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Future Combat Air System: Too Big to Fail

Differing Perceptions and High Complexity Jeopardise Success of Strategic Armament Project

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The development of the Future Combat Air System (FCAS) is Europe's most important defence project. Both technologically and militarily, the project has the potential to set new standards and revolutionise the use of air power. Politically, the multinational project is a litmus test for the extent to which Europe is capable of cooperating on security policy, developing its own capabilities and putting national interests to one side for this purpose. The success of the project rides to a great extent on Germany and France. However, the different perspectives and procedures of these two countries place FCAS at risk of collapse – a failure that would have serious disadvantages for all involved.

The beginnings of the Future Combat Air System date back to 2001, when the first studies were carried out on the development of new combat aircraft by a European alliance. The FCAS project is scheduled to be ready for deployment by 2040. The term Future Combat Air System or its acronym FCAS is often used in a misleading way. Although there are, of course, connections to the successor solution for the Tornado fleet, FCAS is much more than a combat aircraft project.

The German government's military aviation strategy describes it as a "system of systems" that is to form the backbone of the air force in the long term. FCAS is in fact not a single flying platform, but rather an operational network composed of existing systems (e.g. Eurofighters or Tiger combat helicopters), but also new platforms such as the Eurodrone and a Next Generation Weapon System (NGWS). The NGWS is the innovative core of the FCAS project. It consists of a new fighter aircraft, the Next Generation Fighter (NGF), as well as remote carriers (RCs), all of which are connected to each other in a protected data exchange system called the Air Combat Cloud (ACC).

FCAS and NGWS are not synonymous, but the latter is an integral part of the former. The overarching FCAS system can be imagined as an arrangement of concentric circles: In the centre is the NGF, the next generation combat aircraft. In the inner circle, together with the remote carriers, is the Next Generation Weapon System,

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which is connected and controlled via the Air Combat Cloud. In the outer circle, the NGWS is linked with other systems. These include fighter aircraft, such as the Eurofighter or the French Rafale, but also tankers, naval vessels, satellites and assets of the other integrated armed forces. This is what makes up the Future Combat Air System, in which all elements must constantly communicate with each other to form a cohesive system.

The military value will therefore lie less in the individual platforms than in the way they are combined. If this architecture is transferred to the Bundeswehr's existing systems, it means that the Eurofighter will be further developed and will continue to be operated within the FCAS framework, while the Tornado will be replaced by another system that will also have to be integrated into the FCAS.

The conceptual complexity makes a fact-based debate difficult. Some publications are dedicated to FCAS, but in essence only refer to the combat aircraft component. This results in a loss of definition and depth of detail. Reducing FCAS to the NGF component underestimates the complexity and scope of the project and neglects relevant subcomponents such as the development of remote carriers, i.e. the development of a technology for armed drones that are at least semi-autonomous.

The actual form FCAS takes may differ across the different partner nations, and the integrated platforms may vary. It is possible that in the future, individual states will only use the inner circle with the NGWS or only deploy the NGF or individual remote carriers in their armed forces. Despite all these options, it is important that FCAS is always understood as an overarching system. The design of the project's architectural framework takes this into account. FCAS is divided into a total of seven development fields (pillars), each of which is led by one company (see Figure 1).

Development within these separate pillars proceeds at different speeds and on the basis of separate contracts. The system follows an incremental approach. The explicit intention is not to wait until all components have been fully developed, but rather to make interim results available in order to gather practical knowledge for the rest of the process.

Germany and France are key players in the development fields, while Spain joined the organisation at a later stage. Opportunities for Spanish companies to participate arise firstly from gaps that are still emerging and need to be filled in a meaningful way and, secondly, from Spain's industrial policy interests. Although it is emphasised that all seven pillars will make significant contributions to future developments, the most tangible and formative results are certainly to be expected in the areas of aircraft development, including the engine and drones (remote carriers).

The perception of FCAS as a Franco-German project has in fact become obsolete since Spain joined. In view of the division of development packages between Germany and France and the progress of the project, this view nevertheless remains valid. One of the central tasks for the further development of the project is the full integration of Spain, which can also serve as a blueprint for the later inclusion of other partners. Here, it is important to allow Spain to participate in the progress of the project as quickly as possible to create a common starting point for the three sponsoring nations.

Cultural and Structural Differences between Paris and Berlin

Germany has previously favoured multinational European cooperation for the Tornado and Eurofighter. France, on the other hand, has opted for national development approaches. Berlin and Paris are unequal partners, united in an ambitious, sometimes visionary armament project. However, their different political and strategic cultures also influence joint projects such as FCAS. France's centralist presidential system contrasts with Germany's strong parliamentary system, while France's claim

Figure 1

Design architecture of FCAS (Future Combat Air System)

Pillar	Aircraft	Engine	Remote carrier	Cloud solutions	Simulation	Sensors	Stealth
Key partner	*Dassault Aviation*	*Safran Aircraft Engines**	*Airbus*	*Airbus*	Co-contracting of partners	*Indra Sistemas*	*Airbus*
Associate partner	*Airbus* *Airbus*	*MTU Aero Engines** *ITP Aero*	*MBDA* *MBDA* *Satnus*	*Thales Group* *Indra Sistemas*	*Airbus* *Dassault Aviation* *Indra Sistemas*	*FCMS* *Thales Group*	*Airbus* *Dassault Aviation*

* Joint venture for lead role in engine pillar between *Safran* and *MTU* scheduled for 2020

Pillars with German lead

Germany
France
Spain

to be capable of unilateral military action contrasts with Germany's orientation towards multilateral structures. FCAS is therefore just as much a political project as a military one — misunderstandings and thus risks can always arise from the above-mentioned differences, and these need to be addressed at the governmental level. In view of the complexity and the manifold implications of the project, the German participants need to be clear about their own, the French and the general European interests.

In FCAS, the "best athlete" principle is applied: Each participating company is responsible for the area in which it has already proven capabilities. The individual nation heading/leading a specific pillar will be supported by a main partner. This division mainly pertains to the upcoming demonstration phases of the project (phase 1B and 2).

A crucial question that arises at this point concerns the protection of emerging or existing intellectual property: to what extent should companies disclose their processes and know-how, to what extent will technical specifications be made available to the other partners later? An agreement on how to deal with intellectual property rights (IPRs) is essential for the further progress of the project and impacts many other issues. For example, how the use of the individual components is organised will ultimately depend on this. Are maintenance and repair work only to be carried out by the lead manufacturer, or is access to the documentation guaranteed to such an extent that this can largely be done within the armed forces supported by national industrial cooperation? If only the manufacturer can and is permitted to carry out certain parts of the maintenance, this might also affect operational readiness.

Legal questions like this are also relevant for adaptations to and further developments of FCAS, such as the integration of new weapons or avionics systems. Today, Germany and France use different, to some extent nationally developed armament systems for their aircraft. If certain parts of the technical documentation remain under lock and key, a bottleneck could also develop here.

In addition to these rather practical impacts of the aforementioned legal issues, industrial policy aspects also play a particularly important role. German interests in terms of national key technologies (e.g. sensor technology and electronic warfare) and French interests in maintaining national

industrial strategic autonomy (e.g. the ability to develop a fighter aircraft completely independently) come up against each other. The goal of a European solution needs to be to minimise, ideally completely avoid, technological black boxes, as is often the case now with US imports. Before FCAS can proceed to Phase 1B and thus towards the development of demonstrators, these issues must be resolved and contractually fixed in the individual project pillars.

Berlin and Paris each pursue their own national (economic) interests in industrial policy. France's defence sector, however, is structured fundamentally differently from its German counterpart. The French defence industry is closely interlinked with the state and resembles a cohesive entity. The state-run *Direction générale de l'armement* (DGA) functions as the highest level of coordination for all defence projects and the central point of contact for all equipment issues. However, it is more than just a French procurement office. For example, the DGA is responsible for a national pool of military engineers (*corps des ingénieurs des études et techniques de l'armement*, IETA), who are specifically trained through assignments in the military, but also in industry placements. Thus, there is a much higher degree of permeability between the army and industry, as well as strong cultural and personnel links. The government has no qualms about being linked with the defence industry; on the contrary, the flow of information between government and industry is formalised and a natural part of national defence policy.

The German side not only lacks an institutional counterpart to the DGA; German industry is also far less homogeneous. This imbalance both from an institutional perspective and in terms of the engineering culture leads to misunderstandings on both sides. Whereas in France the DGA, as the point of contact, centrally controls everything, from signing the contract to issues around development and utilisation, in Germany various actors play a role, both internally and externally: the government, represented by the Ministry of Defence and Ministry for Economic Affairs, respectively; the Bundeswehr, through its procurement office (BAAINBw); and finally, industry, through individual companies or through its umbrella organisations, each with different roles and interests. This structural difference generally favours France's position and especially in the case of the fighter aircraft, where it is the development leader. Ultimately, this also shows that the German procurement process needs to be reformed.

The Different "Generations" of Fighter Aircraft

The French-led Next Generation Fighter, the core of FCAS, is also described as a sixth-generation fighter. It would thus formally be at the forefront of technical development. The US F-22 and F-35 models, for example, form the so-called fifth generation, which are currently the most modern fighters.

Fighter aircraft have long been divided into generations by experts. This system makes it possible to distinguish fighter aircraft models without having to deal with the exact technical specifications each time.

The categorisation is essentially based on the characteristics of the technical stage of development and the period of development. The division into generations is therefore rather sketchy and becomes blurred at the transitions between two levels. Furthermore, the generations in question are not uniformly defined, generally recognised standards. There are even several approaches to the division of generations, some of which differ greatly from one another. In 1990, for example, the historian Richard Hallion already identified six generations, whereby the then common, now obsolete designs such as the Tornado, Mirage 2000 or F-14 represented the sixth and most modern generation.

These days, more common systems use a different methodology, which is focused more on technology than era. The model published by the American Air Force Magazine in 2009 is particularly widely used (see Figure 2). It identifies five existing generations based on technological milestones.

Figure 2

Review of fighter jet generations
Differentiation by characteristic technologies

Generation 1	Generation 2	Generation 3	Generation 4	Generation 4+	Generation 5	Generation 6
· Jet propulsion	· Swept wings · Range radar	· Supersonic · Beyond visual range missiles	· Pulse-Doppler Radar · Look-down/ shoot-down capability	· Sensor fusion · Multirole · Datalinks	· Stealth · Supercruise · Network integration	· Optional manned · Extremely sensitive sensors · Teaming (manned/unmanned)
e. g. *Me 262*	e. g. *F-86, MIG-15*	e. g. *F-4, MIG-21*	e. g. *F-16, MIG-29*	e. g. *Eurofighter, Rafale*	e. g. *F-35, F-22*	e. g. *NGF, Tempest, F/A-XX*
						

This system presents the prospect of a sixth generation as the next step in development, to which it attributes features such as optional manning. The Tornado and the Eurofighter are classified as Generation 4 (Tornado) or 4+ (Eurofighter), which is also the consensus in the German discourse on the issue. The French Rafale (4+) and Mirage 2000 (4) are on the same spectrum. The assignment of an aircraft type to a certain generation can therefore be quite controversial and is ultimately always an aspect of the marketing efforts of the manufacturing companies.

For each generation, several criteria have been defined that must be fulfilled for classification. What is unclear, however, is whether these criteria can be weighed against each other. For example, does better radar capability compensate for a lack of speed?

If the term "generation" is used, it must be complemented by further classification and explanation rather than being used as a standalone designation. The label "Next Generation", as used in the components of FCAS, refers to the system described (see Figure 2), but also allows other interpretations. If the claim that the NGF is to be a sixth-generation fighter is accepted, the F-35 is considered the technological benchmark. This also implies that one generation needs to be skipped if we are to get from the Eurofighter to the sixth-generation NGF without an intermediate step. This is unlikely to be possible, above all, because characteristic features of both the fifth and the sixth generation, such as stealth technology, have not yet been manufactured by any of the companies involved and are considered very ambitious technologies.

On the other hand, the term "next generation" can also refer to the aircraft that exist today. This would relativise the NGF somewhat, because it would then "only" be classified as being more modern than the Eurofighter and Rafale and would no longer have to explicitly form the sixth generation. From a German point of view, it is reasonable for the development of the NGF to consider the technological status of the Eurofighter as a basis. In this case, further development in the direction of the NGF should primarily take place in those areas that the Eurofighter does not currently cover, i.e. primarily electronic combat as a key national technology.

The Nuclear Dimension of a Future Combat Air System

Questions of technology sovereignty and the generational allocation of the NGF also play a decisive role when it comes to the nuclear capability of FCAS. France regards nuclear deterrence as an essential corner-

stone of its own and European sovereignty and has earmarked 37 billion euros for it in its military budget until 2025. With around 300 warheads, France's nuclear potential is the fourth largest in the world. In addition to ballistic missile-equipped submarines, France has nuclear cruise missiles that are carried by the Rafale fighter aircraft, partly from aircraft carriers. From a French perspective, the NGF, as the successor to the Rafale, must be capable of performing this task. Two capability requirements result from this: firstly, the carrying of the nuclear stand-off weapon ASMP, and secondly, the capability to operate from aircraft carriers.

For Germany, the link between FCAS and the nuclear role is more indirect. Today, the Bundeswehr participates in NATO's nuclear sharing with its Tornado fleet. In addition, nuclear gravity bombs are stationed in Germany. The future of this role is politically controversial. Among other things, critics are calling for an end to nuclear sharing, since it does not guarantee any influence on US nuclear strategy and the use of nuclear weapons is ethically unacceptable under international law. This debate crystallised around the question of the successor to the Tornado.

From the federal government's point of view, the continuation of nuclear sharing is a fundamental capability requirement in the choice of combat aircraft. The opposition, on the other hand, tabled a motion in the German Bundestag to end operational nuclear sharing and no longer certify a combat aircraft for this purpose. In April 2020, the Federal Ministry of Defence (BMVg) proposed a solution whereby it would like to replace the Tornados in the German Air Force with American F-18 models (Generation 4+). It refers to this as a "bridging solution" because the aim is to ensure operational readiness in the period between the imminent phase-out of the Tornado and the NGF, which will presumably not be available until 2040. However, there is no concrete indication of how the nuclear role will be taken into account in the future.

If the "bridging" logic is followed, the American F-18 would be the next nuclear weapon carrier in this scenario. However, this aircraft does not have the necessary nuclear certification from the USA. Later, the NGF would have to take over the nuclear role, for which it would also need certification. This circumstance appears particularly problematic from today's perspective: Firstly, a technical solution would have to be found to meet the requirement that this aircraft would have to be able to carry both the American and the French weapon. There is currently no aircraft capable of doing this. It would make the project even more complex because not only technical (gravity weapon vs. cruise missile) but also confidentiality aspects would have to be clarified.

Secondly, the question of whether the Eurofighter could be certified as a nuclear carrier has already shown that this issue will be associated with major hurdles. For this certification, the technical documentation of the fighter and all other equipment involved in the mission must be disclosed on a regular basis. Since all user states must give their consent, the matter is very sensitive for reasons of military and industrial secrecy. Since the NGF will officially be the French nuclear weapon carrier, it is part of France's strategic autonomy. The necessary French approval for certification therefore seems uncertain from today's perspective — after all, this is also a question of intellectual property rights, an issue which is a common thread running throughout the project.

If Germany sticks with the F-18 bridging solution, it might have a new nuclear carrier, but would face the challenge of integrating this aircraft into the overarching FCAS system. An implicit weakening of the alliance and additional costs for fleet management would be the result. In the worst case, it could even become apparent that the NGF would not be considered a replacement in the nuclear role. Since Germany might not have a successor for the F-18s, it would be forced to use a Generation 4+ system for decades.

Even today, doubts are being raised about the operational suitability of airborne nuclear sharing and the older the carrier

aircraft, the more justified these qualms in fact are. It is therefore not unlikely that the bridging solution will either become permanent or that nuclear sharing in its current form will be put into question nolens volens. Germany and France tackle this dimension from different positions on deterrence and sovereignty, which is reflected in the debate on development at all levels. FCAS is undeniably a nuclear project as well. Paris articulates this clearly; Berlin must not ignore this reality, but instead should also assert their rights to shape it in this context. The future of nuclear sharing should be explicitly addressed in the next legislative period. If the German government simply allows FCAS to continue in this direction, it will limit its own scope for action, which may have consequences for Germany's role in NATO.

Outlook and Recommendations

The different strategic cultures of Germany and France are evident in many areas. FCAS is another context which makes the partners aware of their differences but at the same time also of their mutual dependence. From the French perspective, the project is both an expression of European sovereignty and an essential component of national security and industrial interests. In Germany, this strategic significance is lost in a thicket of responsibilities within the procurement process. For the further course of the project, it is important to change the way it is perceived. A stronger commitment on the part of the Federal Chancellery can help to achieve this.

FCAS is not just another expensive armament project, it is so much more than that. It aims to develop and cultivate technological excellence within Europe that is capable of having an impact far beyond the military sector. Applications such as secure European cloud services or unmanned autonomous flight control are technology drivers whose potential is just as relevant for civilian use. Development and data sovereignty are closely linked to the call for European products to be used as a matter of priority. This is one of the reasons why it is so important to view FCAS as a holistic system.

The project schedule is very ambitious given the complexity of the project and the many unknowns. The first flight of the NGF planned for 2035 and the start of the roll-out in 2040 will only be possible if all measures run smoothly without delay, which is unlikely from today's perspective. The most pressing issue is the regulation of IPRs.

We have to accept the fact that there will of course be some delays. Additional postponements due to political ambiguities, lack of financial security and procedural inconsistencies must, however, be avoided. The German side is certainly lagging further behind. A necessary vehicle for improvement is a fundamental reform of the procurement process.

Making the project a political priority is both expedient and feasible in the short term. In light of the political explosiveness and military significance of the project, a future German government should name FCAS as a priority and European lighthouse project in the coalition agreement.

Within the framework of a Defence Planning Act as part of a reform of the armament process, the next project phases could be defined and financed on a multi-annual basis. On the one hand, this would send a strong signal to Paris, and, on the other, it would provide planning security for the German armed forces and industry.

In addition, the European perspective of the project must be expanded. This also includes considering the project, particularly the NGF component, as an export commodity and ensuring corresponding regulations. The task of future federal governments will be firstly to fully integrate Spain and then to find other partners in the medium term, but as customers rather than developers. The later developers enter the project, the more complex their participation will be, because construction sites that have already been closed would have to be reopened. The NGWS part of the project, in particular, is further advanced than other comparable projects in Europe, such as the British Tem-

pest; further integration efforts should not endanger this lead.

France, Spain and Germany currently do not have a fifth-generation fighter aircraft, unlike the UK or Italy, for example. For all three FCAS countries, the NGF is an essential part of the future plans of their air forces. Technologically, however, the idea of moving straight from the fourth generation to the sixth and setting the benchmark is extremely challenging. Overly optimistic expectations should be tempered, irrespective of justified ambition. The objective must be to develop a platform that represents a significant advance on both the Eurofighter and the Rafale and, moreover, is capable of competing with the F-35 in the market. Defining a Generation 5+ such that the jet becomes the European standard, would be better than coming up with an expensive solution that emulates the "real" sixth generation but cannot be fully used by any state.

As far as the timetable is concerned, the issue may arise as to whether more emphasis should be placed on completing the NGF portion. France's interest in this is likely to be very high, if only in view of its lead role in this segment and the lack of alternatives in the area of combat aircraft. Although the overarching idea must be to see FCAS as a comprehensive system, prioritising the most tangible part of the project may be the most sensible move under certain circumstances.

If this project is not successfully completed within a European framework, future major joint armament projects in Europe will become increasingly unlikely. Efforts to consolidate European armament cooperation would be thwarted, and dependencies on US manufacturers would continue to grow. The partners must remain acutely aware of this pan-European responsibility.

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