket/missile under its fuselage, thus providing great responsiveness.

Source: Jean-Pascal Breton | No. 118 - Le Spatial, 1 June 2019

(Jean-Pascal Breton is the operational manager of the FCAS programme.)

The FCAS will also **be an open system** capable of interconnecting and interoperating all the weapons systems together. This approach is new: even the United States has tended to implement closed systems until now. The F35, despite its modernity and its performance, is a rather closed system, which explains the difficulties it has in working outside its own network.

This does raise the question of **the authority that is able to impose the standards of this interoperability**, however. One possibility would have been to integrate into the American standards that support the F35. However, that would also have been a significant blow to Europe's strategic autonomy. So instead, France decided to develop its own cloud with Germany and Spain, which implies then working on NATO interoperability. In concrete terms, FCAS countries must be able to develop an interoperability standard that will substitute NATO's Link 16 based on American technology and which cannot be used outside the United States without their agreement (see the EcoWar programme already covered, page).

4. Artificial intelligence

Artificial Intelligence (AI) will be essential to the FCAS's performance. It will act as a virtual assistant to the pilot, capable of helping

them to take decisions by sorting the most relevant information from the sensors to avoid saturation and reduce stress in combat. The AI will also help to automatically generate mission plans, adjust sensors to the terrain and predict maintenance. It will also play a role in cooperation between drones. AI will play an essential role both within the NGF and for remote carriers.

Developments related to AI touch on a wide range of fields, in particular issues of military organisation and ethics (the use of lethal force/the laws of war). In any case, for now, FCAS programme leaders consider artificial intelligence as a way **to increase human capabilities as they will remain at the heart of the system, instead of as a way to replace them.**¹ In this spirit, the Armed Forces Ministry launched **the "Man Machine Teaming" (MMT) project** on 16 March 2018 with the precise goal of preparing the artificial intelligence technologies needed for future combat aviation. A contract was awarded to Dassault Aviation and Thales. As part of this programme, a quarter of studies will be awarded to laboratories, innovative small businesses and start-ups specialised in artificial intelligence, robotics, and new human-machine interfaces. The goal is to develop technologies that will benefit both a modernised Rafale and the future FCAS. Two calls for projects have already been launched to select companies.

The Man Machine Teaming project

This project seeks to equip the various machine systems with greater autonomy and artificial intelligence **"to serve an expanded and redesigned human-machine relationship"**. In this perspective, these intelligent systems would no longer be limited to just executing actions requested by an operator. It would allow for collaboration that would make operators' actions and decisions more efficient and effective while saving their mental and physical resources.

For this, these systems will be equipped with an increased knowledge of situations using various means of perception and analysis (operators' conditions, interactions, predicting actors' intentions, tactical combat situations, etc.). This capability will allow systems to learn from the situations it encounters, adapt to the consequences and share relevant information to support operators' decision making and planning. To ensure the high level of performance needed for missions to succeed, this **Cognitive Aerial System** will also include new ways of interacting that are more natural and suitable to the situations that operators encounter.

In this context, the role of the MMT project is to begin identifying technologies that might be integrated into this Cognitive Aerial System. Should these technologies not be mature enough, MMT's mission is to help develop them. One of the things that makes this project original is its goal of developing technologies in collaboration with an ecosystem of French start-ups, small businesses and research institutions that are already involved in exploring, using, or producing these emerging technologies.

¹ *We are far from the "technological singularity" predicted by certain science fiction authors (Vernor Vinge) and futurologists (Ray Kurzweil) who hypothesised that artificial intelligence would suddenly cross a threshold that would place it out of human control.*

To structure this approach, the MMT project is broken down into six areas of technological development: (I) Virtual Assistant & Smart Cockpit, (II) Interactions, (III) Mission Management, (IV) Intelligent Sensors, (V) Sensor Services and (VI) Implementation & Support.

Source: the Man Machine Teaming project

5. The challenge of designing a new engine

Developing a new engine for the propulsion of the NGF is one of the main challenges of the FCAS programme.

a) An issue of strategic autonomy

Once again, this is foremost an issue of strategic autonomy for Europe: maintaining its capability of producing a combat aircraft engine like the United States, the United Kingdom, and Russia. China is also making big investments in this field.

In particular, it is a central issue for SAFRAN, who helps to produce civilian engines but only for the "cold parts" (low-pressure parts considered less "cutting edge" than the hot parts), in partnership with General Electric (GE) on the CFM56, the engine for Airbus's A320, as part of the CFM International 50/50 joint venture. This way, the FCAS should help SAFRAN to maintain its capabilities in the "hot parts", including on civilian engines, even though the company has not produced engine hot parts since the Rafale's M88.

b) A technical challenge

The technical challenge for a combat aircraft consists in obtaining the most powerful and most compact engine possible.

The Rafale M88's maximum thrust is 7.5 tonnes (with versions of more than 8 tonnes possible). This thrust is less than its direct competitor, the Eurofighter's J200 (9 tonnes), a heavier aircraft than the Rafale, and much less than the Pratt & Whitney F135, the F35's engine (up to 20 tonnes of thrust for a heavier single-engine aircraft than the Rafale). **The objective is to reach at least 12 tonnes of thrust for the engine that will be equipped on the FCAS's NGF, since this aircraft will necessarily be bigger and heavier than the Rafale.** More power implies a higher operating temperature. Currently, the F35's engine has a significant advantage over the Rafale M88 engine in the matter.

The DGA has awarded Safran a contract for an upstream study programme (PEA), Turenne 2, in the amount of €115 million to work on

increasing the power of the M88, which could eventually be used on the Rafale and make progress on the FCAS.¹

The second challenge for the future NGF engine is to develop technological innovations that can maintain high thrust at supersonic speeds and reduce fuel consumption when cruising at low altitude. **Variable engine cycle technology**, by varying the proportion between hot and cold air flow, allows such a result to be achieved. In fact, this is a very active field of research for American engine manufacturers (experimental tests on the F35 engine).

These are considerable technical challenges. We should note that Pratt & Whitney and General Electric, two American engine manufacturers, have each received more than \$1 billion in 10 years to tackle them. **For the moment, of the €150 million planned on 20 February 2020 for the FCAS's phase 1A, €91 million are allocated for the aircraft and only €18 million for the engine.**

During their hearing, Safran's representatives clearly indicated that they were aware of the challenge that needed to be addressed to create the NGF's engine.

6. A necessarily incremental approach

To be able to adopt the technologies as they emerge by integrating new capabilities into the programme as it develops, **it must take an incremental approach.** This gradual change in operational capabilities is also needed as part of the upcoming changes to the Rafale, which will accompany the NGF for several decades.

Thus, according to MBDA's representatives, a cooperative combat system could be developed before 2030. This stage could be reached as part of a Rafale F4 and the Connect@aero project. Then, in the early 2030s, features of collaboration between the aircraft and between aircraft and carriers (arms and the first remote carriers) could be implemented. The Rafale F5 and the Typhoon LTE could be an opportunity to implement this stage of capability. Finally, after 2035, we could see a gradual deployment of the components of the Next Generation Weapon System.

C. THE FCAS'S POLITICAL AND INDUSTRIAL STAGES

The decision to launch the FCAS programme was initiated by **the CFADS resolution of 13 July 2017** in which France and Germany agreed to develop a European air combat system, reflected in the signature of the HLCORD signature already discussed and by the announcement of the

¹ *The goal would be to go from an engine that can handle a temperature of around 2000 degrees K instead of the 1850 degrees K for the current high-pressure turbine.*

Dassault/Airbus agreement in principle in April 2018 at the ILA trade show (Berlin's international air show). It was announced that **France would be the programme's national leader and Dassault the international leader** in return for German leadership of the European MALE drone and the future combat tank (MGCS).

1. The joint concept study

France and Germany awarded Dassault Aviation and Airbus the **joint concept study (JCS)** for €65 million on 6 February 2019.

Conducting such a joint concept study is a departure from the usual weapons programme philosophy. The JCS will clarify the HLCORD by analysing the various operational levels and translate them broadly into technological specifications (aircraft dimensions, number of decoy or saturation drones, the bandwidth needed for data transfer, etc.), i.e. the **preferred basic concepts** for the next generation combat aircraft, the drones, a system of systems and the related next-generation services. It also seeks to identify shared technological needs and demonstrators.

The JCS is entrusted to two teams under the control of the DGA acting on behalf of the two countries, a French team led by Dassault that includes MBDA France, Safran Aircraft engines and Safran Electronics and Defence, Thales DMS and Thales SIX, and a German team led by Airbus DS with MBDA Germany, Diehl, Hensolt, R&S, MTU and ESG.

The JCS will **continue until the first half of 2021**. Interim results on about ten architectures are expected in summer 2020, and the most promising target architectures will be selected in October and then fine-tuned until the study ends. Finally, they will be recalibrated according to the result of the demonstrations until production starts.

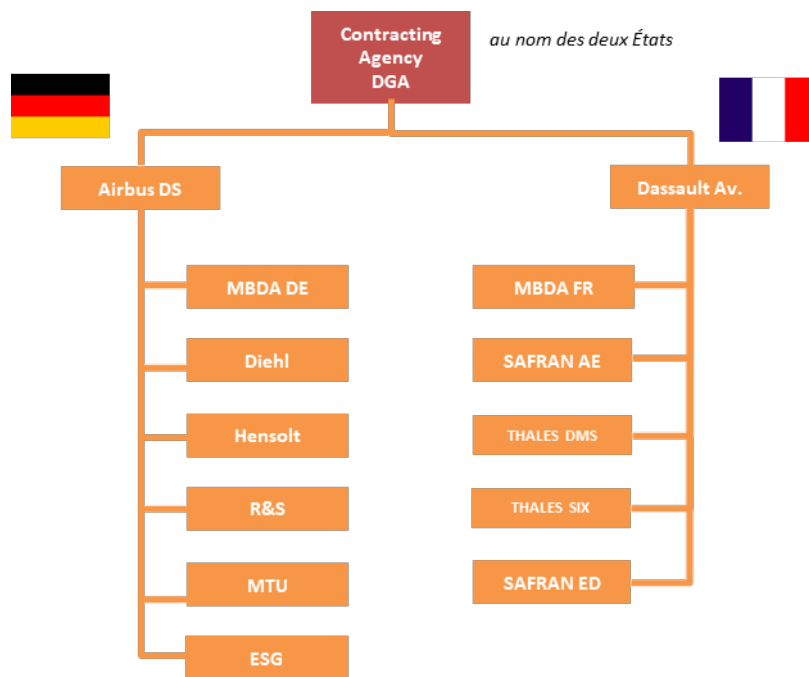


Diagram source: MBDA

2. Organisation in pillars, phase 1A of the demonstrator

a) Why one or several demonstrator(s)?

Creating one or several demonstrators is now planned (a demonstrator of the future combat aircraft, a demonstrator of the engine on the ground and, possibly, a later fighter drone demonstrator) for 2025 (or 2026 given the delay due to the length of Franco-German negotiations in 2019).

Making a demonstrator is not self-evident. Traditionally, weapons programmes go through a prototyping sequence which occurs at the end of the process. Prototypes are used to make the final adjustments, but these are devices that are nearly identical to the ones that will be produced. Demonstrators, on the other hand, arrive much earlier in the process, and these are not nearly finished products. Rather, they *represent* the definitive device in an incomplete way (the scale is not necessarily 1:1 nor built with the same materials as the definitive device) and highlight poorly understood aspects that need to be explored to avoid errors, for example, in aerodynamics or communication systems. It is also an intermediate step, an approval step that can be used to reorient development in the right direction to **reduce the very significant gap between today's technologies and the very advanced technologies that will ultimately be implemented**. The FCAS's demonstrator will help to combine the Rafale's handling and the Neuron's stealth in a single combat aircraft.

According to the programme directors that the mission heard, the same level of confidence in the technologies cannot be reached by computer

simulation alone. **Only a demonstrator can remove risk from the project by testing the technologies for a reasonable cost, while errors can be very costly if they are only discovered when the product is finalised**, both for the manufacturers themselves who have committed themselves to specifications they cannot fulfil and for the governments who see the programme go out of control. Once again, the errors of the A400M are often held up as an example, but we could also discuss the F35, for example, which is now encountering problems with its stealth coating at supersonic speeds.¹

b) A delay of a few months due to difficulties in the Franco-German negotiations

At the Paris Air Show in June 2019, the French president and German, French and Spanish defence ministers attended the presentation ceremony for a model of an NGF concept of 18 metres long (1:1 scale) at the Dassault Aviation stand. Two remote carriers, one manufactured by Airbus and the other by MBDA, were also shown at the event. **At the end of the ceremony, several government and industrial framework agreements were signed.** Defence ministers from the three countries signed a framework agreement that definitively formalised Spain's participation. Meanwhile, Dassault Aviation and Airbus signed an industrial agreement and filed a joint industrial offer with the DGA for the FCAS's initial demonstration phase (phase 1A), planned for 2020-2021.

The demonstrator's development contract could not be awarded at the Air Show **due to difficulties between Safran and MTU around the industrial organisation for producing the NGF's engine** (see below). The organisation decided at the government level (with Safran as prime contractor and MTU as main partner) was called into question by German stakeholders who contested the French engine manufacturer's leadership because it would penalise German industry. However, difficult negotiations resulted in a new agreement in early 2020 with the creation of a new joint venture between Safran and MTU.

An additional challenge came from the **link established by Bundestag MPs between the FCAS and the MGCS** (see box below). These MPs felt that the place reserved for German industry in the latter project could be improved.

¹ However, we should note that the competing British programme Tempest does not include such a demonstrator at the moment. The project's participants told the mission that, for them, technological solutions can be tested on the ground through simulations.

The difficult negotiations on the industrial organisation of the future tank MGCS (Main Ground Combat System)

On land, France and Germany have been working since 2012 on a shared vision of their needs to replace combat tanks (the Main Ground Combat System - MGCS project) to replace the Leclerc and Leopard tanks. The letter of intent signed on 19 June 2018 during the ministerial seminar at Meseberg confirmed the shared desire to begin preparing a new phase of cooperation under German leadership to prepare a demonstrator of the future MGCS in 2024 which should lead to the first deliveries in 2035.

Initially, Franco-German authorities had sent a document to the three manufacturers concerned (Nexter, Krauss-Maffei Wegmann and Rheinmetall) proposing the following allocation of tasks: 50% for Nexter, 25% for Krauss-Maffei, and 25% for Rheinmetall. However, Rheinmetall executives wanted to take control of KNDS (the holding company that resulted from the joint venture between Krauss-Maffei Wegmann and Nexter) threatening the balance between France and Germany. **The Bundestag's budget committee, which has the power to authorise or reject any project that reaches €25 million, blocked the MGCS programme.**

Finally, an agreement was reached between the three manufacturers. **On 28 April 2020, the German defence minister announced that the two partners had signed two agreements:** a framework agreement and implementation agreement that allows for a contract for a study to define the future system's architecture. The first architectural studies contract awarded, which will last 18 months, is worth €30 million: €15 million for French industry (with Nexter as prime contractor) and €15 million for German industry. While France is keeping 50% of the workload on MGCS, the three manufacturers will share responsibilities equally on the future tank. The architecture study contract will be broken down into nine batches which will be divided equally among the three manufacturers.

Finally, FMCS, the federation of German manufacturers (bringing together missile manufacturer Diehl, Hensolt, the former division of Airbus specialised in radars and sensors, ESG and Rhode & Schwartz), also wanted to be more involved in the project, feeling that it was disadvantaged by the choice of Airbus as the prime contractor in the Remote Carrier and Cloud fields.

c) The seven demonstrator pillars

In early 2020, the Bundestag approved the funding for the programme's first R&T contract (phase 1A)¹ in **the amount of €155 million**, with equal funding from France and Germany (€77.5 million each: around €90 million for the aircraft, €18 million for the engine, €20 million for the remote carriers and €15 million for the cloud) with a duration of 18 months.

¹Phase 1B seeks to define the architecture of the aircraft demonstrator. The following phase (phase 2) will take this architecture down to the finest level and then produce, test, assemble and, finally, flight-test the components.

The framework agreement for the launch of phase A1 was signed in February 2020 by the DGA and the manufacturers concerned.

The Research & Technology (R&T) study plans for **an organisation in five pillars, with each pillar having one manufacturer as prime contractor and one as a main partner** who is more than a "simple" subcontractor. In 18 months of work, this phase must result in the specifications of the upcoming demonstrations and justify them with operational concepts and techno-operational analyses from the Joint Concept Study.

After identifying a set of needs shared by the two countries, **this step helped to implement an essential aspect of the programme: designating a true industrial prime contractor for each pillar and for the whole project.** This is an organisation that seeks to take into account the errors and failures of the past. The countries that are participating in a programme of this magnitude can no longer allow for costs and planning to go out of control as it did for the A400M:

1st pillar: NGF combat aircraft (Dassault prime contractor and Airbus DS main partner),

2nd pillar: Engine (SAFRAN and MTU),

3rd pillar: "Remote carriers" (Airbus and MBDA),

4th pillar: Tactical or combat cloud (Airbus and Thales),

5th pillar: "Simlab", overall coherence (Airbus, Dassault, Safran and MTU as well as MBDA and Thales as subcontractors),

Two new pillars will be added to these five during 2020: "sensors" and "stealth".

This project organisation seeks to respect the "best athlete" principle: each company is in charge of the area in which it has already demonstrated its skills in previous programmes (and not in the field or fields in which it would like to develop new skills or break into new markets).

In reality, the organisation chosen is not entirely consistent from one pillar to another. It varies according to the specific content of each of the agreements between the manufacturers and reflects political checks and balances:

- For example, concerning the cooperation between Dassault and Airbus on the **first pillar (combat aircraft)**, it is based on a reference agreement between the two manufacturers in 2018. They agreed to Dassault Aviation's leadership on the NGF part while Airbus was given leadership on the "system of systems" aspect, originally understood as encompassing the project overall rather than as one of the pillars. Now, in the organisation approved in February 2020, Dassault is the prime contractor and Airbus the

main partner on the Fighter Aircraft pillar. The two manufacturers set up a virtual platform during the coronavirus crisis, a platform which became physical in June 2020. Cooperation will take place using digital tools shared by France and the Airbus site in Manching, Germany, and calls for bids will be sent to the supply chain. The two manufacturers will report regularly to the DGA and the German defence ministry.

While Airbus's representatives highlighted their company's long experience in programmes with international cooperation, Dassault's representatives underscored the cooperation on the "Neuron" combat drone demonstrator (2012-2015) that brought together six countries and, according to the manufacturer, was a test of efficient collaboration thanks to leadership that the partners had clearly understood and accepted. The Alphajet is also an example of successful cooperation, according to the aircraft manufacturer.

- **On the engine pillar**, Safran is the prime contractor and MTU the main partner.

German company MTU is a supplier for engine parts, modules and components for engine manufacturers such as Safran and Pratt & Whitney. They also maintain, service and repair aircraft engines. It's a reputable company that has participated in the creation of many engines (such as the J200 on the Eurofighter Typhoon). For two decades, Safran has worked with MTU (Alphajet, A400M, etc.): it is a partner and competitor that the engine manufacturer knows well.

A letter of intent from February 2019 and signed by the two manufacturers detailed the breakdown of tasks between them. It specifies that "*Safran will be responsible for all the design and integration of the engine and MTU Aero Engines will be the leader for services*". The partnership includes a breakdown of roles according to each company's specialities: Safran will be responsible for the combustion chamber, the high-pressure turbine and the afterburner ("hot" parts), and MTU will be responsible for the low- and high-pressure compressors and the low-pressure turbine ("cold" parts). After negotiations that took place in late 2019, they decided on the creation of a 50%/50% joint venture at the end of 2020 to carry out development, production and after-sales support activities for the new engine. This company will also hold the contracts and rely on the skills of the two parent companies.

- Airbus DS signed a partnership agreement with MBDA for R&T **on the "remote carriers" pillar**. According to this agreement, Airbus DS has the position of prime contractor and MBDA their main partner. MBDA will participate in all the tasks, including system architecture. The partners' precise roles will evolve as the remote carrier field is structured following the joint concept study (JCS) and the initial R&T work. For now, it is expected that MBDA will focus more on small remote carriers and Airbus on large machines and connectivity, in accordance with the "best athlete"

principle. ADS and MBDA will call on the French and German entities of each company. It should be noted that MBDA has direct access to the DGA, the contracting agency. Therefore, it is indeed a partnership with Airbus DS and not a traditional subcontract.

- **On the Combat Cloud pillar**, Thales is the main partner of Airbus Germany, which, according to the terms of the agreement made with Airbus, allows it to dialogue with the DGA directly, similar to MBDA.

- **On the "sensors" pillar**, FCMS (Hensoldt, Diehl Defence, ESG and Rohde & Schwarz) and Thales have been joined by **Spanish company Indra who will be the prime contractor** (the company won out over Airbus Spain to be the national project coordinator in Spain).

- **Regarding the "stealth" pillar, its content is still not well known.** This is a field that is strategically, operationally and industrially very sensitive. The partners are working on it, but sharing is more difficult in this field, at least initially, while waiting for the initial phases of cooperation to generate enough mutual trust.

In the field of stealth, Airbus revealed the LOUT ("Low Observable UAV Testbed") at its 2019 "Trade Media Briefing" on 5 November 2019. LOUT is an R&T project covering stealth that has been conducted and kept secret since 2010 for the German defence ministry. This project consists of a demonstrator hosted in an anechoic chamber in Manching, Germany. It is a test bench used for technologies that reduce radar, infrared, visual and acoustic signatures. Similarly, on 20 February the *Direction Générale de l'Armement* announced the end of a **flight test campaign using the Neuron**, Dassault's stealth drone demonstrator, with the support of the French armed forces.

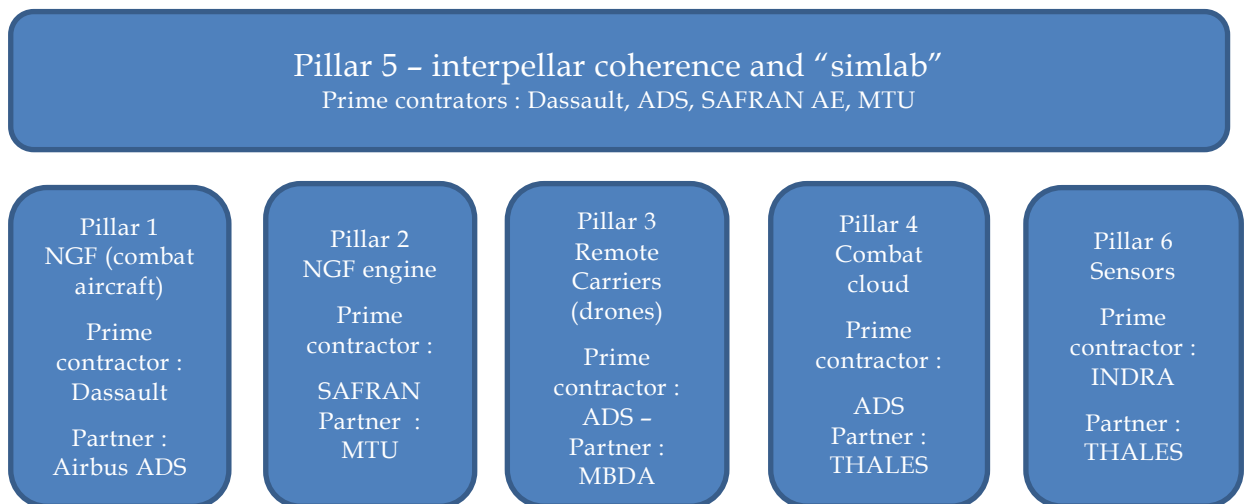
While the FCAS programme will evidently include a significant aspect of stealth in both the NGF and the remote carriers, this should not be its main asset. General Philippe Lavigne, Chief of Staff of the Air Force, stated that *"it is important to understand that we must be strong in all fields. Developing high stealth is necessary. This does not mean that we bet everything on stealth. If we are the best in jamming, saturating and transmission, in the end we will be better than our adversaries."*

- **The "simlab" or "coherence" pillar** will work to coordinate all the other pillars so that they progress together even though they require very different technologies, notably through the end-to-end simulation of all the project's aspects. **It is also a pillar where artificial intelligence, a significant part of several other pillars, will play an important role.**

While they are each led by a prime contractor/main partner pair, each pillar also involves many other manufacturers acting as traditional subcontractors.¹

Spain joined this organisation gradually. Airbus Spain will participate in the NGF and stealth pillars. Indra, as already discussed, will be the prime contractor on the "sensors" technology pillar. ITP will work on motorisation while a consortium of Sener, GMV and TecnoBit should contribute to the "remote carriers" pillar.

The six pillars already identified, to which a "Stealth" pillar will be added:



d) Work is progressing despite the coronavirus crisis

The manufacturers launched the phase 1A work despite the coronavirus crisis. The project team also began the following phase to stay in line with the objective of launching a new phase of works in 2021 that should lead to the demonstrator in 2026.

Meanwhile, **intense work continued during this phase to complete the integration of Spain's part.** The contracts involving Spanish manufacturers should be signed in July 2020.

¹ Furthermore, a company such as Thales is potentially involved in all the pillars.

3. Ad-hoc governance and an innovative organisation of government/industry relations

a) A specific organisation

A **specific governance** has been implemented for the FCAS programme. In France, a working group (GTSCAF) was set up between the DGA and the air force staff working on delegation from the armed forces staff. The DGA intervenes through certain divisions or sub-divisions. Internationally, **a project team under General Jean-Pascal Breton has been set up** in Arcueil with GTSCAF for France and counterparts from Spain and Germany, with a programmatic division and an operational division.

The DGA is the contracting agency for the entire project on behalf of all partners: French, German and Spanish.

Additionally, in his hearing, General Breton highlighted the need to develop a new system engineering approach in government/industry relations to better "capture the need". To this end, **a shared working environment between government and industry has been set up for the first time based on Dassault software**. It will also use end-to-end simulation for the first time.

The project's richness and complexity also entail mobilising the creativity of the civilian sector, either through the project's manufacturing prime contractors or through start-up accelerators. This is the case for the "Man-Machine Teaming" upstream study programme already mentioned.

b) The role of the defence innovation agency

Also, on the French side, the *Agence de l'innovation de défense* (AID - Defence Innovation Agency) will also play a significant role through several of its structures. These structures allow us to look to the future in varying degrees:

- the "defence technology projects" carried out following the needs statements by the EMA and DGA, in cooperation with the DGA's technical division, operations division, and the defence system architecture department. These are the former "upstream studies" used to fund studies to remove risk from the aspects related to artificial intelligence, materials and stealth, which we know are necessary for the project **in the near future**.

- the "innovation acceleration projects" intended to capture civilian innovation to project ourselves further into the future by developing **technologies that are not yet mature** today.

- research projects that allow us to imagine **technologies that do not exist yet**, for example in the field of quantum radars or neuroergonomics.

- Even more prospectively, **the new "Red Team"**, which is being set up by recruiting science fiction authors or futurists, will be responsible for

coming up with new and unforeseen political, geopolitical, technological or social environment scenarios to "challenge" AID staff and their ability to adapt to these scenarios.

All these mechanisms have an important role to play to allow the FCAS to be truly innovative, maybe even revolutionary in 2040.

III. MEETING CHALLENGES FOR A SUCCESSFUL FCAS

Given the large number of domains that it encompasses, the technological leaps to be made, the duration required for its development and the nature of the project led in international cooperation, the FCAS programme is a challenge both for public authorities and for the manufacturers in charge of leading it to completion.

A. DO NOT GET THE PROJECT WRONG

All project stakeholders strongly agree: **the FCAS is not a combat aircraft project but a "system of systems" project, of which the aircraft is just one part.** While it is a central part, it is not the most innovative, since the innovation lies more in that which connects and drives the platforms toward collaborative combat (the combat cloud, artificial intelligence, as well as sensors, etc.) than in the platforms themselves. Also, while many countries have combat aircraft programmes, very few have such programmes for an air combat system of systems.

In any case, it is important to keep this "system of systems" nature in mind at each step of the project since its added value will mainly come from its ability to **embody the concept of collaborative combat** in a series of innovative platforms and technologies. Furthermore, it will be necessary to **look well beyond 2040** to 2080: the FCAS must not be obsolete as soon as it is commissioned.

1. Putting artificial intelligence and autonomy capabilities at the heart of the FCAS's development

The HLCORD, the single document that expresses all the FCAS's needs, stipulates that the NGF (Next Generation Fighter) can have a pilot on board or will be "optionally" piloted.

For the moment, as already discussed, the role of drones and remote carriers, while important, is designed **to be subordinate to the NGF which will, in principle, be manned.** For the most advanced drones, the model used is a "Loyal Wingman", i.e. a drone that accompanies or precedes piloted combat devices to carry out a variety of tasks: strikes, surveillance, electronic attacks, decoying and battle damage assessments.

Russia (Sukhoi S- 70 Okhotnik- B) and the United States (Kratos XQ-58A Valkyrie in a programme launched in July 2016, the "Low-Cost Attritable Strike Unmanned Aerial System Demonstration" and Boeing's "Loyal Wingman" programme developed in partnership with the Australian Air Force), the United Kingdom ("Lightweight Affordable Novel Combat Aircraft" with, initially, the awarding of three initial design contracts to Blue Bear Systems Research, Boeing Defence UK and Callen-Lenz) are developing such "loyal wingman" programmes.

Considered as a remote carrier or sensor, piloted devices must remain in control of the "loyal wingman".

Being able to fly a drone by itself without support from a piloted device runs up against the **fragility of the satellite data link, which can be hacked or jammed** in disputed areas.¹ The drone would then become uncontrollable. By remaining integrated within a formation directed by the piloted aircraft, the drone can use a local network that, while it too can be jammed, is much more resilient.

However, even in this situation, artificial intelligence is fully required to offload the pilot's simplest tasks, aid in decision-making and avoid the loss of drones in case the data link is severed.

The United States is quickly developing this use of artificial intelligence to support piloted combat aircraft. AI is installed on a loyal wingman, in a combat aircraft transformed into a drone or directly on the cockpit of the piloted aircraft. **The Skyborg programme** is studying the ability of having an "in-board" piloted combat aircraft (which, in this case, could be an F35 or the new, modernised F15EX) + a "wingman", a drone equipped with artificial intelligence, which could be an XQ-58 Valkyrie.

Furthermore, a way to overcome the difficulties of a long-distance data link is to consider **a fully autonomous drone** that does not depend on this data link. However, this situation raises two issues:

- an **ethical and legal** issue (see box below).

The issues raised by Lethal Autonomous Weapon (LAW) systems

On current armed drones, the targeting and shooting are always done by one or more human operators. It is this idea of a "human in the loop" that justified the drone falling within the same legal framework as other weapons systems.

¹ unlike uncontested areas such as the Sahel and Sahara where MALE drones can fly over the theatre of operations without really being threatened.

Conversely, "Lethal Autonomous Weapon" (LAW) systems, which do not exist yet, but which are the subject of scientific and military research, raise legal and ethical issues of another magnitude.

Some fear that the risk of armed conflict and the use of military violence will increase with the deployment of truly autonomous systems: LAWs do eliminate the psychological barriers to using lethal force, which is not the case for drones that are piloted by a human being (hence the post-traumatic stress syndrome sometimes seen in drone pilots).

There are also doubts about LAWs' ability to respect the principles of international humanitarian law (or the law of conflict). Given these concerns, a European Parliament resolution recommends prohibiting the development of LAWs.

Article 36 of the First Protocol to the Geneva Convention stipulates that a new weapon may be studied, developed, acquired or adopted only after it has been determined whether it might be contrary to the Protocol or to another rule of international law.

More specifically, respecting the key principles of international humanitarian law (IHL) (distinguishing between combatants and civilians, proportionality and minimising collateral damage, precaution) requires a use of judgment that, for now, is exclusive to human beings. In certain environments, distinguishing between civilians and soldiers can be very difficult. It may be necessary to analyse a person's behaviour to decide if it is some way "good" or "bad". It seems unlikely that algorithms will be able to make such a judgment. Conversely, certain legal experts highlight the risk that human soldiers might violate principles of IHL when under stress or fear, emotions to which LAWs are not subject. However, considering that the current rules suffice because robots are better able to respect them than humans is tantamount to claiming that it is ethically equivalent whether a human or a robot does the killing. On the contrary, we can view the development of autonomous systems as a paradigm shift that requires new rules since IHL was invented to be applied by human beings.

Furthermore, since we do not fear (or at least fear less) for a robot's life, we can imagine that they will ultimately be subject to stricter rules for the use of force than humans: for example, that it is necessary for a person to display a weapon or be unequivocally aggressive for them to be considered as a combatant and become a target, or that the robot be able to incapacitate its human target, but not kill them.

In 2014, the first informal meeting of experts on LAWs was held as part of the Convention on Certain Conventional Weapons (CCWC) at the UN in Geneva with France as chair. The third edition was held in April 2016 with 95 countries, the ICRC, numerous NGOs and experts attending. At these meetings, France's representation committed to not developing or using LAWs unless "these systems demonstrated perfect compliance with international law". However, it also considered that any preventive prohibition on developing LAWs would be premature. Since the debate focuses on the "significant human control" to which LAWs must be subject, the expression "appropriate human involvement", a bit vague but acceptable to all the participants, was adopted under the German delegation's initiative. Finally, some raised questions about the coherence of the concept of LAWs itself: for armed forces, doesn't the total autonomy and lack of a link to a human operator run counter to military command's overriding need for operational control?

In any case, these discussions in a multilateral framework led to the creation of a governmental group of experts. This expert group's work could lead to a code of good conduct and best practices for LAWs. According to certain experts, this code could include:

- limiting the use of LAWs to objectives that are military in nature (and not by location, destination, or use), to certain contexts (non-urban environments and those with few inhabitants) and only in cases where a person cannot make the decision themselves (subsidiarity),
- ensuring that the autonomous mode can be reversed,
- programming the "benefit of the doubt" into the LAW,
- recording the LAWs' actions,
- training LAW operators in IHL.

On 5 April 2019 at the DATA IA institute in Saclay, Armed Forces Minister Florence Parly **presented the new strategy on artificial intelligence and defence**. During this presentation, she discussed the ethical and legal aspect, stating that *"France refuses to entrust the decision of life or death to a machine that could act fully autonomously and beyond any human control. Such systems are fundamentally contrary to all our principles. They have no operational interest for a country whose armies respect international law, and we will not deploy them"*.¹ The minister added, *"we will develop artificial intelligence for defence according to three main principles: respect for international law, the maintenance of sufficient human control, and the permanence of command responsibility."*²

However, we should note that one of the minister's arguments is that artificial intelligence could contribute to a better application of international humanitarian law: *"I will cite, for example, the proportionality of the response, distinguishing between combatants and non-combatants, and minimising collateral damage. Artificial intelligence will not change any of these guidelines. On the contrary, artificial intelligence will help us to continue to respect them in future conflicts."*

Furthermore, the Armed Forces Ministry has set up a **Defence Ethics Committee** which the minister instructed to consider the initial guidelines for applying artificial intelligence to weapons systems by summer 2020.

¹ Ministry for the Armed Forces, "Speech by Florence Parly, Armed Forces Minister: Artificial Intelligence and Defence", April 2019

https://www.defense.gouv.fr/salle-de-presse/discours/discours-de-florence-parly/discours-de-florence-parly-ministre-des-armees_intelligence-artificielle-et-defense

² Note that in late 2019, Airbus and the Fraunhofer Institute for Communication, Information Processing and Ergonomics (FKIE, Bonn, Germany) set up an independent group of experts whose mission is to define the responsible use of new technologies and propose "ethical and international legal safeguards" within the FCAS.

The ethical and legal issues continue to be the subject of international discussions which, however, do not seem to be offering great results for the moment.

- the issue of **tactical efficacy**. Some think that AI cannot be more effective than people in an environment heavily contested by sophisticated access denial systems or, more generally, in "tactically fluid" situations where there are many choices and decisions to make.

In her speech, the Armed Forces Minister warned of AI's potential fragility: *"The handling of learning data, the cognitive biases that people pass on to algorithms, systems that are disoriented and disabled by simple pieces of tape, systems that can be hacked remotely: the risk factors that we must evaluate and control from the design stage are immense."*

However, these difficulties, while very real, could be greatly overcome in 2040. Remember that, in 2016, the experienced air force instructor Force Gene Lee could not win a single victory in an air combat simulation against the artificial intelligence "Alpha" installed on a low-cost, low-powered computer. In the same vein, a project of the Air Force Research Laboratory (AFRL) seeks to have an AI-equipped drone (which may initially be an F16) fighting against a manned fighter by July 2021. This project echoes a statement by Elon Musk, CEO of Tesla, on the fact that a fighter equipped with AI could defeat a manned fighter without difficulty.¹

FCAS project participants are very aware that one of the challenges they must meet is to integrate between them systems that are 1) piloted by a person onboard the aircraft, 2) piloted remotely and 3) autonomous. It is one of the main issues of the FCAS and one of the main topics of research for the project's partners, and **it must be possible, in a certain measure, to vary the proportion of these three elements in the "finished product" according to the needs that will exist starting in 2040 and in the following decades.**

The choice of AI is not choosing whether or not it is present; **it is a question of degrees.** When a missile is approaching an aircraft at Mach 4, the pilot does not have time to make a decision. The reaction is necessarily automated, sort of like when ABS takes control of a car's brakes when the driver brakes heavily before an obstacle. In this case, there is no point in the person being "in the loop". The position defended by the Armed Forces Ministry and shared by the mission is that people are in the loop overall: **a machine can be autonomous, but it cannot create or change a mission without asking permission from a human being.** People must maintain the **responsibility of command** and be able to **respect international humanitarian law.** Many tasks of self-defence, automatic targeting or overall

¹ Russian President Vladimir Putin also stated about AI in 2017 that "whoever becomes the leader in this field will be the master of the world", while the company Kalashnikov announced that it had developed several lethal autonomous weapons (LAW). There are similar projects in China.

trajectory calculation can be automated without infringing on these three principles, which do not ordinarily appear as self-limits, according to the Armed Forces Ministry.

In any case, AI will have a prominent role, at least, within the FCAS to support pilots within the system formed by the NGWS. Therefore, it seems necessary to **continue to invest massively in artificial intelligence** since the FCAS will necessarily make extensive use of it, even if it is not exactly predictable today. We should welcome, in addition to the Armed Forces Ministry's drafting of the strategy on artificial intelligence that was already discussed,¹ that the Armed Forces Minister stated in her above-cited speech that "*obviously the French Armed Forces are investing and will invest in artificial intelligence*" and announced an investment of €100 million a year from 2019 to 2025 for AI. The minister also mentioned six priority areas for investment in the matter, including collaborative combat.

Given our adversaries' accelerated development of this technology, we must be ready to respond in the future to countries that do not always respect the ethical and legal standards that France and its allies respect and want to continue to respect. Without this preparation, the French army could find itself against enemies in the same situation as Gene Lee or the world's best chess player who, by all accounts, could no longer win a single game against an artificial intelligence. Meanwhile, we must continue international discussions to arrive at a clear legal framework on these issues that is consistent with our ethics and the principles of international humanitarian law.

Proposal: Consider artificial intelligence as a "transversal pillar" of the FCAS that must be developed with the broadest possible scope of application.

Resume international discussions on lethal autonomous weapons (LAW) to arrive at a clear legal framework that is consistent with ethics and the principles of international humanitarian law.

2. The crucial importance of data links and the combat cloud and sensors pillars

The data links, whether high-speed intra-patrol links, high-speed satellite links, or optical links, as well as their security and resilience to cyberattacks and jamming, will be essential. **The information superiority provided by the cloud will allow for decisional superiority.**

Additionally, it is imperative that the cloud's scope be as broad as possible, thus encompassing land and naval forces. For example, close air

¹ *Artificial Intelligence in Support of Defence, Report of the AI Task Force, September 2019.*

support will need to be connected with land and naval artillery. This involves **addressing the integration of the FCAS's tactical cloud and the new SCORPION Command Information System (SCIS)**, a regiment-to-regiment battlefield command and information system that automatically exchanges data and warnings down to the landed group leader level and optimises fire support requests.

In total, **the FCAS's added value likely lies as much, if not more, in the combat cloud, connectivity, and the interoperability architecture than in the combat aircraft and its engine.** It is possible to compare this with how cars may evolve, should autonomous cars continue to develop; the software, the connections and the cloud will probably have more added value than the car itself. This is why we must pay the greatest attention to the "combat cloud" pillar as well as to the future "sensors" pillar, directed respectively by Airbus and Indra. **In particular, the "combat cloud" pillar must allow Thales and all its defence electronics subcontractors to contribute to the essence and the core of the FCAS.**

Proposal: give the "combat cloud" pillar the same priority as the aircraft and the engine.

Start preparing the integration of the FCAS combat cloud with the Scorpion Command Information System (CIS) immediately

3. Which engine for the demonstrator?

The demonstrator of the new engine will not be available before 2027, but the aircraft's demonstrator should fly in 2025 or 2026. Thus, it is expected that the demonstrator will be equipped with an improved version of the M88 until it can be replaced by a demonstration version of the new engine.

However, even this improved version may be insufficient to power a demonstrator on a 1:1 scale. A demonstrator at a scale of 0.8:1 could alleviate this problem, for example. If this option is not chosen, the demonstrator could use an engine already on the market. However, **this solution could represent a risk** to Safran's participation in the rest of the programme. The Eurofighter's J200, which could be selected, is made by a consortium including Rolls-Royce (a potential competitor with the Tempest), Avio, ITP and MTU Aero Engines. When asked about this issue, Eric Trappier, CEO of Dassault Aviation, specified that an improved version of the M88 remained the main option being considered. This solution, which complies with the initial industrial agreement, is also the mission's preferred solution.

Proposal: Equip the demonstrator planned for 2026 with the M88 engine (the Rafale engine), or a new version of it, and make the necessary investments.

4. The environmental aspect

Protecting the environment is not necessarily what first comes to mind when thinking about combat aviation, a very high-performance field that often goes hand-in-hand with maximum energy consumption. The FCAS's first objective is to outdo potential adversaries with superior performance. Additionally, the NGF's size and weight will very likely be greater than the Rafale, which implies greater fuel consumption. However, the comparison is not totally valid since we should compare the consumption of a current formation of Rafales with the consumption of an NGWS formation, which will consist of as many or more platforms (taking the remote carriers into account) but, no doubt, fewer combat aircraft.

However, **looking ahead to the period after 2040 and towards 2080** requires us to consider, for example, the possibility that energy may be less abundant, the need to improve energy independence, or extending certain standards developed for civil aviation to military aviation.

The Armed Forces Ministry has already taken this concern into consideration. Emmanuel Chiva, Director of *Agence Innovation Défense*, stated¹ that "*the issues of energy and the environment are topics of research in their own right. Research work specifically on hydrogen is under way, with a project for a hydrogen station for drones...AID does not ignore the challenges to the climate and is involved in the same way as the ministry as a whole*".

Furthermore, on 3 July 2020 the armed forces minister presented **the ministry's energy strategy** which lays out efforts to save energy in all fields to reduce the armies' energy bills with the additional goal of reducing their dependency on petrol procurement, which sometimes relies on uncertain sea routes.

Finally, in the field of aviation, studies are already under way on using biofuel. Airbus, Air France, Safran, Total and Suez Environnement signed a commitment to green energy with the government in December 2017 on aviation biofuels. The goal is to introduce a proportion of biofuel alongside the kerosene. These biofuels will be able to respect the

¹ Interviewed by Michel Cabirol, *La Tribune*, 11/09/2019.

requirements of military aviation.¹ Work is also being done to reduce the electric power that aircraft require.

As for other defence programmes, it seems necessary to take this aspect into account right from the start of the FCAS project's implementation.

Proposal: Include environmental concerns from the start of the FCAS programme while seeking the best performance possible.

B. MAKE INTERNATIONAL COOPERATION SMOOTHER

1. A different ranking of political, operational and industrial priorities

By developing a future combat air system, the three current partners are pursuing objectives that are partly convergent, but which also differ in certain aspects.

Thus, the main objectives that France is pursuing are:

- politically, a deepening of Franco-German and Franco-Spanish cooperation,

- in terms of capability, a renewal of its capabilities for 2040-2050 to support and then gradually replace the future versions of the Rafale,

- operationally, adapting to new threats, including denial of access (current and future air defences), cyber capabilities used even by second-rank powers, the FCAS competitors' systems of weapon systems; being able to continue to carry out all the missions on the spectrum with a system that can be adapted to naval use and the ability to project power in interventions anywhere in the world with an international mandate and to protect France's interests abroad,

- on the industrial level, preserve and develop France and Europe's strategic autonomy and their DTIB,

- concerning interoperability, the FCAS system's ability to dialogue with NATO and French allies' systems,

The main objectives that Germany is pursuing are partly similar, but their order of precedence differs somewhat:

- politically, the same desire to move forward by deepening Franco-German cooperation,

¹ However, it seems that we must exclude the idea of electric aircraft, both civilian and military. The power needed would require batteries whose weight would practically equal the weight of the aircraft itself.

- industrially, strengthen and improve the skills of the military aviation, civil aviation and aerospace industries. After all, whoever dominates combat aviation technologies also dominates civil aviation technologies. Progress in aviation is perceived as a way to gradually make up for a potential slowdown in Germany's traditional strength in automobiles,

- in terms of cooperation, continuing to make a first-rate contribution to NATO missions in close cooperation with the United States,

- a relative increase in strategic autonomy to make up for the United States' relative disinvestment and less-smooth relations between the US and Germany.

For its part, Spain wants to:

- increase Spanish industry's technological level by increasing research and developing in aviation,

- continue its tradition of cooperation with European countries in defence programmes, particularly in aviation,

- renew the Spanish Air Force's capabilities.

All these motivations are good reasons to move forward with the FCAS programme, **but some of them may conflict with certain aspects of the programme or with the motivations of other partners.** The desire to increase skills in certain areas is not necessarily compatible with the "Best Athlete" principle, which entrusts an aspect to the manufacturer who best knows how to do it. Similarly, the desire to continue to be a first-rate actor within NATO can lead to taking decisions that do not favour a programme that works towards Europe's strategic autonomy. From a German point of view, France's desire for strategic autonomy could also conflict with the desire to share the programme's benefits for industry equally. Thus, a compromise must be found between strategic autonomy, which is above all desired by France, and Germany's desire to develop its aviation industry.

Furthermore, **each of the partners does not see the FCAS programme in exactly the same way.** For France, the FCAS is essential for large manufacturers who cannot allow themselves to remain without a project for a combat aircraft or a combat aircraft engine. German and Spanish manufacturers are not in the exact same situations: for them, it is more an opportunity to gain skills in these areas. However, the simultaneous MGCS programme is essential to German industry, and Bundestag MPs consequently want to see it progress at the same rate as the FCAS.

2. Different strategic approaches for France and Germany

The nuances in the approaches to the FCAS programme also recall deeper differences.

a) Different strategic approaches

First, beyond certain misunderstandings and different priorities in how to act in a crisis, **there are differences in these two countries' strategic ambitions**. According to Christophe Strassel,¹ comparing the French, British and German white papers helps us identify global ambitions for the first two countries, contrary to Germany who is limited to a Europe and near-abroad vision: "*Whereas France and the United Kingdom affirm a global vocation and true strategic autonomy, Germany remains focused on its regional role and does not question the traditional framework of its defence policy within the Atlantic alliance.*" The ambition of global influence, or at least the political display of it, is not present in Germany's strategy. The *Weissbuch* (the German white paper) does not discuss this issue, whereas France highlights its "*global responsibilities*" and the United Kingdom its role as a "*key global power in terms of soft power*" and a "*global*" country Caroline Hertling also underscores this difference in approach and ambition: "*the German government's international ambitions are weak, whereas Germany often considers France to be a chronic interventionist*".²

France and Germany do not share the same military ambitions, and their understanding of threats is different. Germany's priority is almost exclusively the protection of its territory and national population, whereas France tends to identify threats in distant theatres that could have national repercussions. Germany takes into greater account the threat that Russia can represent while agreeing that it is an essential partner for Europe. These separate military objectives result in different needs in terms of capability which complicates bilateral collaboration on industrial weapons programmes, since the equipment designed does not have the same intended uses. In this way, **France's specifications for the equipment used by land forces exposed to a high level of risk are more specific than Germany's, whose soldiers are exposed to a lesser extent.** Similarly, concerning Europe's future drone MALE, Germany expressed a desire for a drone that could be used for observation and intelligence, while France wanted a drone that was capable of combat.

We should also note that, in Germany, **the armed forces commissioner's report published in April 2018 pointed to a number of shortcomings in the German army:** a real lack of financial resources despite the announced increase in military spending, a gap in manpower and the difficulties the army had in recruitment, as well as serious deficiencies in equipment. The readiness rates of military assets are among the lowest in NATO.

¹ *L'Allemagne peut-elle (et veut-elle) redevenir une puissance militaire ?* Christophe Strassel, *Hérodote* 2019/4 (no. 175).

² *Le désamour franco-allemand et l'Europe de la défense*, Caroline Hertlings, *Revue internationale et stratégique* 2014/1 (no. 93).

Budgetary approaches also differ. In its 2019-2025 military programming act, France set a target for military spending of 2% GDP, as required by NATO, up from 1.77% in 2017. Germany has lower budgetary ambitions. Germany wants to reach 1.5% of GDP in 2024 and 2% in 2031 (from 1.39% in 2019).

b) "Cultural" misunderstandings between the two partners

While Germany and France ultimately came to an agreement in less than three years to proceed through the FCAS's initial stages, the negotiations between the two countries were not without difficulties. These difficulties were due to differences that were both cultural and institutional, which led to misunderstandings and disagreements.

In a study¹ published by the *Institut des relations internationales et stratégiques* (IRIS) on 14 January 2020, Jean-Pierre Maulny, Deputy Director of the IRIS, who gave testimony to the mission, and Christian Mölling, Director of Research at the German Council on Foreign Relations (DGAP), analysed these challenges. They noted the existence of areas of agreement (a strong political will on both sides to move forward with the project) and areas of disagreement where negotiation was possible (threat perception, the issue of arms exports) but **also issues where the two countries "do not speak the same language"**. **These are the issues that lead to the most significant challenges.**

First, Germany is accustomed to seeing their position as institutionally disadvantaged compared to France. They consider that this is characterised by the **close cooperation between the French government and industry, significant support from the former to the latter within the framework of a true strategy, whereas this support and this strategy are both lacking in Germany**. Additionally, Germany sees the French concept of national strategic autonomy as somewhat contradictory with, on the one hand, the idea of European strategic autonomy and, on the other, the desire to engage in industrial cooperation. Germany must also submit to procurement rules and processes to which French industry is not accustomed.

Government-defence industry relationships that are very different in the two countries

In Germany, the government maintains a distance in designing weapons programmes, which is ultimately delegated to national manufacturers. Since the federal government and the chiefs of staff provide fewer directives than in France, the industrial sector predominates in defining military needs and enjoys greater freedom.

¹ *Consent, dissent, misunderstandings. The Problem Landscape of Franco-German Defense Industrial Cooperation, 14 January 2020*

Since 2000, the Customer Product Management (CPM) is in charge of designing procurement after a reform ended the EBMat (*Entwicklung und Beschaffung von Wehrmaterial*). This restructuring removed prerogatives from the new body responsible for procurement. **Thus, skills disappeared and were transferred to industry, which involved itself more in development tasks.** The army now only takes charge of a reduced number of trials and experiments on very specific products. The CPM requires a prototype or demonstrator from manufacturers to verify that the equipment indeed meets the requirements. Nevertheless, the directives remain fairly broad. The BAAINBw, the German equivalent of the DGA and the German army's central purchaser, gathers proposals that are more or less detailed and more or less costly from manufacturers before choosing which company will produce the equipment requested. According to Gaëlle Winter,¹ this operating method "*reinforces the Defence Ministry's dependency on the private sector and deprives it of its capability to drive strategy and expertise to guide its maintenance of critical technological skills and the emergence of new sectors*".

In France, the *Direction Générale de l'Armement*, which possesses technological knowledge, defines the required equipment according to a very specific, centralised procedure in collaboration with the Armed Forces Staff. These are then implemented by defence companies. The French method for developing new equipment is "capability-based and effect-based", and the definition of operational needs and the specifications, which is very thorough in France, does not exist to the same extent in Germany. Similarly, the Chief of Armed Forces Staff has greater influence in the design of programmes than their German counterpart, the Bundeswehr Inspector General.

The German government's lesser involvement in the process for designing equipment can be explained in part by legal factors.

The BAAINBw, which is responsible for defence procurement, takes great care to avoid any political influence in the process given the liberal-inspired public procurement regulations. Gaëlle Winter highlights the "*constant concern for being legally beyond reproach in the choices made*". Thus, the General Legal Affairs Department scrupulously ensures compliance with the law. For Gaëlle Winter, "*The BAAINBw's legal formalism is exacerbated by the judicialisation of procurement; the reduction in the number of procurement projects has led companies to increasingly scrutinise the impartiality of decisions, resulting in an increase in the number of complaints to the Federal Chamber of Public Procurement (Vergabekammer des Bundes)*". Indeed, the cases where manufacturers were successful and where the programmes were sanctioned by the courts are "*those who had been most politically influenced*".

Germany's paradigm of limited government intervention in the arms industry's affairs is also cultural. **The government's role is contested by German manufacturers who see themselves as independent entrepreneurs** and who feel that additional rules would represent increased costs and lead times. Gaëlle Winter explains that "*the prevailing economic discourse is mostly reticent about strong sectoral plans*" for three reasons. Firstly, "*politicians do not have a better understanding of future technologies than private investors*", particularly since the CMP has lost skills. Secondly, "*political decision makers are worse than private investors at stopping unsuccessful projects at the right time*". Finally, "*there is the danger that politically influential and established companies will take advantage of industrial policy to obtain privileges at the expense of competitors, taxpayers and consumers*".

However, while manufacturers opposed the plan presented by Economy Minister Peter Altmaier in February 2019 which would facilitate government participation, **the German government is trying to increase its influence somewhat.** From 2013 to 2017, the Social Democrats had tried to steer industry in a concerted manner by holding industry dialogues in sectors considered strategic, including the arms industry. Above all, government efforts have been made in protecting national industries. **To protect and support them, the executive branch defined five "key national technologies" in July 2015.** Germany also strengthened its supervisory mechanisms in merger control and tightened its control over foreign investment. For example, following the sale of Airbus' defence electronics business, under the name Hensoldt, to the US investment fund KKR, the government invested in the company, concluded a security agreement and appointed two government representatives to the Board of Directors. Thus, Germany is monitoring its national strategic interests.

¹ Gaëlle Winter, "*La politique industrielle de défense de l'Allemagne : l'Etat pris dans un jeu de perles de verre*", *Note de la Fondation pour la Recherche Stratégique* no. 18/2019, 16 September 2019

German manufacturers are asking for better support, but not support that would be intrusive. They want an increase in the defence budget allocated to procurement and research, lighter parliamentary scrutiny (via an increase in the project approval threshold which is currently set at €25 million), better support for exports and to be more closely involved in decision making while excluding direct government control.

For their part, **French players feel that German defence players do not have the same perception of threats that they do**, and that Germany's processes are less well adapted to providing the armed forces with the equipment they need. This perception is based on the fact that **the French army has a specific view of what it needs given its much more frequent engagement in real combat** and that the process for meeting these needs through the interactions between the Armed Forces Staff and the DGA are very smooth. French players feel it is necessary to develop a European strategic autonomy, which implies keeping the production of certain equipment within its borders, guaranteeing the procurement of that which cannot be produced and to protect companies from foreign investment. France wants Germany to draw up its own defence industry policy.

French players interpret German manufacturers' reluctance to work with their potential French partners, itself due to the German view that the French government has too much influence, as a desire to develop Germany's national industry instead of strengthening Europe's industry and defence base.

Thus, there is a series of misunderstandings that hinder cooperation on defence. According to Jean-Pierre Maulny, while the FCAS programme has indeed made progress in the three years thanks to a strong will on both sides, **the conditions for continuing to advance smoothly are not in place.** There is a risk that the programme will fall too far behind schedule.

These difficulties require specific responses. Players on both sides must clarify their strategy and objectives. For France, it is necessary to explain and educate that the French government is acting to maintain a strong technology base and national and European sovereignty. For this, it must be more transparent, potentially by writing out France's strategy for the defence industry, similar to what the United Kingdom does. It is also important to undertake small-scale projects without hesitation to recreate habits of cooperation and build trust.

To go further, consideration could be given to **drafting a joint document laying out the two countries' defence industry strategy and its shared aspects as well as a provisional planning of industrial cooperation projects** so that the two countries can further commit to their future cooperation and avoid recurring obstacles. Later on, this document could also include Spain so as to build a base for smoother cooperation in the future between the three countries.

Proposal: Improve reciprocal understanding between the three partners; identify and publish a "joint industrial defence strategy" that includes a forecast schedule of the joint projects.

c) A more complex German decision-making process

The German executive branch is traversed by deep fractures not just between the coalition parties, but within each party itself. This affects the Franco-German defence relationship, in particular industrial cooperation, and it can also suffer from the Bundestag's desire to increase its involvement in the decision-making process, as the mission observed during its trip to Berlin.

The German parliament's very significant role in the army and defence programmes

In Germany, the Parliament has very strict supervisory powers over the army. By approving military engagements with a simple majority vote, it plays a much more consequential role in the national defence strategy. The Bundestag decides on the amount of forces deployed as well as the duration those forces are deployed. Article 87a of the German Basic Law stipulates that the "*employment of the Armed Forces shall be discontinued if the Bundestag or the Bundesrat so demands*". Members of parliament define the directives of Germany's defence and security policy. The requirement for their approval for any foreign engagement of German forces has led to the notion of a German "parliamentary army".

Given Germany's more constraining rules of engagement and the legal issues related to the application of labour laws, the Franco-German Brigade has consequently been used very little.

The German parliament does not hesitate to contest the guidelines given by the federal government. For example, this is illustrated by the attempt to include surface buildings in the five key national technologies that the government had identified in July 2015, even though they had been deliberately excluded by the Defence Ministry. In addition, a Parliamentary Commissioner for the Armed Forces, a senior civil servant elected by the Bundestag for five years, is responsible for inspecting the internal command as well as the respect for human rights within the troops. They publish an annual report of their investigations, which is often critical of the armed forces' operations.

The German parliament can also exercise influence over capabilities through its power to approve any military programme that exceeds €25 million. The Bundestag's Budget Committee is in charge of this approval, a prerogative that does not exist in France. German manufacturers are calling to relax this rule by increasing the threshold for draft contract approval. The FCAS and MGCS programmes, supported jointly by France, have been blocked by the Budget Committee. German MPs are also able to force the federal government to change a contract: this is how the German order for the A400M, which was initially for 60 units in 2002, was ultimately lowered to 40 units in January 2011.

Furthermore, while arms export controls by members of parliament are made *ex post facto* in France and Germany, **German MPs are more involved in defining export policies.**

Furthermore, the mission saw in Berlin that German politicians remain **reluctant towards initiatives that seem to them susceptible of competing with NATO**. Despite American criticism sometimes targeting Germany (the low defence budget, Nord Stream 2, the Huawei 5G network), Germany takes utmost care to preserve the Alliance. Within the Alliance, the German Framework Nations Concept allows it to play a leading role in developing capabilities, encouraging cooperation with its immediate neighbours (Poland, Netherlands).

Above all, to accept the German share of the R&D contract on 12 February 2020 (€77.5 million), **Bundestag MPs laid out six conditions**: a report from the Defence Ministry on the MGCS project and, more specifically, on the consolidation of the German land industry sector (Rheinmetall and Krauss-Maffei Wegmann), the implementation of an inter-ministerial management to supervise the FCAS and MGCS projects as well as the publication of quarterly reports so that members of the budget and defence committees can monitor both projects' progress, **the definition by the government of the key national technologies for the two projects and the guarantee that measures will be taken so that their design, production, and availability to Germany will be guaranteed**. These are technologies resulting from Germany's participation as prime contractor or main partner in the national and international projects in technological and demonstrator programmes. For R&T that can be used in civilian industry, similar measures must be taken by the Defence Ministry, the Economy Ministry, and the Research & Development Ministry. Furthermore, the German parliament wants the agreement concluded in 2013 between Airbus (EADS at the time) and the German government on the protection of essential security interests to be updated with regards to the FCAS project.

These conditions, in particular the conditions relating to key technologies, seem quite restrictive, especially since the Bundestag can block any new investment of more than €25 million.

d) The need for a longer-term commitment to avoid any repeated stalls to the programme

Eric Trappier, CEO of Dassault, insisted on this point during his hearing; France and Germany may be strongly committed to the programme, but not to amounts that would make it irreversible.

There are now many reasons in favour of moving to a scale of one billion with a framework agreement that covers all the operations needed to produce the demonstrator, at least until 2024 and ideally in 2026, thus breaking with the "small slices" strategy. Each delay represents a loss of time and money since the project teams are inactive. It would no doubt be preferable that this framework agreement be signed before the coalition in power in Germany is elected in September 2021, since the election will open a period of uncertainty that will likely be unfavourable to moving forward with large projects.

Proposal: Prioritise signing an overall framework agreement at the start of 2021 to continue developing the FCAS demonstrator through 2025/2026 rather than a succession of contracts requiring repeated political approval.

3. The FCAS's exportability: an essential issue

The European market alone will not be enough to make major Franco-German and European equipment projects such as the future tank or the FCAS economically efficient: **credible possibilities for export based on clear, predictable rules is an essential condition for the sustainability of the European defence industry.** Remember that Germany, like France, is one of the largest exporters of defence equipment in the world: €6.24 billion in 2017, of which €3.7 billion to third countries outside NATO and the EU, compared to €6.9 billion for France and €4.35 billion for Spain.

The European market is one of the most open in the world, unlike the United States, but in the absence of a European preference for the procurement of military equipment within Europe—many Member States prefer to buy non-European equipment—its reduced size makes it difficult to see a return on investment in defence without exporting the equipment produced to outside markets. Thus, exports are necessary to allow industry to provide equipment to the armed forces at an affordable unit cost. **Furthermore, it participates fully in developing strategic global security partnerships with partners outside the European Union.**

a) Germany's specific approach to arms exports.

Starting in 2013 with the new guidelines contained in the coalition contract and the growing politicisation of the debate in public opinion, Germany's policy towards the scrutiny of exports has become more unpredictable. Germany is applying a more restrictive policy by toughening rules and curbing sales to countries outside the EU or NATO or to those countries that do not have similar standards.

Weapons exports: a sensitive issue for German public opinion

The arms industry has a bad image in Germany. Above all, it is the export of weapons judged "unethical" that have been subject to criticism since the end of the 1960s. German society is truly mobilised on this issue, and it has found a relay in two institutions: the Catholic and Protestant churches and union organisations. Today, criticism focuses more on controlling exports than on the exports themselves, this control accused of being too lax and lacking transparency. The executive branch has therefore adopted a restrictive posture to this type of exportation.

Foreign manufacturers, the French among them, are encountering increasing difficulty in obtaining export licences for German components that are integrated into their products, even though sometimes they only make up a small part of the system. The processing time for licence requests, sometimes taking more than a year, has led to certain cases of companies having to pay heavy late fees or losing contracts. This reinforces the sentiment that Germany's rules are not so much restrictive as they are subject to change according to Germany's internal politics, and not just a rigorous application of European criteria and treaty provisions. **This situation has even encouraged French manufacturers to design German-free materials** without German components, which places a risk to our bilateral defence cooperation and for the construction of European sovereignty.

The similarities between the French and German defence industries should encourage a return to an application of the principle of mutual trust, which had been the rule for decades and which France has never stopped applying.

b) Towards pragmatic solutions within the framework of the Aachen Treaty.

France and Germany included a clause in the Aachen Treaty signed on 22 January 2019 stipulating that "*the two countries will develop a common approach on arms exports with regards to joint projects*".

The Debré-Schmidt agreements in December 1971-January 1972 already stipulated that, unless there is a major issue, **the partner's exportation projects would be looked upon favourably**. However, these texts were somewhat "forgotten"; after a wave of cooperation in the 1980s, there were fewer programmes in the 1990s-2000s, and there have been many misunderstandings since 2016.

The two parties finally reached a **new legally binding agreement, which was the subject of an exchange of letters between the governments on 23 October 2019**.¹ This text stipulates that France and Germany will continue to fulfil their obligations with regards to the European Common

¹ Decree No. 2019-1168 of 13 November 2019 publishing the Agreement in the form of an Exchange of Letters between the Government of the French Republic and the Government of the Federal Republic of Germany on Defence Export Controls.

Position of 2008 and the treaty on the arms trade and of acting with respect to their respective national legislation.

On this basis, the two countries agreed on the applicable principles:

Article 1. For programmes developed jointly:

- mutual information about projects for exportation before negotiations open,
- a principle of "exportability" except for "*exceptionally, when this transfer or export harms its direct interests or national security*",
- notice within no more than two months of their intention to oppose a transfer or exportation and the immediate organisation of high-level consultations to share analyses and find suitable solutions, the opposing Contracting Party making every effort to propose replacement solutions.

The future tank (MGCS) and the FCAS are explicitly held up in the document as examples of programmes developed jointly.

Article 2. The same principles apply to defence-related products resulting from industrial cooperation.

Article 3. For defence-related products developed by a manufacturer in one of the Contracting Parties that falls outside the scope of application of the above provisions (programmes developed jointly and defence-related products resulting from industrial cooperation), a *de minimis* threshold applies.

When equipment produced by one of the two countries includes a portion of components produced by companies in the other under a certain threshold (generally 20%), the country producing the bulk of the equipment is responsible for controlling its export. According to the *de minimis* principle, "*when the share of the products intended to be integrated by the manufacturers in one of the Contracting Parties in the end systems transferred or exported by the other Contracting Party remains less than a percentage stipulated beforehand by mutual agreement, the Contracting Party approached will deliver the corresponding authorisations for export or transfer without delay, unless, exceptionally, this transfer or export harms its direct interests or its national security*". This clause seeks to correct the current situation, where integrating a simple engine gasket or switch from Germany into a piece of equipment gives Germany a statutory right to veto the export of this product, even if the bulk of this project is French.

Thus, Articles 1 and 2 of the treaty are more focused on the future of Franco-German cooperation and arms programs that could be exported in the future, **including the FCAS**, and Article 3 more on the present and

current issues. For France, the proper application of Article 3 is a sort of test of Germany's good will. However, there has been a complication concerning Article 3. While the parties had agreed that it applied to current contracts (i.e. spare parts intended for equipment that had already been sold: it was not about retroactivity, strictly speaking), the German side corrected its interpretation and now considered that the agreement was only valid for the future.

However, Germany finally granted a dispensation from this interpretation to a significant share of the licences needed to export equipment (spare parts) for contracts that had already been signed.¹ Nevertheless, one can note that a rather significant number of arms and munitions are excluded from this *de minimis* principle under Annex 2 of the treaty.

Finally, the agreement provides for a standing committee to consult on all issues governed by the agreement. This committee has already met twice.

Thus, the new agreement seems to settle the case of joint programmes such as the FCAS on the one hand and, on the other, set a framework for arms exports that will take place in the coming years to avoid tensions that could have spilled over into the FCAS programme.

Now, it seems necessary to find a legal solution so that Spain can join this agreement. More specifically, Germany should be encouraged to sign a similar agreement with Spain so that Spain no longer encounters, as it does currently, the same problems as France when exporting equipment with German-origin components.

<p><u>Proposal:</u> Invite our German partners to sign an agreement on arms exports with Spain similar to the one signed with France.</p>
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C. IMPROVE INDUSTRIAL COOPERATION

International cooperation between defence companies remains a significant challenge because they are more used to working in a national framework. However, in three years of negotiations on the FCAS, significant progress has been made in the matter between French and German manufacturers, the best example being the collaboration now under way between Dassault and Airbus.

¹ The German side was also waiting for a general licence to be published to apply the *de minimis*; the licence was published in May 2020.

Careful not to repeat the errors that led to great difficulties in previous international programmes, the DGA, the leader on the FCAS project, has for the moment been successful in **imposing "vertical" steering of the various pillars**, with a clearly identified prime contractor and main partner in charge of orchestrating subcontractors' contributions. We must **welcome this desire to learn the lessons from past failures** as well as the scale of the efforts made since mid-2017.

However, **the programme is only just beginning**. For each pillar, the negotiations between governments and between manufacturers were difficult. Additionally, it is tempting for manufacturers to pressure politicians to increase their workload beyond what is coherent from a precisely industrial point of view. To this end, they may evoke a return of manufacturing to the country with the jobs that come with it, as well as catching up technologically and gaining skills in certain fields key to military and civilian aviation.

1. The "geographic return" principle and the "best athlete" principle

As the programme develops, **the consequences for each of the participating countries of applying the "best athlete" principle will be felt**. There will be difficult discussions when it comes to deciding whether such and such a part of the combat aircraft or the remote carriers will be built in France, Germany or Spain. For example, in certain fields Dassault and Safran may have to stop working with some of their usual French subcontractors and begin working with German or Spanish companies. This is one of the obvious costs of international cooperation.

However, the three countries participating in the programme have, logically, also agreed on a "fair geographic return". Thus, German taxpayers have the right to as many jobs as the French for the same amount invested by their country, as do Spanish taxpayers. However, and **this is the leading point of attention for France**, it is not certain that there is a sufficient proportion of large foreign companies who will look to work with French small and medium business as there are French system makers who would have preferred foreign small and medium businesses.

Conversely, the principle of fair geographic return itself is a factor of increased costs, industrial inefficiency, and duplicate skills.¹ As the DGA representatives highlighted, **we should apply this principle of geographic return very flexibly and globally to safeguard the "best athlete" principle**.

¹ As the Court of Auditors underscored in its 2010 report on arms programmes: "Even more perverse, the concern of certain countries to see their industry advance paradoxically leads them to bid for work in sectors where their skills still need to be developed".

This situation is further complexified by various players' perceptions: **as the Bundestag sees it, Airbus is also "French"**, although ADS represents 38,000 jobs in Germany and is the leading supplier to the German army (space, aviation, systems). For phase 1A at least, the bulk of Airbus's activity will be focused in Germany. Additionally, certain players see the FCAS as a French project overall, which would explain the "best" pillars being "awarded" to France. As already discussed, this perception is not correct: **the tactical cloud and remote carrier pillars are just as essential to the programme**, and Airbus DS is present in nearly all the pillars.

Spain's inclusion after-the-fact¹ in the scope of the cooperation has also, logically, resulted in expanding phase 1A and increasing its costs to make room for Spanish manufacturers and bring in new areas for cooperation. This is another reason for the next stage of the FCAS to consist of a major contract of over €1 billion which would test the partners' desire to make a contribution in proportion to the role they wish to have in the project.

Proposal: Support the "Best Athlete" principle (the one who has demonstrated competency is the prime contractor) throughout the duration of the FCAS programme to avoid the errors of the A400M programme, while remaining vigilant of the participation of French small and medium defence companies in the programme.

Proposal: Strengthen Spain's position on the "sensors" pillar.

2. The unresolved issue of industrial property

Establishing rules of **industrial property** within the framework of the FCAS programme was the subject of long discussions between France and Germany through October 2019. A document with eight principles was signed in December 2019. These are high-level principles to guide manufacturers in their work and ensure the security of information. This is an important issue for France.

Thus, manufacturers will not have to reveal their background, i.e. their own knowledge, which is the heart of their company (MTU's representative used the expression "the crown jewels" during their hearing). **Representatives from Airbus as well as Dassault and MTU stated that protecting this "background" was self-evident.** On what will be developed jointly, **the manufacturer who imagines and designs will own the result, but they can make it available to the other manufacturers as needed** so that they have everything needed to support and develop the aircraft **without revealing the entire "manufacturing recipe"**.

¹ Spain is providing funding of €110 million for the first stages from 2020 to 2023. €20 million are payment appropriations voted for 2020 (a portion for the JCS and a portion for phase 1A).

However, **certain countries**, either trying to catch up or gain industrial power, **tend to request the largest share possible of industrial property**. In particular, as already discussed, the Bundestag required the German government to define the "key national technologies" for the two projects, the FCAS and the MGCS, and to take measures so that their design, production and availability for Germany were guaranteed. These conditions seem restrictive, especially since the programme is sufficiently technologically rich and its scale sufficiently large for all participating manufacturers to derive significant benefits in terms of know-how and skills without having to deviate from the traditional rules of industrial cooperation.

In any case, **Germany made it a condition for moving on to the next phase of the project** to draw up a more precise agreement than the one already referred to, which should guarantee a "smooth" sharing of the technologies resulting from the cooperation, in particular as regards the "combat aircraft" pillar led by Dassault. Therefore, it will be necessary to be vigilant in negotiating this new agreement.

Proposal: Protect manufacturers' *background* in terms of intellectual property. Provide for balanced use of the *foreground*: ensure that each of the countries participating in the programme can maintain or evolve the FCAS after it is commissioned and ensure an adequate protection of innovations that arise during development.

3. What place is there for ONERA?

We should note an inconsistency in the project's industrial organisation. **ONERA, which evidently has very significant skills that could be put to use for a programme such as the FCAS, has not been assigned a place within this programme for the moment**, even though its German competitor DLR (*Deutsches Zentrum für Luft und Raumfahrt*, the German Centre for Aviation and Astronautics), has been awarded an additional subsidy of €106 million by the Bundestag, and the German Defence Ministry awarded it a significant contract within the FCAS. ONERA's skills in military aviation are eminent and renowned. On this issue, we must remember that the negotiations on the breakdown of the various parts of the programme between the two countries' relevant industries and organisations and the trade-offs that implies should not deviate too far from the "best athlete" principle without jeopardising the project's viability.

On 17 June 2020, the armed forces minister responded to a written question from our colleague Martine Berthet that: "*We should also note that building the FCAS will, when work has progressed further, call on national*

expertise and testing capabilities, for France at certain sites of the Direction Générale de l'Armement (DGA) and, of course, within the Office national d'études et de recherches spatiales (ONERA - The National Office for Space Research and Studies). It will also mobilise the capabilities of the equivalent counterparts of our German and Spanish partners. In this context, ONERA will be able to play its full role; they will be responsible for proposing a strategy of cooperation with centres in the project's partner countries." The minister also denied that a mission was awarded to the DLR instead of ONERA within the FCAS programme as compensation for the agreement to make French company Safran the prime contractor on the engines and German company MTU its main partner.

The programme's directors are currently mapping the fields where ONERA could have a role to play. ONERA could also provide project management assistance to the DGA to analyse the technological roadmaps submitted by the manufacturers, produce upstream studies on materials, combine its simulation capabilities with those of the DGA and act as a subcontractor for certain manufacturers.

The ministers' statement is just a first step and still includes too many ambiguities that should be clarified as soon as possible **so we can confirm that ONERA can participate in the programme in accordance with its level of excellence that is recognised by all**. In particular, we must encourage the large manufacturers to use this organisation as a subcontractor.

<p><u>Proposal:</u> Integrate ONERA into the FCAS programme at a fair level given its eminent expertise in combat aviation. Encourage manufacturers to rely on ONERA for sub-contracting.</p>
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4. Expand the project to new partners once the demonstrator is complete

The issue of expanding to other partners should be discussed given the project's European ambitions.

Of course, **distributing tasks has already proven to be complex with three participants**. On most pillars, the negotiations to determine the prime contractor and the main partner were long and sometimes fraught with difficulty, causing fears for the future of the programme (particularly for the engine pillar). Additionally, Spain's place still needs to be consolidated, even if there is no doubt as to its desire to participate fully in the project, and there is an agreement to include its manufacturers in the various pillars. Here as well, the memory of the A400M project and its eight participating countries must encourage us to be prudent, as the project's

delays and cost overruns can largely be attributed to its excessively complex governance.

However, the FCAS programme undeniably includes a strong European aspect, and it was designed as such from the start. The Franco-German base, now expanded to Spain, should be the embryo of a **European strategic autonomy**. The project's German military managers, in particular, see the FCAS as more of a European programme than a simple tripartite programme. For them, Sweden and Italy could be the two countries that could bring the most to the FCAS programme, even though these two countries have started to negotiate with the United Kingdom as part of the Tempest programme.

Furthermore, only such a European dimension for the programme can **create synergies with the European Union instruments already discussed** (PESCO, EDIDP, EDF). Bringing more countries into the programme is also a way to **advance European interoperability** with European communication standards (see the EcoWar project) and act as a better counterweight to American influence in the future.

However, bringing new countries into the programme must not be allowed to jeopardise its momentum. That is why **it seems preferable to defer any entry of a new country until the demonstrator has been completed in 2025/2026**. At this time, the programme will have made great progress, and the financial commitments of the three partner countries will have made it stronger, if not irreversible.

<p>Proposal: Expand the FCAS programme to new European countries in its future stages (post-2026). Develop synergies with European instruments of defence (EDIDP, PESCO, EDF), in particular with a view to developing European interoperability standards.</p>
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D. THE CONSEQUENCES OF THE CORONAVIRUS CRISIS: CONTRIBUTE TO THE ECONOMIC RECOVERY BY INVESTING IN THE FCAS

Given the crisis in the aviation industry due to the coronavirus, Airbus CEO Guillaume Faury stated that Airbus's survival was at stake. A recapitalisation fund should be created for the aircraft manufacturer endowed with several hundred million euros (Airbus, Safran, Dassault and Thales), BPI France.

The Armed Forces Minister has also announced a support plan for the defence sector.

The support plan announced by the armed forces minister on 9 June 2020

"To support the sector's businesses, the armed forces ministry will use two tools:

- The first will be €600 million of military orders that we have decided to bring forward.

In this context of this unprecedented health crisis, we have made way to bring forward orders that had been planned for the future in the military programme.

- We will purchase three A330s which will be transformed after the military programme act into MRTTs, i.e. Phoenix refuelling aircraft for the air force. These aircraft will replace the air force's ageing A310s and A340s.

- We will order eight Caracal helicopters to replace the air force's Puma helicopters which are 40 years old on average. Initially, the Pumas were to remain in service until 2028, but, given the circumstances, we have decided to start replacing them in 2023. This will allow the air force to have new equipment and save money on operations.

- Finally, I wanted to ensure that innovation and small and medium manufacturers and businesses were a part of the new impetus that we are giving to our industry. More than €100 million have been reserved for the production of a light reconnaissance and surveillance aircraft and drones for the navy. These drones will be ordered directly from our small and medium businesses.

All these orders meet an existing operational need at our armed forces: we simply want to act faster. These proactive actions will help save more than 1,200 jobs over three years all over France. Half of these orders will benefit the subcontractors of large manufacturers.

A few moments ago I spoke of the big team that we all make up, Team France, and it goes without saying that in a team, everyone has a role, everyone has responsibilities, but success depends on everyone.

We have also committed to facilitating and accelerating payments to the major general contractors. And I would like to insist on one issue: each euro paid by the Armed Forces Ministry must be immediately passed on to the subcontracting chain.

I also expect our industrial partners to offer fair prices. Now is not the time for profits, it is time to save jobs. And I will make sure of it.

I will also make sure that your commitment, chairpersons of defence companies, to maintenance in operational condition continues. Progress has been made since 2017, but it is not yet enough, and I now expect a significant increase in the availability of our aircraft. Without that, the credibility of our defence system is at stake.

Finally, the aviation industry is the flagship of our national economy. It is a pride that shines beyond our own borders. Despite the crisis that we have found ourselves in, we must not give up on our export ambitions. On the contrary, we must redouble our efforts so that our industry can continue to flourish internationally. Naturally, I am counting on each one of you.

We are aware that these orders that we are bringing forward will not fulfil all the industry's needs. That is why we are actively continuing discussions to modify our order schedule. In particular, I am thinking of Dassault Aviation, our industrial partner for combat aircraft. The Rafale is an absolutely magnificent aircraft, and I love going round the world to say so. Mister Chairman, like you I am closely monitoring the future of the Rafale industrial chain. I will have decisions to make in the coming weeks, and we will speak of them again.

- The second tool is mainly addressed to small businesses and gems in the defence industry and concerns our ability at the Armed Forces Ministry to take stakes in companies' capital. We are working to double the Definvest investment fund to go from €50 million to €100 million over a 5-year period. €100 million to safeguard companies of strategic interest to our defence through capital injections. The Definvest fund will of course act very closely with the fund whose creation was announced just this morning..."

There are fears that the consequences of the coronavirus-related economic crisis may also lead to **a reconsideration of certain defence programmes**, in an approach in which they would be balanced against the necessary investments in social or health programmes. However, this would not necessarily be a relevant line of reasoning: **investments in defence can contribute to the economic recovery and to safeguarding jobs in France** in the supply chain of systems integrators and major equipment manufacturers, because these jobs are not offshore.

Since the FCAS is an international programme and a share of the spending in France should translate into increased activity in Germany and Spain, **it would be desirable that the recovery be coordinated between these three countries to maximise the effect in each of them**. Additionally, if the programme reaches its export objectives, the economic return on this investment will be even greater.

Furthermore, the FCAS includes a significant aspect of sovereignty for France since the future combat aircraft will carry the airborne deterrent. **A significant share of the investment allocated to the FCAS will necessarily bring business to France** in this sovereign industrial sector.

Therefore, the FCAS should be integrated into national recovery plans and consideration should be given, together with the two programme partners, to speeding up its implementation with a view to completing it before 2040. This new deadline would also have the benefit of bringing the FCAS's production date closer to that of the Tempest, should it manage to be completed in the timeframe announced.

Proposal: Encourage the three partners to accelerate the FCAS schedule so that it is part of the post-coronavirus economic stimulus plans. Plan for the programme to be completed by 2040.

E. TAKE THE TEMPEST PROGRAMME INTO ACCOUNT

1. Originally: an aborted Franco-British cooperation project

Within the framework of the Lancaster House agreements in 2010, a letter of intent was signed in Paris on 16 February 2012 regarding a joint

study of military drones with the United Kingdom. **Thus, the FCAS (Future Combat Air System) project had officially been launched in 2014:** the Franco-British Brize Norton summit in January had planned Franco-British studies for a fighter drone, while a memorandum of understanding was signed at the Farnborough Air Show in July by Defence Minister Jean-Yves Le Drian and his counterpart Philip Hammond. The demonstrator was to be developed by Dassault Aviation and BAE Systems with assistance from Thales and Selex ES, Rolls-Royce and Safran. Finally, an initial contract for feasibility studies of **€150 million** had been passed in September 2014.

The works covered the system architecture, stealth, sensors, propulsion, data links, and weapons carriage in the hold. The project was also to rely on the programmes led by Dassault Aviation and BAE Systems, the nEUROn and the Taranis. The feasibility phase lasting two years should have resulted in a development phase and the production of a demonstrator of an armed drone for 2025.

First, however, the projects presented by the manufacturers were considered to be too expensive for a drone alone, particularly by the United Kingdom. Second, the announcement of Franco-German cooperation on the future aircraft after the Franco-German Defence Council on 13 July 2017 and the context around Brexit led **the United Kingdom to announce in July 2018 its desire to begin its own combat aircraft project, the Tempest.** This development also reflects a simultaneous change in perception in the two countries. At the start, the two countries' plan was to have a fighter drone after 2030/2040 that would supplement a renovated combat aircraft (a renovated Rafale and Typhoon). This pair was to be able to carry out all types of missions from low to high intensity, the drone being limited to ground strike and reconnaissance missions. **Finally, it appeared necessary to develop an entirely new combat aircraft within a system of systems, an aircraft capable of taking over from the Eurofighter Typhoon and the Rafale.**

Thus, a programme launched with funding comparable to that committed so far for the FCAS was cancelled.

2. The Tempest: an international cooperation project

While the two projects, FCAS and Tempest, have similar objectives, their methods are different. While the FCAS seeks to be "European", from 2018 the British were looking for partners within Europe as well as outside Europe; **thus, it is more an international project under British leadership than a European project.**

The United Kingdom signed agreements with Italy in 2018 and Sweden in 2019 for a joint study of the technologies of interest to the project but **without a financial commitment**, even though an international financial and capability platform ("Team Tempest" in Farnborough) has been set up

with the participation of manufacturers and subcontractors. Additionally, the United Kingdom has approached Japan, Saudi Arabia and Turkey with a view to bringing in funds, not industrial cooperation. Finally, there is a link with the United States on part of the project via the Boeing Loyal Wingman drone, which could logically integrate with the Tempest. The concept study phase should end in late 2020 and give way to an "assessment phase" in 2021 to evaluate the concepts and architecture with regards to the desired performance. The decision to truly begin development may not come until 2025, even though **the first delivery is planned for 2035 (5 years before the scheduled delivery of the FCAS)**, the start of the Eurofighter's retirement, **which seems extremely ambitious given the project's complexity.**

3. Obvious political will, but an uncertain future

The political will to move forward on the Tempest seems real. The British see defence aviation as a sector that is fully mastered, at the heart of British skills, and represents several thousand jobs. In 2018, out of £14 billion of arms exports, aviation represented 95%. More generally, the United Kingdom has already undertaken significant efforts to modernise its defence system, notably by replacing its AWACS and purchasing nine Poseidons for anti-submarine warfare. The people who gave testimony also highlighted that **preserving British skills in combat aviation is essential, even in light of new joint programmes with the Americans; these are the skills that, in their eyes, justify this cooperation.**

However, with Brexit and the consequences of the coronavirus crisis, **the budgetary context risks becoming difficult in the coming years for such a programme.** The integrity review, an overall budget review that should be completed and in which defence aspects are a major element, has been delayed to late 2020, possibly 2021. The £2 billion available for the technological assessment phase before 2025 seems insufficient, making it even more necessary to seek out partners, but the British are also looking for a massive industrial return to their territory, which will make cooperation more difficult. Additionally, while the United Kingdom's close cooperation with the United States has positive aspects, for example the access to American satellite intelligence or the return of 15% on all the F35s sold around the world (this windfall alone allows the United Kingdom to buy its own F35s), it is also a dependency that the Americans could use to apply pressure to prevent the development of a potential competitor.

Finally, Sweden and Italy's cooperation on the Tempest seems much less developed at this stage than France, Germany and Spain's cooperation on the FCAS.

4. Is a reconciliation between the FCAS and the Tempest possible?

In this context, what are the relations between the FCAS and the Tempest? For now, **the two projects do not intersect**, and there is less and less reciprocal interest. From the former joint fighter drone project, there remain some studies on "technological bricks" for a few dozen million euros per year, but the momentum is not there.

Reconciliation will probably be made even more difficult if the British project succeeds in truly internationalising, in particular with the entry of Turkey and/or Saudi Arabia, possibly Japan. Additionally, **negotiations for splitting tasks among the big industrial leaders within a single project, in particular Airbus, Dassault, BAE, Thales and Leonardo, would be very complex.**

Therefore, it is highly possible that the two programmes will compete directly. **This would be damaging to the construction of a European defence technological and industrial base.** It is not certain that Europe can afford two competing future combat air systems with an export base that is necessarily smaller than if there were just one programme, especially if the economic consequences of the coronavirus crisis are fully realised.

In any case, the fact that a reconciliation seems very difficult today is **all the more reason to equip the FCAS's demonstrator with a Safran engine, i.e. the Rafale's M88, instead of the J200 engine.**

<p><u>Proposal:</u> Take into account the Tempest's simultaneous existence as a competitor to the FCAS; the coexistence of the two programmes makes it more difficult to build the European defence technological and industrial base (EDTIB).</p>

COMMITTEE EXAMINATION

Meeting on Wednesday 15 July 2020, the Foreign Affairs, Defence and Armed Forces Committee, chaired by Mr Christian Cambon, Chairman, examined the information report by Mr Ronan Le Gleut and Ms H el ene Conway-Mouret on the future combat aircraft (FCAS).

Mr Ronan Le Gleut. - With the FCAS, the goal is not just to make a new Rafale or Eurofighter. By 2040, our adversaries will have formidable anti-air systems with a network of sensors, platforms and carriers that will allow for immediate responses, powerful cyber resources and high-velocity missiles. To this systemic threat, the FCAS will bring a system of systems. It will include a combat aircraft, the Next Generation Fighter (NGF), capable of carrying more missiles and of flying for longer with greater stealth and handling than the Rafale. It will be bigger and heavier, which implies a bigger aircraft carrier, as our colleagues Cigolotti and Roger have pointed out. It will also include an entire range of "remote carriers". These are drones entrusted with a wide variety of missions, from decoying to shooting, jamming to intelligence gathering. The third element of the FCAS is invisible but is the true heart of the system. This is the combat cloud: the interconnection of platforms with each other and with databases. Finally, there will be what I will refer to as a transversal pillar, artificial intelligence and function automation, present on all platforms, which will boost the pilot's effectiveness in collaborative combat.

Thus, I arrive at the first of our recommendations: if we do not want the FCAS to be obsolete as soon as it is commissioned in 2040 nor in the four decades that follow, we must not get the project wrong.

Of course, the combat aircraft, the first pillar of industrial cooperation in phase 1A that began in February, is very important. We can take pride in Dassault and Safran being the industrial leaders on the aircraft and its engine, respectively. However, the innovation needed lies just as much, if not more, in the combat cloud and AI.

Here, I would like to make a comparison. The Germans have understood that, with the development of autonomous vehicles, the added value risks shifting from the "car object" to artificial intelligence and data. It is exactly the same thing for the FCAS. For the moment, it is planned that the NGF be only optionally "unmanned", in particular because there are doubts about the capabilities of an autonomous AI in a highly complex tactical situation. However, we cannot exclude decisive progress by 2040 and beyond. We know that the Chinese and Russians are investing massively. The United States will also have an AI-equipped drone fight against a

manned aircraft next year. We must not find ourselves in the same situation as the best chess players in the world who can no longer beat a computer! Reducing the debate on the use of artificial intelligence to lethal autonomous weapons would be a caricature: the main challenge is the interface between people and AI to relieve the pilot's mental load and allow them to maximise all the platforms' contributions. Thus, we recommend that the development of AI be at the centre of the programme.

Another challenge for our capacity for innovation: the new engine. We have fallen behind the Americans, who make hotter, and therefore more powerful, engines than us. We must also develop the variable cycle technique to have a power profile that can adapt to different missions. Another key issue is the demonstrator's engine which is expected to be completed in 2026. It seems to us imperative to use the Rafale's engine, the Safran M88, instead of the Eurofighter's J200. It would be more coherent with the distribution confirmed by France and Germany, which made Safran the prime contractor for the engine.

Finally, breakthroughs are also needed on sensor technology. In this regard, choosing Spain as the prime contractor of the "sensors" pillar via INDRA is a good signal sent to this country who joined the cooperation with a slight delay over France and Germany, but who should now be integrated on an equal footing.

Now, I come to the issue of industrial cooperation. Remember that, after long negotiations, an initial contract of €155 million was agreed this past February with the major manufacturers by the DGA, the international leader of the programme, for the phase 1A of the demonstrator.

To avoid making the same errors as in the past – and here, everyone is thinking of the A400M – we must balance the best athlete principle, i.e. that each manufacturer does what it knows how to do best, with the principle of geographic return.

After difficult negotiations, France succeeded in implementing a strong organisation with a prime contractor and a main partner in charge of orchestrating the subcontractors' work for each of the programme's seven pillars. I will not go into detail on the Safran/MTU negotiations nor on the parallels that Germany requested with the future tank (MGCS), which was blocked for a time due to Rheinmetall. These episodes show us that we must remain extremely vigilant of several issues:

First, we must not let our German friends be told that they have been "poorly served". German companies are heavily represented on all pillars. Obtaining the prime contractorship of the combat cloud pillar over Thales is not insignificant for Airbus DS.

Next, we must not be content with the place obtained by our leading manufacturers, and we must make sure that our subcontractors are truly put to work by the German and Spanish prime contractors.

The third imperative: industrial property must be protected. In addition to the intangible protection of the background, i.e. the intellectual property already acquired on past programs, Dassault, Airbus and Safran must remain in control of what they invent during development while making available to the others that which necessary to maintain and develop the product. The Bundestag made its agreement to last February's contract conditional upon the German government's definition of the "key national technologies" that will have to be fully available to Germany. We know that this country wants to become more powerful in aviation and space, but the philosophy of such a programme does not allow for technological catch-up. Discussions must result in an agreement on industrial protection that is strong and balanced.

Furthermore, as Pascal Allizard and Michel Boutant noted in December, no place was made for ONERA, even though the German DLR is highly involved despite not necessarily being more experienced in military aviation. The minister has brought ONERA back into the game with a rather vague statement, and project leaders confirmed to us that they were working on it. ONERA could provide project management assistance to the DGA by analysing the future technological roadmaps from manufacturers, producing upstream studies on materials and combining its simulation capabilities with those of the DGA. Therefore, it is imperative that we clarify the last remaining ambiguities concerning ONERA's participation in the FCAS programme and encourage manufacturers to subcontract certain tasks to them.

Additionally, the FCAS programme could also contribute to our economy's recovery after the coronavirus crisis. Investment in defence can help to safeguard jobs in France in the supply chain of systems integrators and major equipment manufacturers. Also, the future combat aircraft will also take on the mission of dissuasion, which will necessarily bring activity to France. Additionally, as for health crises, we should not wait for a geopolitical crisis to invest! Thus, in our opinion, we and our two partners should think about accelerating the programme by planning for completion before 2040.

In conclusion, the FCAS programme is an exceptional opportunity for France, Germany, and Spain, for our strategic autonomy as well as for our defence industry. While many countries are content to develop new combat aircraft, we have chosen to stay at the forefront by developing not just a simple aircraft, but a system of systems. The recent setbacks of the F35, which cannot fly in lightning, shows that competition is healthy! However, the path forward is narrow. Let us hope that we have learned enough from former programmes to avoid making the same mistakes.

Ms H el ene Conway-Mouret. - Why make the FCAS with several countries when French manufacturers say that they are capable of doing it alone?

First, with the FCAS, we have the opportunity of advancing European defence with a concrete project in a French-German-Spanish partnership. Above all, it is a political project. Our industrial interlocutors should have this in mind. This project will be completed because it matches a clearly defined desire.

The first goal is to make French-German-Spanish cooperation smoother so that a decisive step can be taken in 2021. The negotiations between manufacturers in 2019 were delicate, of course, because the Bundestag put conditions on the agreement between Safran and MTU. It also insisted on a parallel timetable with the MGCS to approve funding. You know all about this; I won't go over it again.

For the surplus, our approaches are different. Germany fears the influence and weight of an experienced French military-industrial complex. Even more, it seems that they do not have the same understanding as we do of the stakes of strategic autonomy. France, on the other hand, is interpreting Germany's attitude as the expression of a desire to develop their national industry as a priority and gain new skills to protect jobs and support their industrial fabric. This goes for Spain, as well. Thus, this gives rise to fears of ulterior motives on the part of the three partners concerned.

To overcome these misunderstandings, which are mainly due to historical and cultural differences, we must exchange and share more. That is why we recommend drawing up and publishing a joint industrial strategy, potentially accompanied by a joint programming of capabilities. This would shed light on the link between national strategic autonomy and European strategic autonomy. Let us explain everything clearly, again and again.

But we should also be clear with our partners: the programme will not withstand repeated stalls and delays. That is why we recommend signing a global framework agreement early next year to commit the funding needed for the upcoming demonstrator development stages which would result in making the programme nearly irreversible. The idea is to go from a magnitude of a hundred million to a billion euros. Of course, it would be preferable that this new commitment arrive before Germany's parliamentary elections, which adds an additional element of uncertainty. We must be aware of this.

For their part, after long negotiations, the contracts with Spain's manufacturers should be signed soon. This country's entry is excellent news, especially considering that it seems fully committed industrially and militarily. We were pleasantly surprised by the enthusiasm of our interlocutors. This is perhaps because it is a very "Europeanist" country when it comes to defence and strongly favours European solutions. Also, Spain allows France to assume its natural role as a mediator between a Northern European country and a Southern European country. One of our proposals is to invite Germany to sign a treaty on exports with Spain similar

to the one signed by France and Germany on 23 October 2019. Indeed, Spain is encountering the same difficulties as we did on export restrictions.

We must also ask ourselves the question of expanding the programme to other European partners. If we choose cooperation instead of a strictly national—and thus narrower—option to build the FCAS, it is because we want to support the competitiveness of the European defence industry by lowering the cost of each additional system produced while sharing the costs of development—we are talking about €8 billion by 2030, which would allow us to export more easily—if the finished product is less expensive and ensure an initial market at the European level. It is always easier to convince a buyer when they have an interest as a producer in the object on the market!

There are potential points of convergence with European instruments of defence: Permanent Structured Cooperation (PESCO), the European Defence Industrial Development Programme (EDIDP), and the European Defence Fund. Above all, the FCAS is a unique opportunity to develop our own standards of interoperability. In this regard, synergy with the European Union could be a launchpad, notably via the EcoWar programme initiated by France, selected in the PESCO and which brings together Belgium, Spain, Hungary, Romania, Spain and Sweden. Countries disappointed by the F35's lack of interoperability with their other aircraft are interested in this project. By offering them solutions that allow an operational dialogue between the F35 and previous generations of aircraft, we can attract them into the FCAS's "orbit". Therefore, we recommend preparing this enlargement for the post-demonstrator phase when the cooperation between the first three countries has become sufficiently stable and sustainable.

Now, I would like to discuss the FCAS's innovative aspect. We are talking about a weapons system that will be operational between 2040 and 2080, at least. I fully share my co-rapporteur's analysis: imagining the future of air combat through an analogy with its current characteristics would be a mistake. In particular, an unprecedented effort must be made in the field of connectivity and the combat cloud, where Thales must play a full role alongside Airbus. It is also necessary to begin studying an integration of this combat cloud with the Scorpion Command Information System (CIS) immediately. The FCAS must be an open system that can interoperate with all our land and naval forces. It must also be developed incrementally. Thus, a cooperative combat system could be developed even before 2030 within the framework of the Rafale F4 and the air force's Connect@aero programme. Then, in the early 2030s, features of collaboration between aircraft and between aircraft and carriers could be implemented via the Rafale F5 in France and the Typhoon LTE in Germany and Spain.

As concerns artificial intelligence—the influence of which this project will not escape—we must continue to promote our Western vision

that accords with international law. I fully agree with the armed forces minister's statement that "France refuses to entrust the decision of life or death to a machine that could act fully autonomously and beyond any human control." We must restart international discussions to obtain a legal and ethical framework shared by all. Other countries that do not share our values are progressing very quickly in the field and could impose their standards. Meanwhile, the efforts of the agency for innovation, through its innovation acceleration and research projects, must be supported. We are also counting on the future "Red Team" with its science fiction authors to come up with truly original scenarios that will push our engineers to the limit! The FCAS is an upgradeable project. It is up to everyone to take advantage of this to promote fundamental research, innovation and creativity.

The search for very high performance must go hand in hand with concern for the environment. We consider that innovation must also happen in the field of energy savings, in continuity with the "energy strategy" the armed forces minister presented on 3 July.

The FCAS's innovative, perhaps revolutionary, character will be one of the conditions that will make it exportable, an imperative that we do not ever want to lose sight of. To stand out, the FCAS must have exclusive and unprecedented "technological bricks".

However, this exportability is partially threatened by the British programme that it would be dangerous to lose sight of, the Tempest, the successor to the abandoned Franco-British FCAS project. Italy and Sweden are associated with this project; Turkey, Japan, and Saudi Arabia have been approached with a view to financial cooperation. It is expected that the programme will be completed in 2035, 5 years before the FCAS, even if this deadline seems ambitious to us. This project is carried by true political will since the British share our desire to maintain their expertise in combat aviation. For the moment, it is difficult to imagine how the two programmes could converge. This poses a challenge to gradually unifying the European defence industry and technology base if it were to be confirmed that the Europeans were separating into two competing groups. This opposition, or rather this rivalry, would be amplified by a convergence with the American system being developed which is very similar to the FCAS and the Tempest.

In conclusion, for us the FCAS is both an unprecedented occasion – the first of this scale, but also the last if it fails – to build a true EDTIB and a possibility of maintaining a complete model of armies. Despite a rather slow start in 2019, the negotiations progressed well and resulted in agreements. The coming months will be decisive, with Spain's full integration and, we hope, a new pluriannual framework agreement that will give a definitive momentum to the programme. Therefore, this report hopes to contribute to its success, because it has the potential to change the era and dimension of European defence cooperation!

Mr Olivier Cigolotti. - Your report is very clear, precise and complete. I would like to ask you two questions. The first is related to ONERA: the Senate had called for it to be integrated into France's team in charge of the FCAS. Where does that stand? Were you able to clarify this issue during your hearings, and did you obtain the assurance that ONERA would be involved in upstream studies? Should we be concerned that its intervention will only be piecemeal in the overall definition of the project?

My second question relates to the next generation aircraft carrier (PANG), the subject of a report which I recently presented to our committee with our colleague Gilbert Roger. The FCAS project and the PANG project are very much related in their technological compatibility and in their schedule. The FCAS's demonstrator must be ready not later than 2026 to not delay the PANG project. You support using the Rafale's engine, and I fully agree. In the context of the pandemic that we have experienced, Safran was heavily impacted, as witnessed by the announced closure of 25 sites and the heavy use of partial unemployment. Do you think that the demonstrator could really be ready in 2025-2026? If not, that would have real consequences for the PANG.

Mr Jean-Pierre Vial. - Your report on the FCAS, like the previous report on the PANG, established that our future weapons must participate in European defence. We can only agree, but it is essential to defend our expertise. In this field, France has a head start, true mastery of the technology and renowned expertise. There is no question of our total support for the idea of European defence, but we must also defend our industry. I remember a hearing with the Chief of Staff of the Army on the future tank which, above all, allowed us to understand the role that we will not have in this field.

Our technological excellence has a hard time translating into market share, so we must never lose our expertise and our head start. I also make the connection with the position given to ONERA. ONERA's wind tunnel unit, an excellent, state-of-the-art facility, is in my *département*, and it has been modernised at the cost of significant investment. However, this did not prevent ONERA from being side-lined from some previous projects. This must not be the case for the FCAS: we must be vigilant on this contract.

Mr Olivier Cadic. - The issue of whether or not a pilot was to be present came up during the creation of the first Rafale. You remember that we hesitated on whether to equip the aircraft with one or two pilots. In December 1985, just before the presentation to President Mitterrand, I observed that the demonstrator ultimately had a single pilot seat, but the manufacturers confided in me that this pilot seat could be removed, and that a pilot's involvement was already no longer necessarily a part of all missions. This issue is also present for the FCAS's design.

It is difficult to work on such an ambitious project with several countries. When the Eurofighter's design was being considered, Dassault warned the public authorities of the losses that our country would see if we chose that path. After participating in some of your hearings, I am wondering why we are doing something complicated when it could be simple; French manufacturers have confirmed that they could complete the FCAS project by themselves. While I am a convinced European, I would like a review of the costs and benefits of these two possible approaches to producing the FCAS: a national approach and European cooperation. We are approaching this politically when this project should be examined from a perspective of its technological capabilities. Ultimately, it is soldiers and not members of parliament who will use this weapons system. Let us not forget that if we had chosen the Eurofighter, we would still not be satisfied. The initial technological specifications meeting military needs still has not been achieved as yet.

Ultimately, should we not consider a plan B? If our partners blocked the project at a moment in its development, what do we have planned to face it? I would like the recommendations in our report to include a consideration of a plan that guarantees that the FCAS will be completed should the partner countries leave or block the project. Assessing the possibility of a national alternative makes sense and would have consequences for the national defence industrial base. How would we respond to a similar call for tender once the FCAS is complete?

Ms H el ene Conway-Mouret. - We would not be selling an aircraft but a system of systems.

Mr Olivier Cadic. - Certainly, but at some point the issue of knowing whether we will be able to export it will come up and will have a decisive impact on our national industry and maintaining our current advantage in aviation technology and project management.

Mr Pierre Laurent. - What is the status of the negotiation of this multi-year contract that would be decisive?

Mr Bruno Sido. - I, for one, am worried. There are the examples of the A400M and Ariane 6. This does not correspond, technologically and financially, to the needs of the future. I hope there will be a single FCAS so as not to restart the A400M. I hope that everyone works on what they do best, not like on Ariane 6, and that we take great care on the costs, otherwise we will only be able to buy four or five aircraft... Additionally, with the increase in the debt, the perspectives are gloomy.

Mr Ronan Le Gleut. - The size and weight of the aircraft will indeed have an impact on the aircraft carrier. With the requirements for stealth and the carrying capacity, we are going from 15-metres long and 24 tonnes maximum for the Rafale to maybe 30 tonnes for the FCAS. The F22 measures

19-metres long and 35 tonnes at most. The model NGF is 18-metres long. Admiral Prazuck told the Senate about a weight of 30 tonnes.

Ms H el ene Conway-Mouret. - We were surprised by ONERA's absence. Of course, the aircraft is important, but it can only work if connected to all the other platforms. It must also be interoperable with European platforms. We are at the first stage. It is normal that manufacturers are positioning themselves, but we must also ask ourselves what influence France and Europe will have in 2040. We are developing a system that will be operational in 20 years: there are a lot of unknowns in the equation! The DGA told us that ONERA will have a role to play: we think it should be central.

Mr Ronan Le Gleut. - The DGA and the air force told us that work had continued during the lockdown. The real issue is about political schedules: September 2021 for the German parliamentary elections and 2022 for the French presidential. Hence our insistence on the first half of 2021.

Ms H el ene Conway-Mouret. - Germany is making a new contract conditional upon an agreement on industrial property. If we go to a billion in investment, it will be harder to step back. Furthermore, the British Minister for Defence Procurement told us that the Tempest was of existential importance for his country, as the FCAS is for us. The British need to maintain their skills even in the framework of their cooperation with the Americans. So they approach the issue globally and with great care for innovation. They do not plan on a demonstrator. I do not know if their method is the right one, but it is worth studying.

Mr Ronan Le Gleut. - There is no doubt that France has a technological advantage. We don't want to sell the family jewels. But costs are also skyrocketing. Indeed, the point is to create not just an aircraft but an entire swarm with the remote carriers. It is a considerable technological breakthrough. It will be much more expensive than the Rafale, and France's resources alone will not be enough. If we do not make a success of this technological breakthrough, we will lose our superiority on the battlefield. Beyond industrial competition, it is a question of operational superiority. This is the real order of priorities. The question of industrial property is essential in this field. We must protect the background and share the foreground in balanced conditions. Also, the expertise is above all in the brains of the engineers!

Ms H el ene Conway-Mouret. - Obviously, we must be concerned with the issue of exportability. It would be a mistake to dwell on the difficulties between manufacturers. We must think about these questions: who will we sell the FCAS to and why? If we do not advance at the European level, we will never do it. It is currently the most promising project for the future, if only because of the technologies' dual nature. Additionally,

the innovations within the framework of the FCAS could be used to modernise current equipment.

We have always believed in European defence. The official stances are evolving gradually. We must not stop with the cooperation with the Germans and the Spanish. It is no doubt a shame to have missed the boat with the Italians. After the demonstrator, we must enlarge cooperation.

Mr Ronan Le Gleut. - One of the principles set for the FCAS is the "best athlete". This comes from experience on the A400M, where this principle did not prevail. Today, everyone agrees on this principle, and it shows in how the pillars are divided up. It is encouraging. And France is the leader on the FCAS: the DGA is steering it.

Mr Jean-Pierre Vial. - It is a dream that we want to realise together, but let's not forget about the extra costs due to German complexities on the EPR! On the FCAS, should we not be thinking about a European aircraft carrier for the FCAS to land on?

Ms Hélène Conway-Mouret. - That is a relevant question. When Jean Monnet started the European cooperation, he chose a step-by-step policy. He advanced little by little.

Mr Ronan Le Gleut. - All our proposals express prudent optimism.

Mr Christian Cambon, Chairman. - Are the British totally opposed to a convergence of the FCAS and the Tempest? We should investigate this question.

The committee adopts the information report.

LIST OF PERSONS CONSULTED AND TRAVEL

- *Cabinet of the Minister for the Armed Forces*: **Mr Hervé Grandjean**, advisor,

- *Direction générale pour l'armement (DGA)*: **Mr Joël Barre**, General Delegate and **Ms Eva Portier**, General Engineer, "Engagement - Combat" defence systems architect, operational manager of the FCAS programme,

- **General J.P. Breton**, Airborne Division General and **Ms Eva Portier**, General Engineer, operational manager of the FCAS programme,

- *Agence d'Innovation de la défense*: **Emmanuel Chiva**, Director,

- *Secrétariat général de la défense et de la sécurité nationale (SGDSN)*: **Mr Jean-Hugues Simon-Michel**, Director of International, Strategic and Technological Affairs.

- *Airbus*: **Mr Philippe Segovia**, Air France Key Accounts Director and representative of the FCAS France programme, **Mr Bruno Fichet**, FCAS Programme Director, **General Guy Girier**, Defence Advisor to the President, **Mr Philippe Coq**, Permanent Secretary for Public Affairs and **Ms Annick Perrimond-du-Breuil**, Director of Relations with Parliament,

- *Dassault Aviation*: **Mr Eric Trappier**, Chief Executive Officer,

- *MBDA*: **Mr Eric Béranger**, Chief Executive Officer, **Admiral Hervé de Bonnaventure**, Defence Advisor, and **Ms Patricia Chollet**, responsible for relations with Parliament,

- *Safran*: **Mr Alexandre Ziegler**, Group Director of International and Institutional Relations, **Mr Fabien Menant**, Director of Institutional Affairs, and **Mr Christophe Bruneau**, Director General of the Military Engines Division,

- *Thales*: **Mr Philippe Duhamel**, Deputy Director General, Defence Mission Systems, **Mr Bruno Depardon**, Director of FCAS Strategy, **Mr Thierry Calmon**, Director of FCAS, and **Ms Isabelle Caputo**, Director of Parliamentary and Political Relations.

- *Institut des relations internationales et stratégiques (IRIS)*: **Mr Jean-Pierre Maulny**, Deputy Director.

In Berlin (2 March 2020)

- **Mr François Devoto**, First Secretary, Embassy of France,
- **Mr Peter Härster**, FCAS Project Manager at MTU,
- **Mr Dirk Hoke**, CEO of Airbus Defence and Space,
- *Bundestag* MPs: **Wolfgang Hellmich**, SPD (Chairman of the Defence Committee), **Dr Fritz Felgentreu**, SPD, **Rüdiger Lucassen**, AfD, **Katja Keul**, Die Grünen.

For Germany

- **Gernal Badia**, head of planning at the Ministry for Defence.

For Spain

- **Mr Jean-Michel Casa**, French Ambassador to Spain, **Ms Shanti Bobin**, Head of the Regional Economic Service, **Ms Rachel Caruhel**, Second Advisor for European Affairs, **Mr David Machart**, Chief Engineer, Deputy Defence Attaché and Armaments Attaché in charge of the FCAS programme, **Colonel Xavier Toutain**, Defence Attaché,
- *Spanish Ministry for Defence*: Divisional General **José Luis Murga Martinez**, Deputy Director of Planning and Innovation in the Directorate General for Armaments and Materiel, Navy Captain **Mr José Luis Nieto Fernandez**, Head of the Integrated FCAS Project Team in Spain, Lieutenant-Colonel **Pedro Luis Pablo Asensio**, FCAS Team.
- **Mr Paul Everitt**, Director of ADS (a grouping of Spanish defence companies).

For the United Kingdom (Tempest programme)

- *Defence mission of the French Embassy in London*: **Rear-Admiral Luc Pagès**, Defence Attaché, **Colonel Patrice Hugret**, Air Deputy Defence Attaché, **Nicolas Drogi**, Chief Armament Engineer, Arms Deputy Defence Attaché, **Sébastien Le Bouter**, Senior Armament Engineer, Deputy Attaché Arms,
- **Mr Jeremy Mark Quin**, Minister of State (Minister for Defence Procurement), **Mr Berthon**, Director of Air Combat at the Ministry for Defence,
- **Mr Tobias Ellwood**, Chairman of the Defence Select Committee in the House of Commons.

For the European Union

Mr Yves Caleca, Armaments Advisor to the France's Permanent Representation to the European Union.

For NATO

Mr Camille Grand, Deputy Secretary General of NATO.