

Europe and the Future Combat Air System

edited by Alessandro Marrone and Michele Nones

ABSTRACT

The development of the next generation of combat aircraft, to be part of a system of systems with satellites, drones and other military assets, does represent the main technological challenges for air forces and aerospace industries in Western countries. This study analyses the approach to the Future Combat Air System (FCAS) in the US as well as in France, Germany, UK, Italy and Sweden, from the military, industrial and political points of view. Two competing initiatives are unfolding in Europe: a Franco-German project and the Tempest programme led by the UK. Such a competition creates a strategic choice for Italy, since Rome has to decide which next generation combat aircraft develop, from now on, to succeed the Eurofighter in service until the 2040s – while continuing the F-35 procurement and use. The study analyses the pros and cons of both initiatives, and recommends Rome to negotiate with London the joint development of a European FCAS, despite Brexit. A cooperation which should in the mid-term merge with the Franco-German project for the benefit of European defence and strategic autonomy.

European defence | Brexit | Military industry | Aviation | USA | UK | France | Germany | Italy | Sweden

keywords

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Executive summary

The global context

The evolution of the international security environment and the features of defence procurement require Western countries to plan well in advance for the future of their air power – including the Future Combat Air System (FCAS), which is to be used by air force and navy-aviation forces in the medium to long term. The FCAS is also known as the 6th-generation fighter aircraft, although it is generally understood as a “system of systems” centred around a fighter aircraft. In the field of defence procurement, a generational change may occur for several reasons. First, existing platforms may become obsolete if breakthrough technological advancements and new requirements take place in key areas, such as the quest for higher speed and faster propulsion systems, electronics and net-centric capabilities, stealthiness or composite materials. Second, technological improvements or upgrades (e.g. to stealthiness) may, at a certain point, be no longer possible to install on existing aircraft through retrofitting campaigns, thus requiring replacement of the platform itself. Third, generational turnover is accelerated when major military powers compete to gain (or maintain) their armed forces’ strategic advantage vis-à-vis competitors with comparable assets – as is currently happening in an increasingly multi-polar international system marked by aggressive geopolitical competition. Not surprisingly, the overview of air power’s military and technological “state of the art” in six major countries outside of Europe and North America – namely, China, India, Japan, Russia, South Korea and Turkey – reveals a worldwide pathway towards new-generation aircraft. This in turn provides the inescapable background for US and European choices about the strategic advantage of their militaries in the air domain, as well as the future of their aerospace and defence industries.

The United States

In the US, the military rationale for recapitalising America’s combat-aviation fleets is to continue the air dominance that its armed forces have enjoyed since the mid-1940s, particularly vis-à-vis Putin’s aggressive Russia and the upcoming Chinese

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peer competitor. This challenge suggests that the next generation of aircraft meant to penetrate enemy territory will need at least as much stealth, at least in their defence-suppressive abilities, and a longer range than today's models. Stealthiness is first and foremost a matter of shaping, and secondarily of materials and coatings – and new ways of enhancing that sought-after stealthiness are emerging. Whether the FCAS will be manned is an open question. The US Government and its armed forces are rather more comfortable than those of most European countries with remote and autonomous weaponry, and the US defence industry is keen to explore technological possibilities without the pilot in the cockpit. The current US Navy's plans for the Next Generation Air Dominance (NGAD) programme seem to favour a mix of aircraft – some manned, or optionally manned, and some unmanned. Considering Russian and Chinese investments on missile capabilities able to hit US bases in Europe or in the Pacific Rim, the prevailing response is to fly the FCAS over a greater range – possibly from the American homeland. Longer ranges may be possible with new propulsion technologies, but they imply a larger aircraft too. From a procurement and industrial point of view, the difficulty is that successive combat air systems have cost more and taken longer to develop than their predecessors. At the same time, the US seeks to maintain some semblance of competition across its defence industry. The starting point is the F-35 as the only 5th-generation aircraft worldwide, and a major procurement programme for the Pentagon. At this stage, neither the US Navy nor Air Force want another joint programme, and have to prioritise resources on F-35 procurement. Since the latter has acquired a central role for American air power and the US defence industry, this will reinforce enthusiasm for follow-on versions of the type.

The United Kingdom

In the UK, the 2018 Combat Air Strategy provides an ambitious template to retain "operational sovereignty" over key technologies, in order to provide the nation's air force with a capable next-generation multi-role combat aircraft and to produce an export successor to the Eurofighter. In this context, the Tempest project was unveiled at the 2018 Farnborough Air Show with the endowment of a 2 billion pound investment through to 2025 – although there are concerns about the overall financial sustainability of the planned Ministry of Defence (MoD) budget over the next few years (especially in the light of Brexit).

From a military point of view, the development of Unmanned Combat Air Vehicles (UCAVs) has generally been slower than anticipated, while the emergence of a more antagonistic Russia and the renewed risk of state-on-state war have combined to rekindle British interest in a further generation of crewed multi-role combat aircraft – beyond the Eurofighter and F-35. After two decades focused on counterinsurgency operations in environments where British and allied forces were largely unchallenged in the air domain, investments by adversaries in highly capable systems have reduced the technological advantage that Western militaries enjoy in achieving and maintaining control of the air. Accordingly, Tempest aims for a low-observable twin-engine multi-role fighter, and a central element of its notional design involves meeting the need for an air-superiority aircraft as a successor to the Eurofighter.

From an industrial point of view, the political decisions to be taken over the next few

years will not only determine the shape of the UK's defence-aerospace sector but arguably also its fate. The design and engineering skills required to develop a low-observable multi-role combat aircraft still reside on British soil, but without any high-end future programme these skills will dissipate. Buying off-the-shelf would indeed mark the end of the UK as a top-tier defence-aerospace manufacturing nation at the platform level. Accordingly, BAE Systems, Rolls-Royce, Leonardo MW and MBDA have formed the group of industrial players known as "Team Tempest". Given the British legacy of involvement in European projects, then industry participation in a wider Continental effort has a clear rationale. Since London has to deal with the Franco-German FCAS alternative project, it is looking for partners within and beyond Europe – starting with Sweden and Italy, with an eye to Netherlands participation as well as to Japan. In pursuing these goals, the UK has set out an ambitious timeline: by mid-2019, a first assessment of international collaborative options; by the end of 2020, to decide on partners; and by 2025, to have in place final investment decisions. The aim would be to meet an initial operating-capability date of 2035.

France

From a military perspective, French considerations concerning the FCAS are still in their preliminary phase. No public strategic document has provided an official definition of this system so far, and its features may be influenced by timing, the policy-makers in charge of this issue at the French MoD, and potential cooperation at the European level. The national debate currently presents two slightly different approaches. Both of them acknowledge the FCAS's system-of-systems nature, but the first vision centres on the combat aircraft while the second focuses on the whole "architecture", with its connectivity. During a 2018 hearing at the National Assembly, the Air Force Chief of Staff stated that the FCAS "will be built around a combat aircraft platform, manned or not, versatile, around which we will place a number of effectors, combat and non-combat drones, and weapons. Anyway, the game changer will be connectivity." In this regard, achieving air superiority, penetrating contested air spaces – so-called "first in" entry capacity – and reducing the enemy's air threats are all relevant elements. Against this backdrop, the envisioned renewal of the nuclear deterrent could further complicate French considerations on the FCAS and international cooperation.

The industrial rationale is mainly driven by the issue of strategic autonomy, and could also be affected by the aforementioned debate. On the one hand, France's clear objective is maintaining a capacity for air-combat-systems integration within the European Union (EU), and more specifically within Dassault. On the other hand, there is a general understanding that specific aeronautical competencies are losing their relative importance in favour of Information Communication Technology (ICT) ones.

The traditional French focus on strategic autonomy has turned into a call for the development of European strategic autonomy, with the aim to limit as far as possible non-EU dependencies in the armaments sector. France is aware of the necessity of having more EU countries involved in the FCAS loop, but prefers to begin armament cooperation in a purely bilateral framework with Germany. According to this logic, cooperation will be enlarged only after the architecture of

the project, the global common requirements and the main industrial sharing are defined. In February 2019, the French and German ministries of defence awarded a two-year 65 million euro contract to Dassault and Airbus to define the general architecture and the industrial organisation of their next-generation combat aircraft. The contract was awarded by France's defence-procurement agency acting on behalf of both governments, while Airbus and Dassault have co-contractor status in the architecture-study contract. The next step, scheduled for the Paris Air Show in June, will be the award of contracts to Dassault and Safran to design and build technology demonstrators for the FCAS and its engine. Meanwhile, Spain has joined France and Germany in this initiative.

Germany

The FCAS is of outstanding military, political and industrial importance for Germany, despite the related thinking only having started to develop there in 2018. From a military point of view, there is consensus that "FCAS" does not describe a single aircraft but a system of systems consisting of manned combat aircraft and unmanned drones operating together. Moreover, the FCAS cannot be seen in isolation from the overall current and future air-force fleets because it is to deliver on a wide range of capabilities. Moreover, the links towards allied air forces play a significant role in the FCAS's conceptualisation and technical design, as Bundeswehr strategic documents recognise that both air operations and procurement are – and will increasingly be – multinational. Hence, the FCAS necessitates a strategic decision encompassing the issue of who Germany will partner up with in 20 to 50 years' time. Finally, when it comes to cooperative procurement in Europe, the Bundeswehr prefers the "lead nation" principle: one nation takes the lead and responsibility for a development programme.

From an industrial point of view, this is expected to be the largest defence programme of the coming decades. It will determine the structure of the German – and European – aerospace and defence industry with regard to competences, competitiveness and consolidation. In general, Germany's Defence Technological Industrial Base (DTIB) perceives itself to be well prepared for the implementation of the FCAS, and would like to lead in the development of the system of systems as well as leading, or at least playing a key role in, modern mission, communication and network systems, fighter aircraft and Unmanned Aerial Systems (UAS). The industry expressly welcomes the German–French project to develop an FCAS as a networked European system, as it identifies the need for close cooperation between Berlin and Paris as well as to opening it up to other European partners like Spain, Sweden and the UK.

The political rationale comprises several aspects that point in different directions, and thus complicate decision-making about how to go forward on the FCAS. First, both Franco–German relations and EU cohesion are top of Berlin's political agenda, and they are interwoven in many ways. Second, the FCAS is about Germany's role in the global aerospace defence industry and the degree of Europe's industrial autonomy. Here the question for Berlin concerns the optimum balance between European strategic autonomy and transatlantic (inter-)dependence. Third, Germany has to decide on a second military-aircraft project at the same time, as its Tornados reach the end of their life cycle and have to be replaced by up to 90 new

aircraft. This has an important impact on military and industrial capabilities, and indirectly represents an intermediate step on the way to FCAS production. Finally, there is the need to envisage whether the FCAS will play the role of platform for nuclear weapons in the context of NATO nuclear sharing, and this will complicate relations with both France and the US.

Italy

From a military point of view, the key question for Italy is how gradually replace, from 2040 onwards, the 86 Eurofighter Typhoons that will slowly approach the end of their operational life. In this context, the FCAS is generally intended as a system of systems supposed to integrate both manned and unmanned components. Lessons learned and expertise being acquired through the simultaneous use by Italy of both UAS and the net-centric 5th-generation F-35 will probably help to define such teaming between manned and unmanned systems. Building on that basis, an FCAS may well be able to command and control a swarm of UAS and effectively act as a battle-manager platform in complex air operations.

On the industrial level, Italy could play its part in a project for a 6th-generation aircraft by counting on resources and expertise engendered by its participation in previous programmes. This is particularly the case with the Eurofighter, to which Italian industries have contributed through their competencies on airframe, engines, electronics, avionics and the structural integration of systems. In a similar vein, Italy may bring added value by relying on lessons learned and expertise gained through participation in the F-35 programme. Indeed, Leonardo exerted a pioneering role by producing wings and components of the central fuselage, as well as by assembling the whole F-35 aircraft in the Final Assembly and Check Out (FACO) plant at Cameri – the only existing FACO facility in Europe.

An Italian political decision on the FCAS has not yet been taken. Italy's politico-institutional leadership is used to multinational programmes to procure the most advanced capabilities in the aerospace domain – as happened with the Tornado, Eurofighter, F-35, NH90, etc. Bilateral or multilateral cooperation is seen as a necessary *modus operandi* to share the financial burden of expensive procurement programmes that are not affordable on a national basis. It is also deemed crucial to connect the national DTIB to the most advanced industries in the West, in order to improve its competitiveness, innovation and strength. In recent years, the F-35 has been heavily criticised at the political level but it has not been stopped, while Eurofighter has not come under the spotlight at all and has safely continued its procurement path. When it comes to the FCAS, in July 2018, Italian politicians and industrialists participating in the Farnborough exhibition were interested in the Tempest presentation. Then in September the defence undersecretary, Angelo Tofalo from Five Star Movement (M5S), declared that Italy "should join Tempest immediately in order to be at the forefront of cooperation with the UK". Such a clear position is consistent with the Statement of Intent signed by the Italian and British MoDs at 2018 Farnborough air show, indicating the political commitment to enhance the strategic partnership in the defence and security domains. Moreover, the preference for Tempest is very much in line with the attitudes informally expressed within institutional, military, industrial and expert circles in Italy.

Yet the political leadership in both the country's parliament and government is, for

a variety of reasons, not keen to start a public debate on the FCAS. First, defence is ranked very low on the political agenda of the current executive, which affords priority to illegal migration and security issues. Second, the main political party in the government coalition – the M5S – remains very cool on defence spending, which will indeed slightly decrease in 2019 and 2020 after the increase experienced in 2018. Third, decision-making on possible new procurement programmes has been slowed by the review of the F-35 financial commitment as well as by turnover at the top of the Italian military.

Sweden

In 2015, the Swedish Government identified combat air capability as an essential security interest. This decision signals a political commitment to maintain and develop military, technological and industrial capabilities with regard to aerial combat. The development of the FCAS will be necessary for Sweden in order both to meet new military threats and to maintain its ability to develop and produce combat aircraft. Stockholm views Russia's increased military capability, together its willingness to use that capability for political goals, as the main regional security threat. Yet for Sweden, the need for the FCAS is not just linked to Russia. Indeed, Stockholm participates in international military operations: Saab's JAS 39 Gripen, for example, contributed to the 2011 air campaign in Libya. Moreover, the FCAS will become important for Sweden as technologies from such a project will probably be incorporated into the upgrading or replacement of the JAS 39 Gripen E after 2040. From an industrial perspective, the FCAS is of importance to Stockholm in order to maintain and develop capabilities regarding research and technological development and system integration – as well as ensuring a continuing skilled labour pool. For a small country like Sweden, which wants to keep all options open, protectionist tendencies in the US and the potential fallout from Brexit will prove challenging. Saab cooperates with American General Electric as well as with British and Continental Europe partners.

Regarding the FCAS, some form of cooperation will, in all likelihood, be necessary for Sweden. Yet the existence of two European projects creates a conundrum for Stockholm. As of February 2019, the Swedish Government has not officially taken any decision regarding the development of the FCAS. Both the British Tempest and the Franco-German project present aspects that would be attractive to Sweden. As the only Tier-1 partner in the F-35 project, the UK has unique experience with 5th-generation fighter technology. The UK and Sweden have also established important defence-industrial ties – for instance, 30–35 per cent of components for the JAS 39 Gripen come from the UK. On the other hand, the Franco-German project will have the financial backing of two of the largest military spenders in Europe. Additionally, France and Sweden cooperated in the development of the nEUROn UCAV. Any collaboration between Sweden and larger nations facing different operational requirements will most likely entail some degree of compromise.

Towards two European FCASs in Europe

The overall analysis of approaches to the FCAS in the UK, France, Germany, Italy and Sweden does outline a complex but relatively clear picture. Both London and Paris are willing to lead a project aimed to balance, in different ways, on the one hand

national strategic autonomy and on the other hand the partnerships necessary to ensure procurement's economic sustainability. Germany is cooperating with France but does not yet have a clear vision on the FCAS. Berlin has also to face simultaneously pressing choices regarding the upcoming phase-out of the Tornado, a possible early retirement of Eurofighter Tranche 1, and the need to comply with the NATO commitment to dual-capable aircraft. Moving north, Stockholm is keeping all cooperation options open, except repeating a national-only effort after Gripen, and seems to lean towards London rather than Paris. Meanwhile, Spain has joined the Franco-German initiative, in line with its industrial stake in Airbus, and the Netherlands seems to be interested in the British-led project. As a result, two European projects are unfolding to develop and procure an FCAS in Europe – one totally located within the EU, and the other around the North Sea.

The trajectories of these two projects may vary in the medium term. On the one hand, their future convergence in a single pan-European project is not impossible. Such an eventuality would bring several advantages for Europe in terms of synergies of industrial and technological assets, economies of scale, volume of domestic markets, security of supply and ability to compete in export markets – and, in the end, of Europe's strategic autonomy. Yet such a "marriage" seems to be difficult and unlikely, considering that the two main actors in the process – France and the UK – failed to work together on the FCAS in the favourable political conditions set up by the Lancaster House Treaty, despite years of efforts and an investment of 180 million US dollars. The reasons that prevented a Franco-British FCAS project are still valid, including structural rivalry between BAE Systems and Dassault. On top of this, the Brexit path is going to complicate cooperative endeavours between the UK and any EU country while facilitating and enhancing Franco-German cooperation in various ways. As a result, in the short to medium term the most likely scenario sees France and the UK leading two distinct mini-lateral initiatives to develop and procure an FCAS in Europe, each one in competition with the other. Only in the medium to long term could awareness of the increasing gap between the European aerospace industry and its US counterpart, as well as the risk of being overtaken by China, act as a trigger towards industrial consolidation in Europe – including the merger of the two initiatives into a truly European FCAS.

Alternatively, after some work on FCAS technologies, the UK may decide to open negotiations with the US in order to launch a cooperative joint venture across the Atlantic. Yet, again, such a marriage appears to be very difficult and unlikely, mainly because of the imbalance between the two actors. The US enjoys another order of magnitude in terms of military, economic and industrial resources, and is far too advanced on a number of FCAS-related technologies to appreciate a deal with London that would not place Washington squarely in the lead. As a result, the organisational model for any possible US-UK industrial cooperation would probably be the F-35. Alternatively, the F-35 "fatigue" experienced by the Pentagon because of the complexity of such a large multinational programme may lead to a US-only project for the next-generation aircraft. Actually, American preliminary studies point towards a very expensive and advanced FCAS, which may be too much for UK ambitions and budget, and too technologically sensitive from a US point of view to be shared with allies – as happened with the F-22. In any case, the chances of London reaching a workable deal with Washington on the FCAS are far lower than

the possibility of achieving satisfactory results with its other European partners. In the end, the most likely scenario will see, on the one hand, a Franco–German “pole”, with France in the lead and Spain taking up an ancillary role, and a UK-led project, probably in partnership with Sweden and, perhaps, the Netherlands. Accordingly, Italy will soon have to choose one of these two sides, and a timely decision is critical in order to enable Rome to influence the crucial, initial steps of a FCAS cooperative project.

Italy's strategic choice

In choosing an FCAS side, Italy has to bear in mind that its national defence industry needs a long-term, international, high-tech, wide-ranging procurement programme in order to remain competitive, drawing on the lessons learned since the 1970s with the Tornado and then with the Eurofighter and the F-35. Failing to join either of the two unfolding FCAS projects, or postponing such a choice, would imply an inevitable and steady decline of Italy's defence-aerospace industry, and would deliver a serious blow to the country's military air power. From an Italian perspective, a proper assessment of pros and cons, challenges and opportunities on each side should consider at least the following eight elements.

1. Military alignment of air-combat fleets – From the military point of view, Italy and the UK are the two most closely aligned countries in Europe when it comes to air-combat capabilities. Both have developed, procured and operated the Tornado and Eurofighter, and have participated from the beginning in the F-35 procurement programme with a significant role. Consequently, their fleet will experience a similar operational life cycle, by allowing a long-term effort to prepare the replacement for Eurofighter on the post-2040 horizon. This type of alignment cannot take place between, e.g., Italy and France as their air-combat fleets are completely different.

2. Experience of 5th-generation aircraft – From a military and industrial point of view, Italy and the UK are the only two major European countries with access to a 5th-generation aircraft such as the F-35. British and Italian air forces and naval-aviation forces are testing and operating the aircraft, and this experience brings with it a number of tactical, operational and “doctrinal” innovations – for example, when it comes to net-centric and stealth capabilities – notwithstanding the strong US limitation on technology access. Such access constitutes for both countries a basis from which to look to the 6th-generation in military and industrial terms – although its development without US partnership will surely be a challenging leap. By contrast, both France and Germany lack substantial military or industrial experience with 5th-generation aircraft.

3. Industrial room for manoeuvre – In comparative terms, the added value of the Tempest programme lies in the participation of Leonardo MW Ltd, which would help Italian industry to be more involved in the next steps related to a number of technologies and components – such as avionics, cells, sensor systems, communications, radar systems and electronics, as well as training aircraft, integration and the release of weapons systems. In other words, there would be a “mass effect” in technological, industrial and financial terms, which could ensure on certain components an Italian role even greater than in the Eurofighter consortium. Conversely, according to the agreed guidelines for the Franco–

German initiative, an eventual Italian engagement with Paris and Berlin may lead to the emergence of problems in terms of compatibilities and division of labour. Furthermore, should Rome team up with Paris and Berlin, the presence of Leonardo MW Ltd in the competitor Team Tempest would be likely to create a difficult and negative situation for Italy in both projects.

4. Mid-/long-term adaptation – As mentioned above, it is possible that the trajectories of the two FCAS initiatives in Europe may converge. Such convergence is desirable from both a European and an Italian point of view, but Rome will have to deal with this transformation by protecting its assets and role in the programme at the political, military and industrial levels. By that time, should Italy be in a consortium with the UK – and perhaps Sweden and the Netherlands – it will probably be better able to adapt. Indeed, by contributing to defining the military requirements and the system architecture – thanks to the alignment of combat fleets, experience of 5th-generation aircraft and industrial room for manoeuvre – Italy could effectively frame its national interests within the position of a bloc of countries negotiating with another bloc to find a pan-European solution. In contrast, if Rome were to accept an ancillary position in the Franco–German project, it would probably be the weaker partner, whose interests could be sacrificed to make room for a future marriage with London.

5. Recent EU initiatives in the defence domain – The FCAS's technological and industrial efforts could be eligible for financial support through newly developed European initiatives such as the European Defence Fund (EDF) – which is going to invest 13 billion euro over the EU's 2021–2027 Multiannual Financial Framework for cooperative projects. Notably, the inclusion of Spain in the Franco–German initiative makes it compliant with the criteria of three participating EU member states set up by the draft EDF regulation. The same regulation allows participation by entities from third countries, with certain restrictions – particularly regarding security of supply, management of sensitive information and non-interference by third governments. Therefore, projects for the development of FCAS-related technologies by a consortium made up, for example, of British, Italian, Sweden and Dutch partners would be eligible for EDF co-funding. However, the devil is in the detail, as the regulation may be implemented or interpreted in a more or less restrictive way with respect to the UK – depending, among other things, on Brexit implications. The same goes for projects within the EU's Permanent Structured Cooperation (PESCO) initiative.

6. Brexit implications – With the deadline for negotiations approaching on 29 March 2019, different scenarios are still possible. On the one hand, should the UK exit the EU without a deal, it will suffer socio-economic turmoil in the short term and problems in the mid-to-long term. As a result, it is likely that its defence policy will be deprived of political and economic impetus, leading to cuts and/or the postponement of major procurement programmes, including that for the FCAS. At the same time, the UK becoming a third country without any form of free-trade agreement with the EU will pose a number of obstacles and challenges for defence-industrial cooperation.

A second scenario would see the British Parliament approve a deal with the EU in order to avoid the aforementioned turmoil. Finally, a third scenario would see a postponement of the March 2019 deadline for exiting the Union. In both these

cases, avoiding a “cliff-edge” exit would ensure a further period of regulatory status quo for economic relations across the Channel, and create a less uncertain scenario for both public finances and the private sector – including with regard to defence. Cooperative procurement strategies like that of the FCAS would find a more favourable environment and greater political and financial support, as well better chances to access the EDF and PESCO frameworks. Both deadline rescheduling and the acceptance of the deal may in turn lead to different outcomes, including an agreement about a customs union or a free-trade deal – or even a UK decision to remain in the EU.

7. Political circumstances – Brexit and EU initiatives like PESCO and the EDF heavily affect the defence and foreign policies of major European countries. An EU without the UK will politically accelerate defence cooperation and integration, and the Aix-la-Chapelle Treaty signed on January 2019 by France and Germany would probably be a driver in this direction. As a result, within the Union there would be stronger political pressure for exclusive intra-EU cooperation on the FCAS, which may act as a catalyst for others to join the initiative. In this context, should Rome side with London on the Tempest, this would add another element of political divergence to relations between Italy and the Franco–German driver for EU integration. Such a divergence would not be new in recent history; its management would be complicated, but feasible.

8. Negotiating positions – The UK seems to be open to cooperation with Italy on the FCAS, and informal signals have already been exchanged between the two countries’ militaries. One of the reasons is probably the need to maintain and develop military–industrial partnerships with EU members in order to offset the negative effects of Brexit. This is not to say that dialogue with London on military requirements and industrial work sharing would be easy, but at least there would be a positive starting point in terms of negotiating positions. Similar preconditions do not exist in the case of France. Moreover, the Brexit process has enhanced France’s pivotal position within the European defence sphere, thus increasing Paris’s deep-rooted preference for leading rather than for compromising. Rome’s proposal would probably be considered by Paris only after the military requirements had been set up and the industrial architecture designed, with little room to accommodate Italian requests. In other words, for Italy, achieving a satisfactory compromise with Paris and joining the Franco–German project is not impossible, but it is much more difficult and unlikely in comparison with a deal with the UK. In the end, it takes “two to tango”.

As a whole, Tempest represents the best strategic choice for Italy according to a military, industrial and political rationale. Such an evaluation is likely to be endorsed by both Italy’s military and defence industry, and should be taken into account by the Italian Government in order to protect national interests. Should policy-makers eventually decide to pursue Italian participation in the Tempest project, in negotiating a deal with the UK, Rome should develop the partnership within Eurofighter; exploit the synergies with the F-35; stress the European character of an enlarged Tempest consortium; and, at the same time, show enhanced commitment to intra-EU defence cooperation. This choice and the subsequent approach will be crucial for the future of Italy’s air power and defence industry – two fundamental pillars of the country’s defence and foreign policy.

1. The global context

by Andrea Aversano Stabile and Livia Botti*

1.1 A worldwide pathway towards next-generation aircraft

The evolution of the international security environment requires advanced countries to plan in good time the future of their air power. Priorities needing to be addressed in a timely fashion include the development of an FCAS to be used by their air forces and navy-aviation forces in the medium to long term.

The FCAS is also known as the 6th-generation fighter aircraft since it can be placed at the end of a continuum of platforms already developed over previous decades, which were meant to address slightly different goals and to mirror the latest technological developments of the times (see Table 1, below). A generational change may occur for several reasons. First, existing platforms may become obsolete if breakthrough technological advancements and new requirements take place in key areas, such as the need for higher speed and faster propulsion systems, electronics, net-centric capabilities, low observability or composite materials. Second, technological improvements or upgrades may, at a certain point, become impossible to install on existing aircraft through retrofitting campaigns, thus requiring replacement of the platform itself.¹ Third, a generational turnover is accelerated when major military powers compete to gain, or maintain, a strategic advantage for their armed forces vis-à-vis competitors with comparable assets – as it is currently happening in an increasingly multipolar international system marked by aggressive geopolitical competition.

A rapid summary of generational turnover underlines the fact that fighter aircraft belonging to the 1st generation were those having basic avionics systems and the ability to attain only subsonic speed (i.e. the US F-86).² The shift to the 2nd generation was defined by the introduction of the first specimens of range radars, missiles and afterburners, as well as the possibility of achieving supersonic speeds (i.e. the Soviet MiG-21).³ The 3rd generation encompassed new multi-role fighter aircraft whose radar systems were upgraded to detect pulses and whose tasks were

¹ Australian Air Power Development Centre, "Five Generations of Jet Fighter Aircraft", in *Pathfinder*, Vol. 5, No. 170 (January 2012), <http://airpower.airforce.gov.au/APDC/media/PDF-Files/Pathfinder/PF170-Five-Generations-of-Jet-Fighter-Aircraft.pdf>.

² Laurence K. Loftin, "Pioneer Jet Fighters", in *Quest for Performance: The Evolution of Modern Aircraft*, Washington, NASA Scientific and Technical Information Branch, 1985, <https://history.nasa.gov/SP-468/ch11-2.htm>.

³ Jones Averino, Answer to "What Are the Differences Between Different Generations of Fighter Aircrafts?", in *Quora*, 5 November 2016, <https://www.quora.com/What-are-the-differences-between-different-generations-of-fighter-aircrafts>.

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amplified to the level of “look-down/shoot-down capability” – namely, the ability to detect targets located out of the sight (i.e. the Japanese F-1).⁴

Radar systems were further modernised to the Doppler version and to high/low capacity of engagement in the fighter aircraft of the 4th generation. Better technologies for this pool of aircraft – still in production – were also facilitated by the introduction of digital components like the head-up display and the fly-by-wire control system (i.e. the US F-16).⁵ The so-called 4.5th-generation fighters (i.e. the Eurofighter Typhoon) is considered an intermediate step towards an entirely new platform, and characterised by high levels of manoeuvrability as well as basic stealth; sensor fusion; and, in some cases, super-cruise capacities.⁶ The quantum leap marked by the possibility for the pilot to obtain a unique picture coming from the elaboration of data selected from various sources (full sensor function) has led to the 5th-generation aircraft such as the F-35.⁷ At the same time, 6th-generation fighters are to be equipped with a new level of stealth capacities, advanced sensors and directed-energy weapon systems, as well as hypersonic speed and the ability to control unmanned aerial vehicles (UAVs).⁸ These new fighters also experienced a strengthening of radar functions, upgraded to the Active Electronic Scanned Array (AESA) system.⁹

In this context, the present chapter aims to shed light on plans unveiled by major military powers outside Europe and North America for the future replacement of their in-service aircraft. In particular, this overview of air power’s military and technological state of the art, which also takes into account the current capability strength of fighter aircraft, refers to six countries standing at the forefront in this context – namely, China, India, Japan, Russia, South Korea and Turkey. Such overview reveals a worldwide pathway towards next-generation aircraft, which provides the inescapable background for US and European choices about the strategic advantage of their military in the air domain.

⁴ John Wayne Jones, Answer to “What Is the Oldest Jet Fighter That Can Still Fight Against Modern Aircraft?”, in *Quora*, 20 April 2017, <https://www.quora.com/What-is-the-oldest-jet-fighter-that-can-still-fight-against-modern-aircraft>.

⁵ Military Factory website: *4th Generation Fighter Aircraft*, <https://www.militaryfactory.com/aircraft/4th-generation-fighter-aircraft.asp>.

⁶ Shubhit Oberai, Answer to “What Are the Main Differences Between 4th and 5th Generation Fighter Aircrafts?”, in *Quora*, 11 July 2015, <https://www.quora.com/What-are-the-main-differences-between-4th-and-5th-generation-fighter-aircrafts>.

⁷ On F-35 and Europe see, among others, Vincenzo Camporini et al., *The Role of Italian Fighter Aircraft in Crisis Management Operations: Trends and Needs*, Roma, Nuova Cultura, 2014 (IAI Research Papers 16), <https://www.iai.it/en/node/2155>.

⁸ “Sixth-Generation Fighter Aircrafts Being Developed for Air Superiority in Future Anti-Access/Area-Denial Environment”, in *IDST*, 6 April 2018.

⁹ Loren Thompson, “The Evolution of Jet Fighters Takes a Giant Leap with ‘Fifth Generation’ Planes”, in *Forbes*, 1 June 2016, <https://www.forbes.com/sites/lorenthompson/2016/06/01/what-makes-a-jet-fighter-fifth-generation>.

Table 1 | The six generations of fighter aircraft

Generation	Examples	Characteristics	Years
1st	F-86, MiG-15, MiG-17	Subsonic speed	Mid-1940s–mid-1950s
2nd	F-104, F-106, MiG-19, MiG-21, Mirage III, J-7	Supersonic speed, range radar, afterburning, missile	Mid-1950s–early 1960s
3rd	F-1, F-4, F-5, MiG-23, J-8	Pulse radar, detection of target out of the sight	Early 1960s–1970
4th	MiG-27, MiG-29, MiG-31, Su-27, Su-30, Su-33, Su-34, Gripen A/B/C/D, F-15, F-16, J-10, J-11, Mirage-2000, Mitsubishi F-2	Doppler radar, high/low capacity of engagement, fly-by-wire, digital avionics, head-up display	1970–late 1980s
4.5th	Eurofighter Typhoon, Rafale, Gripen E, Su-35, F-15SE, J-20, F/A-18, Tejas	AESA radar, high manoeuvrability, basic stealth and sensor fusion, partial supercruise	Late 1980s–1990s
5th	F-22, F-35, J-31, Ghatak, T-50, Su-57, MiG-41, Mitsubishi F-3, FA-50, KF-X, T-FX	AESA radar, supercruise, advanced stealth, full sensor fusion, network-centric function	2005 to date
6th	Ongoing projects (J-28, Dark Sword, Huolong, Tempest, i3 fighter)	New-generation stealth, advanced sensors, directed-energy weapon system, control UAVs	Future (2040s)

1.2 China

According to data gathered from the publication *The Military Balance*, China counts on a total of 1,922 available fighter aircraft.¹⁰ A large portion of this fleet – including the locally produced J-7, J-8, J-10 and J-11, as well as the Russian Su-27 and Su-30 platforms – is planned to be replaced in the near future by aircraft belonging to the new generations.¹¹ The Chinese approach aims to simultaneously produce aircraft through the national industry and to acquire Russian platforms by ensuring their development upon receiving a license. This approach has also been confirmed as

¹⁰ International Institute of Strategic Studies (IISS), *The Military Balance 2018*, February 2018, p. 254–255.

¹¹ “Did China Just Unveil the World’s First Sixth Generation Combat Jet? ‘Dark Sword’ Unmanned Fighter Dubbed a ‘Nightmare’ for the United States”, in *Military Watch*, 8 June 2018, <https://militarywatchmagazine.com/article/70674>.

regards 4.5th-generation aircraft, as China owns both locally manufactured J-20 and Russian Su-35 platforms. The J-20 aircraft – similar to other fighters like the Japanese X-2, but equipped with two anterior canard wings like the Eurofighter – has suffered from problems related to the development of the local WS-15 engine. Consequently, its operational availability has been postponed and is now likely to take place in 2019.¹² In a similar vein, plans have also been unveiled by Beijing for a 5th-generation fighter aircraft, the Shenyang J-31, which is currently passing through its testing phase.¹³

Against this backdrop, the Chinese fleets of upgraded and more sophisticated J-20s and J-31s are to be joined by 6th-generation fighter aircraft in the long term as a result of a strong technological, industrial and financial effort to address the strategic/capability gap vis-à-vis the United States.¹⁴ To this end, rumours about several plans have been spread even though there is still uncertainty regarding the Chinese Government's final decision. First, as reported by Russian media, China is in the process of developing the J-28 aircraft, able to detect and react to nuclear threats coming from both the airspace and outer space. According to these rumours, the J-28 would also have a speed capacity so high that it could chase a ballistic missile after a failed interception.¹⁵ Second, by 2020 China could give the green light to the new unmanned combat aircraft called "Dark Sword", which, if the timing were to prove accurate, might be the world's first next-generation fighter.¹⁶ The Dark Sword may either include both manned and unmanned configurations or be developed as a purely remotely controlled platform fielded alongside manned ones.¹⁷ Although an unmanned aircraft is more exposed to potential problems – for example, in the event of electronic attacks – its introduction to the global scenario would represent a significant leap forward. It would also entail a symbolic defeat for the US, as Washington has decided to abandon the future development of risky unmanned systems in favour of more reliable manned ones.¹⁸ Lastly, a limited number of sources have also identified a potential cooperative multinational project for the development of next-generation fighter aircraft by Beijing. The development of the "Huolong" (Fire Dragon) aircraft, endowed with the latest technological components and achievements, would in fact be supervised and

¹² "China prepara la producción en masa de su caza J-20 de 5ª generación", in *Infodefensa*, 7 September 2018, <https://www.infodefensa.com/mundo/2018/09/07/noticia-china-prepara-produccion-generacion.html>.

¹³ "J-20, J-16 and J-10C Armed and Ready; China's New Generation of Fighters Conduct Combat Exercises Together", in *Military Watch*, 3 June 2018, <https://militarywatchmagazine.com/article/70667>.

¹⁴ Kyle Mizokami, "China Is Already Planning Its Next-Generation Fighter Jet", in *Popular Mechanics*, 15 March 2018, <https://www.popularmechanics.com/military/aviation/a19446493>.

¹⁵ "Sixth-Generation Fighter Aircrafts Being Developed for Air Superiority in Future Anti-Access/Area-Denial Environment", cit.

¹⁶ "China's 'Dark Sword' UAV Program", in *South Front*, 9 January 2018, <https://shar.es/amhQRk>.

¹⁷ "Did China Just Unveil the World's First Sixth Generation Combat Jet?", cit.

¹⁸ Harry Pettit, "China Unveils Its Unmanned 'Dark Sword' Fighter Jet That Could Fly at Supersonic Speeds and Prove a 'Nightmare' for US Defences", in *Daily Mail Online*, 6 June 2018, <https://www.dailymail.co.uk/sciencetech/article-5811677>.

closely monitored by a group of first-class Russian scientists.¹⁹ While collaborative efforts between Beijing and Moscow in this field have been already conducted, as previously highlighted, Russian military experts doubt the credibility of these reports because of the lack of Chinese technical expertise in the development of advanced systems (e.g. engines) required for 6th-generation fighters.²⁰

Table 2 | Fighter aircraft in use in China

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
J-7	528	J-8	24
J-8	144	J-10	23
J-10	347	J-11	72
J-11	205	J-15	20
J-16	16	JH-7	120
J-20	20	Su-30	24
JH-7	140		
Su-27	52		
Su-30	73		
Su-35	14		
Q-5	100		
Total quantity		1,922	

1.3 India

The total number of fighter aircraft already in service in India amounts to 785.²¹ Although India is pursuing strategic independence in the military domain, the majority of these platforms have been acquired from foreign suppliers – as proven by the composition of its Air Force and Naval Aviation, including Russian MiG-21s, MiG-23s, MiG-27s and MiG-29s, as well as of French Mirage 2000s. India lags behind if compared with other regional powers in the process of replacing old and obsolete aircraft with those belonging to the new generations. The most recent fighters in use in India are in fact two nationally-produced Tejas, officially designed as 4.5th-generation aircraft and currently undertaking an extremely time-consuming development phase characterised by high costs.²² In the meantime,

¹⁹ Dmitry Sudakov, "China Suddenly Builds Sixth-Generation Fighter Jet with Russia's Help", in *Pravda Report*, 18 September 2017, http://www.pravdareport.com/world/138695-china_sixth_generation.

²⁰ "Bajak Ilmuwan Rusia, China Bangun Jet Tempur Generasi Keenam", in *JejakTapak*, 19 September 2017, <https://www.jejaktapak.com/?p=82630>.

²¹ IISS, *The Military Balance 2018*, cit., p. 264-265.

²² Satyajeet Kumar, "With 6th Generation Fighter Concept Beginning to Take Shape, Is It Time for India to Take Course Correction?", in *IDRW*, 20 July 2018, <http://idrw.org/?p=176074>.

India is also facing a very high attrition rate, which depletes the operational force of a substantial number of combat aircraft every year. The inability of the Indian military and industrial sectors to keep up with their foreign competitors has been evident – as has its attempts to flank an adequate trainer to the Tejas platform. In this context, after the beginning of national research on a turboprop-powered version (i.e. the HTT-40) and of a jet trainer (i.e. the HJT-36), India ended up acquiring the Swiss PC-7 and the British Hawk.²³ Furthermore, the Tejas is not considered to be on an equal footing with other Western or Russian 4.5th-generation fighters.

At present, India has inaugurated the Advanced Medium Combat Aircraft (AMCA) programme leading to the introduction of a 5th-generation combat aircraft that – after the first flight trials, to be conducted by 2020 – is planned to be operational around 2025 and whose aim is to replace the old MiG-23, MiG-27 and Mirage 2000 platforms.²⁴ Plans have also been unveiled as regards a new Autonomous Unmanned Research Aircraft (AURA), called “Ghatak”, whose completion timeline seems to match the one estimated for the AMCA.²⁵ Additionally, a Fifth Generation Fighter Aircraft (FGFA) is the object of intensive talks with Moscow, in the light of India’s decision to introduce a national variant of the Russian T-50 platform at its military bases. Despite announcements regarding the retirement of New Delhi from the bilateral initiative, due to a shift in interest as well as the impossibility of the national industry satisfying certain technological requirements,²⁶ reassurances have recently been given in this respect.²⁷ It remains to be seen if India will ultimately decide to develop its own variant of the T-50 aircraft or simply acquire the Russian version of the platform, since a national project requires a significant amount of economic resources.²⁸

In the light of these reasons, the future needs of the Indian Air Force are not easily comparable with those of other regional powers in the global scenario. While 5th-generation fighters are already operational elsewhere, India is experiencing a capability gap that is likely to widen over the next decades. Its first priority is to choose a successor to the 4th-generation Su-30 aircraft, whose phasing-out is estimated to occur in the 2040s. Subsequently, when the operational availability of a 5th-generation fighter aircraft is guaranteed, India could start thinking about a system of systems belonging to the 6th generation. Therefore, current plans

²³ Siddharth Mishra, Answer to “Why Is India Unable to Design a Jet Engine for Fighters?”, in *Quora*, 4 April 2017, <https://www.quora.com/Why-is-India-unable-to-design-a-jet-engine-for-fighters>.

²⁴ Shiv Aroor, “The Bittersweet Dilemma of India’s AMCA 5th Generation Fighter”, in *Livefist Defence*, 11 April 2018, <https://www.livefistdefence.com/?p=15063>.

²⁵ Akshara Parakala, “Flying High: India’s Indigenous UAV Programmes”, in *Jane’s International Defence Review*, January 2018, http://www.janes.com/images/assets/793/77793/Flying_high_Indias_indigenous_UAV_programmes.pdf.

²⁶ Rahul Bedi and Reuben F. Johnson, “India Withdraws from FGFA Project, Leaving Russia to Go It Alone”, in *Jane’s Defence Weekly*, 20 April 2018, <https://www.janes.com/article/79457>.

²⁷ “Russia, India Engaged in Talks on 5th Generation Fighter Jet – UAC”, in *Sputnik*, 19 August 2018, <https://sptnkne.ws/jujb>.

²⁸ “India Clears the Path for Its 5th Generation Fighter”, in *Sputnik*, 31 July 2017, <https://sptnkne.ws/fb5F>.

regarding the development of an Advance Heavy Combat Aircraft (AHCA) concept,²⁹ whose outcomes are expected by 2040, are somewhat premature. This step-by-step process also has the potential to bear fruit for India's national industry and military sectors, since a generational leap would necessarily entail dependence on foreign enterprises in the development phase – thus definitively halting the hope of bridging the gap with the rest of the world within the next few years.

Table 3 | Fighter aircraft in use in India

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
Jaguar	117	MiG-29	45
MiG-21	174		
MiG-23	20		
MiG-27	65		
MiG-29	62		
2000	50		
Su-30	250		
Tejas	2		
Total quantity		785	

1.4 Japan

Currently, 332 fighter aircraft differentiated in four main basis models are stationed on Japanese soil.³⁰ Similarly to the previously analysed national cases, Japan also needs to ensure air-power projection within the next few decades and, consequently, first steps are now being taken to replace its in-service aircraft. Japanese platforms currently in use have either been home-assembled under US licence (F-15s and F-4 Phantoms) or developed with a technological contribution from foreign companies (F-2s). In addition, four F-35 5th-generation aircraft have already been delivered to Japan – although their operational use is limited since testing and trials are still ongoing at time of writing.³¹

Tokyo has recently decided to increase its order of F-35s, thus reaching a total of 147 units in both the conventional take-off and the vertical-landing versions.³² Apart from granting capabilities to the country's naval-aviation forces, the procurement of an additional 105 platforms will render the Japanese F-35 fleet the biggest in

²⁹ Satyajeet Kumar, "With 6th Generation Fighter Concept Beginning to Take Shape...", cit.

³⁰ IISS, *The Military Balance 2018*, cit., p. 273.

³¹ "First F-35 Fighter Jet Assembled in Japan Completes Test Flight", in *Defense World*, 14 June 2017, <http://www.defenseworld.net/news/19562>.

³² Greg Waldron, "Tokyo Set to Become Second Biggest F-35 Operator", in *Flight Global*, 18 December 2018, <https://www.flightglobal.com/news/articles/tokyo-set-to-become-second-biggest-f-35-operator-454503>.

numerical terms after that of the US.³³ This acquisition, financed through the sale of F-15 jets to the US, aims to replace the 3rd-generation F-4 Phantom and to address Tokyo's capability needs as regards 5th-generation aircraft.³⁴ In a complementary fashion, Japan has also planned to substitute the F-2 aircraft, produced by Mitsubishi in close collaboration with Lockheed Martin,³⁵ with its successor, likely to be labelled "F-3", thereby ensuring a sufficient number of new-generation aircraft for the next decade. Lessons learned from previous involvement in cooperative multinational programmes may open up ways for renewed concerted efforts, as also proven by the deep interest shown by the US company Northrop Grumman in the F-3 programme.³⁶ The search for a successor to the F-2 aircraft, set to be phased out in the late 2020s, has been accelerated by Mitsubishi with an Advanced Technology Demonstrator (ATD-X or X-2) unveiled in 2016 but still considered a mere demonstrator rather than a prototype.³⁷

Despite technological and industrial resources theoretically allowing for the national development of a 5th-generation fighter aircraft, the Japanese Government has decided to purchase F-35 platforms from the US.

Japan is also proceeding with the elaboration of a strategy for the procurement of 6th-generation fighter aircraft, while no official position has been taken on the development of unmanned systems. Initial talks about the "system of systems" were inaugurated in 2010, thanks to the publication of a concept by the Japanese Ministry of Defence.³⁸ In this document, the future aircraft is called the "i3 Fighter" because of the threefold qualities attributed to the new platform – namely, network-centric skills ("informed"), cutting-edge technological and robotic capacities ("intelligent") and an ability to respond to stimulus in real time ("instantaneous").³⁹ However, notwithstanding the country's significant technological and industrial heritage, the costs of embarking on a purely national programme cannot be ignored by the Japanese Government as they are estimated to total, at a minimum, around 7 billion US dollars.⁴⁰ Therefore, Japan is also considering the possibility of

³³ Aaron Mehta, "With Massive F-35 Increase, Japan Is Now Biggest International Buyer", in *Defense News*, 18 December 2018, <https://www.defensenews.com/global/asia-pacific/2018/12/18/with-massive-f-35-increase-japan-is-now-biggest-international-buyer>. See also "Japan Plans Selling F-15 Jets to US to Fund F-35 Fighter Purchase", in *Defense World*, 24 December 2018, <http://www.defenseworld.net/news/23933>.

³⁴ Lara Seligman, "First Japanese-built F-35 Begins Assembly", in *Defense News*, 15 December 2015, <https://www.defensenews.com/air/2015/12/15/first-japanese-built-f-35-begins-assembly>.

³⁵ "Lockheed & Mitsubishi's F-2 Fighter May Be Replaced with ATD-X (X-2)", in *Defense Industry Daily*, 8 October 2018, <https://www.defenseindustrydaily.com/?p=3188>.

³⁶ Kyle Mizokami, "Now Northrop Grumman Wants to Build Japan's New Fighter Jet", in *Popular Mechanics*, 9 July 2018, <https://www.popularmechanics.com/military/aviation/a22093705>.

³⁷ James Simpson, "Japan's Stealth Fighter Prototype Should Finally Fly in February", in *War Is Boring*, 30 January 2016, <https://warisboring.com/?p=11870>.

³⁸ Ibid.

³⁹ "Il Giappone valuta la cooperazione con Londra nel programma Tempest", in *Analisi Difesa*, 5 August 2018, <https://www.analisdifesa.it/?p=117383>.

⁴⁰ James Simpson, "Japan's Stealth Fighter Prototype Should Finally Fly in February", cit.

joining forces with the UK in the Tempest programme.⁴¹

Table 4 | Fighter aircraft in use in Japan

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
F-2	88	N/A	
F-4	51		
F-15	189		
F-35	4		
Total quantity		332	

1.5 Russia

Moscow owns the second largest fleet of all the countries accounted for in this chapter, with 972 fighter aircraft in service. Like China's,⁴² Russia's capability strength comes purely from domestic suppliers, since its fighter aircraft have been built solely by local producers: Mikoyan-Gurevich (MiG-29s, MiG-31s) and Sukhoi (Su-27s, Su-30s, Su-33s, Su-34s) have in fact monopolised the Russian market with their platforms. With regard to numbers, it is remarkable that only 70 Su-35 aircraft belong to the 4.5th generation, while the rest of the country's in-service fighters are 4th-generation platforms with more than 30 years of activity. Whereas on the operational plane these aircraft can be considered close to phasing out, financial factors point to their further modernisation and life extension.⁴³

Russia's reliance on the latest technological and industrial resources has allowed for the development of advanced aircraft: studies and research have paved the way for the introduction of the first 5th-generation fighter, the T-50 manufactured by Sukhoi. Also known as Prospective Aviation Complex of Frontline Aviation (PAK-FA) or Su-57,⁴⁴ the T-50 fighter is currently still a prototype performing its trial phase and, after several announcements,⁴⁵ its entry into service has been postponed in the light of technical difficulties and a shortage of financial resources. At this stage,

⁴¹ "Il Giappone valuta la cooperazione con Londra nel programma Tempest", cit.

⁴² IISS, *The Military Balance 2018*, cit., p. 197-199.

⁴³ "A New MiG-41 Aircraft May Be Developed on the Basis of MiG-31 Fighter Interceptor", in *Russian Aviation*, 5 March 2014, <https://www.ruaviation.com/news/2014/3/5/2209/>. See also Maurizio Sparacino, "Sono più di 60 i Sukhoi Su-35 consegnati alle Forze Aerospaziali russe", in *Analisi Difesa*, 5 November 2018, <https://www.analisedifesa.it/?p=119734>.

⁴⁴ Dmitry Sudakov, "Russia to Create PAK DA Fifth-generation Strategic Bomber", in *Pravda Report*, 4 May 2015, http://www.pravdareport.com/russia/121793-fifth-generation_strategic_bomber.

⁴⁵ Dave Majumdar, "Russia's Fearsome PAK-FA Stealth Fighter Will Enter Service in 2018", in *The Buzz*, 16 February 2017, <https://nationalinterest.org/node/6662>. See also "Aircraft Plant in Russia's Far East May Start Producing First T-50 Fighter Jets in Late 2017", in *ARMSCOM*, 20 September 2016, <http://armscom.net/node/15440>.

Russia plans to have 60 units in service by 2020, but doubts have arisen over the feasibility of this schedule.⁴⁶ In order to fill this temporary capability gap, Russia has decided to go ahead with modernisations and retrofitting campaigns on 4th- and 4.5th-generation models like the Su-30s and Su-35s.

As mentioned in previous sections, Russia has strengthened close collaborative ties with China and, mainly, India. The latter nation is extremely dependent on Russian-made fighter aircraft, as shown in particular by the national willingness to adhere to the FGFA programme. While the attractiveness of this bilateral initiative is also high for Moscow, due to substantial economic returns coming from the predictable acquisition of Sukhoi basis models, the aforementioned problems faced by Russian industry in the development of fighters clearly embody, at the present stage, an obstacle to the realisation of significant gains. Furthermore, in recent times delays have heavily influenced the public debate, to the point that the possibility of developing an entirely new Indo-Russian fighter aircraft is taking hold.⁴⁷ Lastly, Moscow has opened negotiations with the United Arab Emirates (UAE) for the development of a 5th-generation fighter through updates on the backbone of the MiG-29.⁴⁸

That being said, Russia is also focusing on an alternative project consisting of the replacement of MiG-31 fighters with a new aircraft tentatively called the MiG-41, which is likely to constitute a sort of intermediate solution between the 5th- and 6th-generation aircraft.⁴⁹ However, in line with the considerations previously outlined in the Indian case, the MiG-41 should not be regarded as a simple alternative to the PAK-FA project since its foundations must necessarily lie on the achievements of the aircraft manufactured by Sukhoi. Once this step is accomplished, presumably within the next decade, Russia could join the "club" of owners of 6th-generation aircraft, benefitting also from the good records of its industrial and technological sectors. Within this domain, whereas the Russian armament industry is ready to guarantee developments like radio-photonic radars⁵⁰ and hypersonic weapons systems able to bypass the interception of enemies,⁵¹ its gap in the field of unmanned systems should be addressed in the next few years if it is to continue producing its fighter aircraft without relying on components manufactured by

⁴⁶ Joseph Trevithick and Tyler Rogoway, "No, Russia's Su-57 Stealth Fighter Program Isn't Dead, at Least Not Yet", in *The War Zone*, 18 July 2018, <http://www.thedrive.com/the-war-zone/22234>.

⁴⁷ Manu Pubby, "Indo-Russia Fifth Generation Fighter Aircraft Will Be Completely New, Not Linked to Sukhoi T 50: Russia", in *The Economic Times*, 14 July 2018, <http://www.ecoti.in/b93hxxZ>.

⁴⁸ "Russia-UAE 5th-Generation Fighter Jet to Be Developed No Earlier Than 2025", in *Sputnik*, 20 February 2017, <https://sptnkne.ws/dAxz>.

⁴⁹ Dave Majumdar, "MiG-41: Russia Wants to Build a Super 6th Generation Fighter", in *The Buzz*, 6 April 2017, <https://nationalinterest.org/node/7052>.

⁵⁰ Dave Majumdar, "Stealth Killer? Russia's Sixth-Generation Fighter Might Have a 'Radio-Photonic Radar'", in *The Buzz*, 9 July 2018, <https://nationalinterest.org/node/25361>. See also Dave Majumdar, "Russia's Next Fighter Could Come Loaded with Stealth Killing Radar and Lasers", in *The Buzz*, 1 August 2017, <https://nationalinterest.org/node/8216>.

⁵¹ Interviewee 6.

foreign companies.⁵²

Table 5 | Fighter aircraft in use in Russia

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
MiG-29	120	Su-24	41
MiG-31	92	Su-25	5
Su-24	70	Su-27	18
Su-25	155	Su-30	21
Su-27	121	Su-33	17
Su-30	90	MiG-29	22
Su-34	98	MiG-31	32
Su-35	70		
Total quantity		972	

1.6 South Korea

The number of fighter aircraft in use in South Korea amounts to 507 platforms, which are split into five basis models – namely, the F-4 Phantom, F-5, F-15, F-16 and FA-50.⁵³ In a similar vein to the state of the art detected in the national cases analysed above, Seoul's capability strength mainly refers to 4th- and 4.5th-generation fighters whose replacement is expected in the foreseeable future. Similarly to the case of Japan, a large number of these aircraft have been acquired from the US, not only because of the reliability of platforms such as the F-15s and the F-16s but also thanks to good commercial, political and security relations between the countries, including the American "umbrella" against the North Korean threat. In line with this statement, Seoul has purchased 60 advanced F-15K aircraft from the US according to a plan to stimulate the creation of industrial and technological expertise in the country. Avionics systems and other components of the aircraft, whose design has been envisaged specifically to attain the needs of the South Korean Air Force, are in fact locally produced and assembled on the basis of an arrangement between Boeing and local industries.⁵⁴ Close collaborative ties with the US have been further enhanced by the decision to participate in the multinational programme leading to the F-35 acquisition.⁵⁵ However, the first of the 40 fighters planned to replace the F-5s at the end of their operational life have

⁵² "Russia Developing Unmanned Next Generation Fighter – General", in *Sputnik*, 26 August 2013, <https://sptnkne.ws/cBX8>.

⁵³ IISS, *The Military Balance 2018*, cit., p. 197-199.

⁵⁴ Ryan Maass, "Boeing to Sustain South Korea's F-15 Fleet", in *UPI*, 13 March 2017, <https://upi.com/6504213t>.

⁵⁵ Jeff Jeong, "South Korea's F-35 Purchase Under Probe", in *Defense News*, 20 April 2018, <https://www.defensenews.com/air/2018/04/20/south-koreas-f-35-purchase-under-probe>.

thus far only been unveiled in the US facility of Fort Worth, and their operational deployment is estimated to be finalised in 2021.⁵⁶

Concerning 5th-generation aircraft, South Korea has part of the technological and industrial potential to develop its own platform, thus reducing its dependency on the US. This notwithstanding, cooperative efforts and exchanges with foreign partners are required in domains in which the national industry is lagging behind – for instance, propulsion, electronics and weapons systems.⁵⁷ A practical example of this template is the launch of the FA-50 light fighter, promoted by Korean Aerospace Industries (KAI) for the home and export markets⁵⁸ as a result of a collaboration, with Lockheed Martin performing the leading role in the development of the airframe while the engine is provided by the US directly.⁵⁹

In addition, South Korea is heavily involved in another project, labelled “KF-X”, potentially leading to the domestic production of a 5th-generation fighter aircraft.⁶⁰ The programme became multinational in 2010 after an Indonesian decision to join forces with South Korea, and foresees a key role for Seoul and a mere contributory part for Jakarta – with the latter prevented, due to restrictive clauses in the contract, from selling the fighter abroad or locally producing some components.⁶¹ Here again, in the case of KAI, an inability to ensure the autonomous competitive development of components requires a partnership with US industries. Aside from Lockheed Martin, in charge of the “furniture” of several technologies inherited from the F-35,⁶² close contacts have also been established with the US-based United Technologies Corporation, which has been contracted to provide other equipment like environmental control systems to the KF-X fighter.⁶³ Such a project appears to be extremely ambitious, especially in the light of two developments. First, with sources recently reporting a delayed payment from Indonesia, serious doubts have been raised over the reliability of Jakarta in ensuring an adequate financial

⁵⁶ Yeo Jun-suk, “S. Korea’s First Stealth Fighter Unveiled”, in *The Korea Herald*, 29 March 2018, <http://www.koreaherald.com/view.php?ud=20180329000544>.

⁵⁷ Richard A. Bitzinger, “Can South Korea Build Its Own Fighter Jet?”, in *Asia Times*, 27 October 2017, <https://www.asiatimes.com/2017/10/opinion/can-south-korea-build-fighter-jet>.

⁵⁸ Jose Katigbak, “Phl to Buy 24 More Combat Aircraft from South Korea”, in *The Philippine Star*, 20 March 2015, <http://po.st/y4UGJO>.

⁵⁹ Eric Tegler, “This Is Lockheed’s Training Plane Built with F-16 DNA”, in *Popular Mechanics*, 21 June 2016, <https://www.popularmechanics.com/military/a21437>.

⁶⁰ “KF-X Fighter: Korea’s Future Homegrown Jet”, in *Defense Industry Daily*, 23 October 2018, <https://www.defenseindustrydaily.com/?p=10647>.

⁶¹ Jeff Jeong, “Is South Korea’s Future Fighter Jet Partnership with Indonesia Falling Apart?”, in *Defense News*, 7 May 2018, <https://www.defensenews.com/global/asia-pacific/2018/05/07/is-south-koreas-future-fighter-jet-partnership-with-indonesia-falling-apart>.

⁶² “5th Generation Fighters and the TF-X Program”, in *Defence Turkey*, Vol. 12, No. 81 (2018), <http://www.defenceturkey.com/en/content/2988>.

⁶³ Valerie Insinna, “United Technologies Announces Role on South Korea’s KF-X Fighter Jet Program”, in *Defense News*, 5 February 2018, <https://www.defensenews.com/digital-show-dailies/singapore-airshow/2018/02/05/united-technologies-announces-role-on-korea-aerospace-industries-kf-x-program>.

contribution.⁶⁴ (Additionally, even in the event of compliance by its partner, the total cost of the programme – estimated at around 7 billion US dollars – may represent a burden too high to be sustained by Seoul in the long run.)⁶⁵ Second, other priorities are more urgent on the defence agenda, given the South's troubled relationship with neighbouring North Korea despite the recent signature of an agreement aimed at easing tensions.⁶⁶

The picture above logically implies that Seoul seems currently unable to produce a 5th-generation fighter aircraft by relying on its own strength alone.⁶⁷ Despite continuous and rapid growth of the national industry – for instance, as regards the development of a powerful engine for its training aircraft⁶⁸ – this is even more likely with reference to a 6th-generation aircraft, the projects for which are still far from being formulated. Acquiring specific expertise and techniques in sectors still suffering from technological downsides embodies a precondition for national industries healing the rift with foreign countries that have already started thinking about the new system of systems.

Table 6 | Fighter aircraft in use in South Korea

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
F-4	60	N/A	
F-5	174		
F-15	60		
F-16	163		
FA-50	50		
Total quantity		507	

1.7 Turkey

Waiting for the delivery of systems already ordered, Turkey's fighter-aircraft fleet is currently composed of 333 platforms.⁶⁹ Even at first glance, it is evident that the capability strength of Turkey in this domain relies upon basis models (e.g. F-4 Phantoms, F-5s and F-16s) entirely produced and manufactured in the

⁶⁴ Prashanth Parameswaran, "What's Next for the Indonesia-South Korea Fighter Jet Program?", in *The Diplomat*, 15 January 2019, <https://thediplomat.com/?p=149642>.

⁶⁵ "Indonesia Resumes Payment for Fighter Development Project", in *Yonhap News*, 2 January 2019, <http://yna.kr/AEN20190102010300315>.

⁶⁶ Pierfrancesco Moscuzza, "Corea: i costi asiatici della pacificazione nella penisola", in *AffarInternazionali*, 23 September 2018, <https://www.affarinternazionali.it/?p=71037>.

⁶⁷ Richard A. Bitzinger, "Can South Korea Build Its Own Fighter Jet?", cit.

⁶⁸ See Interviewee 13.

⁶⁹ IISS, *The Military Balance 2018*, cit., p. 159.

US. As a consequence, Ankara is dependent on foreign partners and companies for the acquisition and usability of its fighter aircraft. This notwithstanding, the country aims at progressively achieving a sort of independence in the domestic development of fighters.

Against this backdrop, Turkey has already planned to replace platforms that are reaching the end of their operational life, and, to this end, has joined the F-35 multinational programme for the procurement of 100 aircraft with an initial investment that amounted to more than 1 billion US dollars.⁷⁰ Despite the delivery of the first batch of aircraft, finalised last June,⁷¹ US President Donald Trump has decided to suspend the sale of additional platforms for 90 days in view of Turkish President Recep Tayyip Erdoğan's planned purchase of the Russian S-400 missile system.⁷² The issue of the S-400s is highly complex and controversial, and still open to different outcomes.⁷³ On the one hand, it seems strange that a member of the F-35 programme should decide to additionally procure a system such as the S-400, which is designed to challenge 5th-generation aircraft like the F-35. On the other hand, Turkey, as a NATO member state, may also decide to share information on the Russian air-defence system with its allies or, vice versa, to provide sensitive data on the F-35s to Moscow.⁷⁴

Apart from these frictions, the phasing out and replacement of the old F-5s and F-16s is to be pursued in a domestic fashion. Turkey, in fact, plans to develop its own 5th-generation fighter aircraft, dubbed "TF-X", the timeline for which foresees the start of testing phases on a completed prototype in the late 2020s and its entry into service at the beginning of the 2030s.⁷⁵ Drawing on the experience of manufacturing activities conducted as regards firstly the F-16 and now the F-35, Turkey has decided to pave the way for the development of its national industry through the establishment of a partnership between the Turkish Aerospace Industry (TAI) and the British manufacturer BAE Systems.⁷⁶ Cooperative efforts have led to the creation of a consortium including other companies such as the UK-based

⁷⁰ Rachel Rossi, "Factbox: Turkey and the Future of the F-35", in *MENASource*, 23 August 2018, <http://www.atlanticcouncil.org/blogs/menasource/factbox-turkey-and-the-future-of-the-f-35>.

⁷¹ Sebastien Roblin, "Congress Temporarily Banned Sale of F-35 Jets to Turkey (But Turkish Pilots Are Still Training to Fly Them)", in *The Buzz*, 2 September 2018, <https://nationalinterest.org/node/30337>.

⁷² Tom Demerly, "President Trump Blocks Sale of F-35s to Turkey, Deepens Rift in Turkish/U.S. Relations", in *The Aviationist*, 15 August 2018, <https://wp.me/p2TYIs-fjs>.

⁷³ In this regard, please see Giorgio Di Mizio, "Turchia: i missili S-400 tra Russia e Nato, match anticipato", in *AffarInternazionali*, 27 April 2018, <https://www.affarinternazionali.it/?p=69293>.

⁷⁴ Chris Scott, "The Consequences of Cutting Turkey Out of F-35 Program", in *Asia Times*, 22 August 2018, <https://cms.ati.ms/?p=249829>.

⁷⁵ Burak Ege Bekdil, "Turkey Sets Timetable for Critical Phase of Its Fighter Jet Program", in *Defense News*, 21 November 2017, <https://www.defensenews.com/air/2017/11/21/turkey-sets-timetable-for-critical-phase-of-its-fighter-jet-program>. See also "Turkey's TF-X Program", in *Thai Military and Asian Region*, 9 March 2016, <https://wp.me/p6MJmN-a3s>.

⁷⁶ UK Government, *UK and Turkey Sign Agreement on Turkish Fighter Programme*, 28 January 2017, <https://www.gov.uk/government/news/uk-and-turkey-sign-agreement-on-turkish-fighter-programme>.

Rolls-Royce, the Italian Avio Aero and the German MTU, contracted by the Turkish group Kale for the furniture of EJ200 jet engines.⁷⁷ In a period characterised by national financial crises, it will be difficult for Ankara to sustain two 5th-generation fighter programmes. Therefore, due to funding shortages Turkey may decide to either halt its ongoing F-35 programme or to abandon the embryonic TF-X one.

Moreover, Turkey is proceeding with plans concerning the purchase of trainer jets for the new systems. In addition to the KAI-manufactured KT-1,⁷⁸ TAI has realised the Horkus model⁷⁹ and is currently developing an advanced jet trainer under the TF-X project in order to replace the old T-38s.⁸⁰

To sum up, Turkey is trying, in technological and industrial terms, to fill the gap with foreign countries that stand at the forefront of production of fighter aircraft belonging to the 5th generation. Positive outcomes in this respect may embody a point of departure for the domestic realisation of a new system of systems belonging to the 6th generation. A successful result also depends on the evolution of Erdoğan's delicate balancing act between long-standing NATO membership and close relations with Russia.

Table 7 | Fighter aircraft in use in Turkey

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
F-4	20	N/A	
F-5	26		
F-16	260		
NF-5	27		
Total quantity		333	

⁷⁷ Burak Ege Bekdil, "Rolls-Royce, Local Firm Face Off in Turkish Jet Engine Contest", in *Defense News*, 19 December 2017, <https://www.defensenews.com/industry/2017/12/19/rolls-royce-local-firm-face-off-in-turkish-jet-engine-contest>.

⁷⁸ "Basic Trainer Aircraft Contract Signed", in *Defence Turkey*, Vol. 2, No. 7 (2007), <http://www.defenceturkey.com/en/content/174>.

⁷⁹ "Hurkus Flight Tests Pass More Important Steps", in *Defense-Aerospace*, 14 April 2014, <http://www.defense-aerospace.com/article-view/release/153243/turkish-trainer-continues-flight-test-progress.html>.

⁸⁰ GlobalSecurity website: *Hürjet - Jet Trainer Aircraft (T-X) Freedom Trainer*, <https://www.globalsecurity.org/military/world/europe/tu-t-x.htm>.

2. The United States

by James Hasik*

From a US point of view, the United States and its European allies face a common adversary in Putinist Russia but show significant differences in many of their other geopolitical ambitions, as well as the means to fulfil them. To fulfil the historically offensive ambitions of American military strategy, the US military could be expected to pursue plans to develop an FCAS along their recent technological trajectories: relatively fast, quite stealthy and meant for penetrating the most heavily defended airspace. However, differing outlooks on each side's role in the world could conceivably lead to an FCAS programme in the US that differs greatly from that in Europe and Canada – and, indeed, from the recent technological trajectory of stealth fighters. Perhaps counter-intuitively, if European and American strategic viewpoints could be harmonised, that FCAS could depart even further, with less reliance on manned, penetrating aircraft. To understand why, we should review how military, industrial, and political rationales differ on either side of the Atlantic.

2.1 The military rationale

Starting from tactics and technologies, the narrow *military* rationale for recapitalising the US combat aviation fleets is to continue the aerial dominance that the United States' armed forces have enjoyed since the mid-1940s. Since the end of the Cold War, the US has been accustomed to getting its way, militarily, with so-called rogue states such as Milošević's Yugoslavia, Ba'athist Iraq and the Taliban's Afghanistan.

The set-piece nature of US military strategy would, as the war unfolds, expect first a fusillade of cruise missiles from the US Navy's submarines and surface ships, followed by a shower of satellite-guided bombs from stealth bombers and then waves of attacks from more numerous, but less stealthy, fighter-bombers. Whether boots follow on the ground is a matter of political will. Perhaps the more acute problem, however, is that the model's continued feasibility – even tactically – appears challenged. Indeed, the diminution of US military dominance, with the recent resurgence of Putin's Russia and the steady rise of China, has signalled an end to the unipolar post-Cold War era. This is because dealing militarily with Russia and China puts one in contact with both lethal, long-range anti-aircraft weapons and precise, long-range missiles for surface strike.

In the first instance, this challenge suggests that the next generation of aircraft meant to penetrate enemy territory will need at least as much stealth, at least in

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terms of defence-suppressive abilities, and longer range than today's aircraft.⁸¹ The alternative would be a rapid diminishing of the value of air power in warfare – something that the United States Air Force (USAF) is institutionally desperate to stave off. On the other hand, if we do not uncritically accept that solution or its premise, it might actually beg some major questions about exactly what form a US FCAS might take.

2.1.1 Stealthy?

The question of stealth capabilities has been a huge component of the debate. The approach that began with the F-117 and then the B-2 was novel, but it really works best at night – and, even then, safety is not guaranteed. In 1999, the Yugoslav 250th Missile Brigade brought down a stealth fighter-bomber, an F-117 – of an admittedly old design – with an even older S-125 Pechora missile and some very good tactics.⁸² The same brigade also bagged an F-16, flown at that time by the current Chief of Staff of the USAF, so the Yugoslav ability to challenge American air superiority may have been more than just a lucky shot.

If the bomber actually cannot always get through, then perhaps everything but a full-on stealth bomber is pointless close to enemy air defences. To do their jobs, airspace- and battlefield-surveillance aircraft must approach the front, but S-500 missiles can kill from 400 kilometres away. Long-range air-to-air missiles with active seekers are difficult to destroy or decoy, and can similarly kill from a distance of over 100 kilometres. These would significantly reduce the survivability of the expensive converted airliners that provide important auxiliary functions in the USAF, from tanking to aerial surveillance. If they cannot participate in the fight, then stealthier, more agile fighters will need to handle battlefield-management tasks themselves.⁸³ We might call this the full implication of the F-35 logic. If, indeed, all future combat aircraft must be both multi-role and stealthy, then logically the USAF should pursue "The One Airplane" approach by concentrating Intelligence Surveillance Target Acquisition and Reconnaissance (ISTAR) and bombing functions in a single and more survivable platform, and retire its JSTARS and AWACS; its B-52Hs and B-1Bs; and, above all, its A-10Cs.⁸⁴ Such all-in-one functionality has been promised for future upgrades to the F-35, but not yet fully realised. Even so, operationally, will such an aerial "Swiss Army knife", such a

⁸¹ See, for example, Jerry Hendrix, *Filling the Seams in U.S. Long-Range Penetrating Strike*, Washington, Center for a New American Security, August 2018, <https://www.cnas.org/publications/reports/filling-the-seams-in-u-s-long-range-penetrating-strike>.

⁸² AP, "Serb Discusses 1999 Downing of Stealth", in *USA Today*, 26 October 2005, https://usatoday30.usatoday.com/news/world/2005-10-26-serb-stealth_x.htm; Guy De Launey, "Foes Now Friends: US Stealth Pilot and the Serb Who Shot Him Down", in *BBC News*, 6 November 2012, <https://www.bbc.com/news/world-europe-20209770>.

⁸³ See comments by former Air Force Secretary Michael Wynne, "Scrap AWACS, JSTARS; Plough Dough into F-35, Wynne Says" in *DoD Buzz*, 31 January 2011, <http://bit.ly/2EP8Kng>.

⁸⁴ James Hasik, "All-In: The Full Implications of the USAF's F-35 Logic", in *James Hasik Blog*, 9 November 2013, <https://www.jameshasik.com/weblog/2013/11/all-in-the-full-implications-of-the-usafs-f-35-logic.html>.

"flying frigate", really function for an air force?

Another question is whether stealth will be enough. The fundamental problem is that observability characteristics are built into an aircraft's initial design and retrofitted later only on the margins. Stealth is first and foremost a matter of shaping, and secondarily of materials and coatings: note how the F-117 was built entirely of aluminium. Through the "Silent Eagle" project, Boeing proposed an upgrade of the F-15E strike fighter by using stealth features, yet decreasing the observability of aircraft with designs predating that of the F-35 is inherently challenging. On the one hand, this irreversibility has restrained Boeing, Airbus, Leonardo, Dassault and Saab from effectively competing against offers of F-35 with even the most updated versions of, respectively, their Super Hornet, Eurofighter, Rafale and Gripen. This has built a defensible market position for Lockheed Martin. At the same time, such irreversibility has also limited what would be achieved with the F-35 once that outer mould line was set. Computing advances are moving fast, and if Moore's Law⁸⁵ still holds, sensors will keep improving for years with greater processing power. Even if not, software techniques will continue improving for years afterwards on the same hardware.⁸⁶

Thus, as former Chief of Naval Operations Admiral Jonathan Greenert notably averred, stealthiness could be "overrated" in future combat aircraft: anything that "moves fast through the air, disrupts molecules and puts out heat – I don't care how cool the engine can be, it's going to be detectable".⁸⁷ To be sure, new ways of enhancing that sought-after stealthiness are emerging. For example, the MAGMA drone project under way at BAE Systems and the University of Manchester is building aircraft controlled entirely by wing-circulation control and fluidic thrust vectoring, whereby supersonically blown air deflects the wings and the engine exhausts. This eliminates not just the tail but all control surfaces, whose seams provide reflective traps for radar waves.⁸⁸ However, over the past few years, research organisations in several countries have been devoting considerable attention to developing infrared and passive radar-detection systems. Follow up such systems with advances in the power and portability of lasers, and combat aircraft may find little sanctuary in the high night skies in the future.⁸⁹

⁸⁵ Moore's law is a prediction made by American engineer Gordon Moore in 1965 that the number of transistors per silicon chip doubles every year.

⁸⁶ James Hasik, "Has Moore's Law Run its Course? Implications for Military Technology", in *Defense Industrialist*, 27 January 2014, <https://www.atlanticcouncil.org/blogs/defense-industrialist/has-moore-s-law-run-its-course-implications-for-military-technology>. To understand why software development can keep advancing even after a halt in hardware progress, see James Fallows, "Why Is Software So Slow?", in *The Atlantic*, September 2013, <https://www.theatlantic.com/magazine/archive/2013/09/why-is-software-so-slow/309422>.

⁸⁷ David B. Larter, "Analysts: Navy Brass View F-35C's Stealth As Overrated", in *Navy Times*, 9 February 2015, <https://www.navytimes.com/news/your-navy/2015/02/09/analysts-navy-brass-view-f-35c-s-stealth-as-overrated>.

⁸⁸ James Tallentire, "A Flight into the Future", in *The University of Manchester Magazine*, Autumn 2017, <https://www.manchester.ac.uk/discover/magazine/features/a-flight-into-the-future>.

⁸⁹ James Hasik and Rachel Rizzo, "Will the Bomber Always Get Through? The Long-Term Survivability

2.1.2 Manned?

It is worth noting that the US Government and its armed forces are rather more comfortable with remote and autonomous weaponry than those of most European countries. That transatlantic difference may obscure the intense variations between two intellectual camps in the US over this very question. Quite a few pilots may believe that some fighters and bombers will always be manned. However, many engineers and industrialists – other than those serving the rather vested interests of Lockheed Martin – when privately pressed on the issue will openly question the value of the flyer in the cockpit. General James Cartwright, a former vice-chairman of the Joint Chiefs of Staff and former Commander of US Strategic Command, has mused openly about why any new bombers should be manned. When asked about the nuclear mission – arguably the most sociologically stressful in considering the role of autonomous weapons – the former naval aviator merely observed, “I don’t remember the last time I manned an InterContinental Ballistic Missile (ICBM).”⁹⁰

Former Navy Secretary Ray Mabus concurred: in 2015, he expressed the view that whatever followed the F-18E/F Super Hornet on carrier decks, then deemed the FA-XX, should be unmanned.⁹¹ Frankly, unmanned aviation’s vector forward has proceeded as functions previously requiring hands-on human intervention have progressively been automated. The latest drones can take off, follow flight paths, take on fuel in the air, refuel other aircraft in the air, drop bombs, even fire air-to-air weapons and then land without a pilot ever pushing a stick. The emergence of adaptive and now cognitive electronic-warfare systems has shown that autonomy is not just preferred but even necessary for effective response to threats.⁹² Today, the US Navy’s plans for its now-renamed Next Generation Air Dominance (NGAD) programme seem to favour a mix of aircraft – some manned, or optionally manned, and some unmanned.⁹³ Even less public have been the air force’s plans for its Penetrating Counter-air Aircraft (PCA), the presumed successor to the F-15C and the F-22.

of the LRS-B Is a Known Unknowable”, in *Defense Industrialist*, 31 December 2015, <https://www.atlanticcouncil.org/blogs/defense-industrialist/will-the-bomber-always-get-through>.

⁹⁰ Mark Thompson, “Air Force Argument for New Bomber Bombs, Top General Says”, in *Time*, 14 July 2011, <https://wp.me/p1mzWy-dXp>.

⁹¹ Sam LaGrone, “Mabus: UCLASS Likely a Bridge to Autonomous Strike Aircraft, F/A-XX ‘Should be Unmanned’”, in *USNI News*, 13 May 2015, <https://news.usni.org/?p=12688>.

⁹² Mark Pomerleau, “What Is the Difference Between Adaptive and Cognitive Electronic Warfare?”, in *C4ISRNET*, 16 December 2016, <https://www.c4isrnet.com/c2-comms/2016/12/16/what-is-the-difference-between-adaptive-and-cognitive-electronic-warfare>. See also the general discussion of the military requirement for autonomy in Paul Scharre, *Army of None. Autonomous Weapons and the Future of War*, New York/London, W.W. Norton, 2018.

⁹³ Sam LaGrone, “Navy Seeking ‘Family of Systems’ to Replace Super Hornets, Growlers; Sheds F/A-XX Title”, in *USNI News*, 21 April 2016, <https://news.usni.org/?p=19229>.

2.1.3 Size and range?

Manned or not, air power's military value derives in part from its reach, its ability to apply force over a long range with great speed. *Ceteris paribus*, the physics of aerodynamics and hydrocarbon fuels indicate that long-ranged means larger. Depending on the depth of the theatre of war, reach can provide sanctuary from precision-missile barrages. Without drop tanks, modern jet fighters largely do not range with combat loads much past 700 nautical miles (1,300 kilometres); with them, they are not stealthy. Stealthy or not, US fighters on the ground on Okinawa or in Germany may not be safe from sudden attack, but presumably bombers in Missouri would be. The problem of base defence in those locations is just as acute for Japanese and German planners, but the Americans at least have the opportunity to rely on greater strategic depth.

Regardless, the more precision missiles that the Russians and the Chinese build, the greater the impetus to fly from increased ranges. Longer ranges may be possible with new propulsion technologies. At various times over the past decade, General Electric, Pratt & Whitney and Rolls-Royce have been working, first through the Adaptive Versatile Engine Technology (ADVENT) and later the Adaptive Engine Technology Development (AETD) programmes, on jet turbines that can alternate between high speed and efficient cruising.⁹⁴ Adding stealthy standoff weapons to stealthy combat aircraft for the most heavily defended targets is also almost certainly in the plan. Escorting the big bombers with smaller fighters remains an option, but that does not provide enough range to the package. To do so economically requires very large fighter aircraft, or heavy tasking of the USAF's tanker fleet, which is not just vulnerable but also behind schedule in its long-promised recapitalisation.

The trade-off here has driven an intriguing notion: if fighters can serve as bombers, can bombers serve as fighters? This would make the biggest combat aircraft self-defending, as the Flying Fortresses once mostly were. John Stillion of the Center for Strategic and Budgetary Assessments (CSBA) has indeed argued that an effective "sixth-generation 'fighter' may have a planform that is similar to a future 'bomber'" – such a plane could even be a modified version of the B-21 Long-Range Strike Bomber (LRS-B), just "with its payload optimized for the air-to-air mission" – that is, with large sensor apertures and scores of air-to-air missiles.⁹⁵ This is an intriguing idea for extending the bomber's capabilities, but not one that the USAF is yet openly discussing.

⁹⁴ "Pratt In, Rolls Out, GE Stays on AFRL Advanced Engine Demo", in *Aviation Week Intelligence Network*, 18 September 2012, <https://aviationweek.com/awin/pratt-rolls-out-ge-stays-afrl-advanced-engine-demo>.

⁹⁵ John Stillion, "Trends in Air-to-Air Combat: Implications for Future Air Superiority", in *CSBA Reports*, 14 April 2015, p. 68, <https://csbaonline.org/research/publications/trends-in-air-to-air-combat-implications-for-future-air-superiority>. For further comments on the idea, see also Franz-Stefan Gady, "Adios, Top Gun: The End of the Fighter Jet?", in *The Diplomat*, 9 April 2015, <https://thediplomat.com/?p=52411>; and Colin Clark, "Should Future Fighter Be Like A Bomber?", in *Breaking Defense*, 8 April 2015, <https://breakingdefense.com/?p=19753>.

2.1.4 Is it even an aeroplane?

More alarming in the USAF pilots' culture would be talk of alternatives to aircraft altogether. All the same, some of the arguments can seem compelling. As noted above, fighter-jet bases can be quite vulnerable to long-range precision-missile attacks. Field-mobile missiles, however, are rather harder to find: even the United States, with all its surveillance and intelligence infrastructure, has never solved the mobile-targets problem ashore. Not so at sea; the concentration of force on a sinkable aircraft carrier, which are increasingly easy to locate, is a yet greater issue.⁹⁶ When missiles come from the sea, they at least come from more numerous warships, so that the loss of any one is less deleterious to the war effort.⁹⁷

Precision reduces the need for warhead size, which was a considerable cost driver behind the F-35, as stealthy aircraft require internal carriage, and internal carriage requires a much larger airplane.⁹⁸ Expendable weapons production is more readily scaled, which could be critical for mobilisation in a large war. Costs can be saved in both capital and labour terms simultaneously: as Clive Blount has argued, ground-based missiles, "which are highly automated and can be operated by less skilled reservists, may provide an attractive alternative to training more pilots and building complex fighters in the event rapid reconstitution is required".⁹⁹

On the other hand, as Paul Scharre has pointed out, tragedies can occur when highly automated, lethal air defences are operated by those less-skilled troops. The US Navy learned this lesson after accidentally destroying an Iranian airliner in 1988, by relying too heavily on automated inputs for information. The US Army took longer, but a similar situation led to fratricides by its Patriot missile crews against US Navy and UK Royal Air Force (RAF) flyers in the 2003 campaign against Iraq.¹⁰⁰

This probably does not matter so much to the less-squeamish Russians, who have shown relative enthusiasm for this alternative – deploying enough S-300 and S-400 missile batteries to threaten NATO's air traffic comparatively deep into the alliance's territory. In the words of Admiral Philip Davidson of US Indo-Pacific Command, the Chinese have similarly build a "Great Wall of Surface-to-Air Missiles [SAMs]"

⁹⁶ For a discussion, see the debate: Jerry Hendrix, "The U.S. Navy Needs to Radically Reassess How It Projects Power", in *National Review*, 23 April 2015, <https://wp.me/p9ETkv-1yr4>; Seth Cropsey and Bryan McGrath, "America's Defense Still Requires Aircraft Carriers", in *National Review*, 23 April 2015, <https://wp.me/p9ETkv-1yrU>; and Jerry Hendrix, "The Navy Must Adapt", in *National Review*, 23 April 2015, <https://wp.me/p9ETkv-1ysa>.

⁹⁷ Phillip E. Pournelle, "The Rise of the Missile Carriers", in *U.S. Naval Institute Proceedings*, Vol. 139, No. 5 (May 2013), p. 30-34.

⁹⁸ T.X. Hammes, "Rethinking Deep Strike in the 21st Century", in *War on the Rocks*, 3 February 2015, <https://warontherocks.com/?p=7309>.

⁹⁹ Clive Blount, "Useful for the Next Hundred Years? Maintaining the Future Utility of Airpower", in *The RUSI Journal*, Vol. 163, No. 3 (June-July 2018), p. 47.

¹⁰⁰ Paul Scharre, *Army of None*, cit.

atop their artificial islands in the South China Sea.¹⁰¹ Dense defences capable of inflicting consistent losses on jet-fighter formations could dissuade allied forces from attempting aggressive counter-attacks, thus facilitating a “smash-and-grab” offensive against the Baltic Republics or moves against littoral states, from Taiwan to Thailand. Even if Russian and Chinese military ambitions are comparatively offensive, they are arguably regional – and so, such a defensive–offensive force structure can be more attractive than larger investments in fighter fleets. Then again, NATO is an arguably defensive alliance whose foremost challenge is possible Putinist revisionism regarding the independence of the Baltic States. With the rise in Chinese military power, US strategy in the western Pacific might need to shift towards a more defensive approach as well.¹⁰²

2.2 The industrial rationale

Besides tactics and technology, military procurement has to attach great importance to logistics, as well as the production and development that lie upstream. In any discussion of the industrial rationale for another US combat air system, the “elephant in the room” remains the F-35. At this stage, neither the US Navy nor Air Force want another joint programme since working together on the F-35 proved to be difficult and expensive.¹⁰³ At the same time, every other country but the United States, Russia and China needs a multilateral programme involving not only more services but also more countries in order to share the financial burden. Everyone seeks to maintain some semblance of competition across the industry. That includes the governments of traditional fighter-jet-producing countries such as the UK, France, Germany, Italy and Sweden, as well as design and production partners from Canada to Brazil – and perhaps now even the United States.

That late American conversion from the blessings of bilateral monopoly will discourage efforts towards another “One Fighter To Rule Them All”.¹⁰⁴ Such was much of the industrial scheme behind the F-35 programme, because in the late 1990s Washington feared that European governments “would keep American defence firms and their weapons out of the market that provided the strongest impetus for international collaboration”.¹⁰⁵ Today, the F-35 is just in the midst of its operational testing; after 17 years of development, it has reached “initial” production – thus

¹⁰¹ Paul McLeary, “China Has Built ‘Great Wall of SAMs’ In Pacific: US Adm. Davidson”, in *Breaking Defense*, 17 November 2018, <https://breakingdefense.com/?p=49939>.

¹⁰² See, for example, T.X. Hammes, “Offshore Control: A Proposed Strategy for an Unlikely Conflict”, in *Strategic Forum*, No. 278 (June 2012), <https://www.hsdl.org/?abstract&did=715487>.

¹⁰³ Comment by Stan Newberry, Deputy Director of Requirements at Air Combat Command. See Sandra I. Erwin, “Air Force Weapon Buyers Brace for Lean Times”, in *National Defense*, 5 November 2013, <http://www.nationaldefensemagazine.org/articles/2013/11/5/air-force-weapon-buyers-brace-for-lean-times>.

¹⁰⁴ A metaphor drawn from the Lord of the Rings book, whose verse says, “One Ring to rule them all, One Ring to find them, One Ring to bring them all, and in the darkness bind them.”

¹⁰⁵ Ethan B. Kapstein, “Capturing Fortress Europe: International Collaboration and the Joint Strike Fighter”, in *Survival*, Vol. 46, No. 3 (Autumn 2004), p. 148.

demonstrating the difficulties and costs of large-scale programmes involving several countries. At this stage, we could say that “it appears increasingly unlikely that a similar program on this scale and magnitude will appear again”, as there will be great incentive to economise by first proceeding to the full-planned purchase of the F-35.¹⁰⁶

Perhaps, then, greater product diversity should not be seen as so challenging economically, as many fighters need replacement and the Russians and the Chinese threats have increased. The difficulty, as the recent British Combat Air Strategy report lays bare, is that “successive combat air systems have cost more and taken longer to develop than their predecessors”. Remarkably, the document continues, “this is not the case in other technologically-driven sectors, such as [the] automotive, and this trend needs to be addressed urgently”.¹⁰⁷ In fact, this adverse cost trend is not even the case in the *military* automotive sector, or in the field of warships, once we adjust for the rise in real national incomes and tonnage in industrialised countries over the past 70 years. Only combat aircraft seem to have become so unaffordable.

But why? Is it just that “the rules our program managers must follow are still too complicated and burdensome”, or is something more technological, deterministic and fundamental at work?¹⁰⁸ From the mid-1960s until very recently, the ratio between research, development, test and evaluation (RDT&E) spending and procurement spending had been gradually rising for the US Defence Department.¹⁰⁹ Some of that trend is a matter of accounting: for example, the software content of weapons systems has been continuously rising, and writing software is counted as development, whether or not the software techniques break new ground. But there remains a nagging feeling that “a dollar does not deliver as much advance as in the past”.¹¹⁰ It is possible that “accumulating knowledge” is demanding progressively greater investment for each succeeding advance, and thus progressively more high-class labour has been required for new development over time.¹¹¹

¹⁰⁶ Sigurd Neubauer, “Norway, the Joint Strike Fighter Program and its Implications for Transatlantic Defense Industrial Cooperation”, in *NUPI Policy Briefs*, No. 27/2015 (November 2015), p. 1, <http://hdl.handle.net/11250/2360485>.

¹⁰⁷ UK Ministry of Defence, *Combat Air Strategy: An Ambitious Vision for the Future*, July 2018, p. 16, <https://www.gov.uk/government/publications/combat-air-strategy-an-ambitious-vision-for-the-future>.

¹⁰⁸ Comments by US Undersecretary of Defense Frank Kendall, quoted in Sean Lyngaas, “Pentagon Submits Acquisition Reform Ideas to Congress”, in *FCW*, 28 January 2015, <https://fcw.com/articles/2015/01/28/pentagon-submits-reform.aspx>.

¹⁰⁹ Kristin Oakley, “RDT&E Must Remain Resilient to Austerity”, in *Defense Industrialist*, 7 February 2014, <https://www.atlanticcouncil.org/blogs/defense-industrialist/rdt-e-must-remain-resilient-to-austerity>.

¹¹⁰ Insight by Chip Pickett, former defense industry executive and staff officer at the Office of Net Assessment, quoted in James Hasik, “Getting Faster at Revolutionary. The Bureaucratic and Technological Challenges in Speeding Up Weapons Development”, in *Defense Industrialist*, 29 January 2015, <https://www.atlanticcouncil.org/blogs/defense-industrialist/getting-faster-at-revolutionary>.

¹¹¹ Benjamin F. Jones, “The Burden of Knowledge and the ‘Death of the Renaissance Man’: Is Innovation Getting Harder?”, in *The Review of Economic Studies*, Vol. 76, No. 1 (January 2009), p. 283-317. The discussion here largely follows that of an earlier essay by James Hasik: “Getting Faster at Revolutionary”, cit.

There are at least three ways forward. In the base case, the US Navy and Air Force would simply tolerate this continuously rising cost curve with fewer aircraft, produced in yet another globalised programme, however distasteful that might be. With more political and technological ambition, they might aim to bend the cost curve for manned jet fighter–bombers with less ambitious designs. Success could still offer a globally marketable product, if their contractors could again manage customers' desires for industrial participation. The lower price point, after all, would appeal to allies with less ambitious goals for global security. With yet more ambition, the navy and air force could seek to break the cost curve with an admixture of disruptive alternatives such as drones and missiles. That would entail significant shifts in strategy and war-fighting architectures, and probably a significant dispersal of commercial power away from Lockheed Martin.

After all, alongside this technological challenge, the industrial–political difficulty of moving forward centres on the huge constituency being built around the F-35. The foremost interest may indeed be industrial: that of Lockheed Martin and all its suppliers, across the United States and the world. Congressional representatives like to fulminate about the costs and the delays, but the legislature has done little to undo the programme. Its economic benefits are dug into many constituencies around the US, and some of that wealth has been spread further.¹¹² Most importantly, much of the military (at least, outside the US Navy) is now sold on the concept: rising USAF officers are already concerned that future promotions will disproportionately fall to those with experience in Joint Strike Fighters (JSFs).¹¹³ This will reinforce enthusiasm for follow-on versions of the type, which Lockheed Martin may then continue to market against freshly envisaged British and Franco–German fighter–bombers.

2.3 The political rationale

Finally, what is the strategic point of all this? Or rather, what is air power good for? Across the myriad applications, from the Western Front of 1918 to the bombing of Islamic State (IS), it has proven a remarkably agile form of military power. Flying fast from distributed bases provides the nimblest way to “get there first with the most”, in Nathan Bedford Forrest’s famous formulation. That in turn provides the admixture of violence needed to continue the political dialogue, in Carl von Clausewitz’s formulation. To evaluate its future in relation with an FCAS for the United States, we might consider Clive Blount’s three measures of military agility: *availability, affordability and acceptability*.¹¹⁴

¹¹² For illustration, see Jeremy Bender, Armin Rosen and Skye Gould, “This Map Explains Why the F-35 Has Turned into a Trillion-Dollar Fiasco”, in *Business Insider*, 20 January 2015, <https://www.businessinsider.com/this-map-show-the-f-35-fiasco-2015-1>.

¹¹³ Conversations with mid-grade USAF officers at the National Defense University, Washington, DC, in 2018.

¹¹⁴ Clive Blount, “Useful for the Next Hundred Years?”, cit., p. 44.

2.3.1 Availability

Military aviation must be there when needed. As noted above, this requires range – but it also needs maintainability, as an aircraft grounded for maintenance work is not available for the fight. A downed aircraft is likewise unavailable. Replacing modern combat aircraft is not quite as challenging as building new warships, but the quantities available have until recently been modest. In 2017, the F-35 programme produced just 66 jets; at full-rate in 2023, annual quantities should reach 160 – as long as the money holds out.¹¹⁵ In 2003, the programme had aimed for a rate of about 190 units annually by 2012.¹¹⁶ But if recent developments in aircraft-killing missiles could cause sharply higher loss rates in combat, then can military needs continue to be met with aviation? As Colonel Mike Pietrucha of the USAF has written on this subject, “having a need doesn’t equate with delivering a capability”.¹¹⁷ For instance, as an operations analyst for one of the leading military-aircraft manufacturers once told me, most of their combat models can be summarised in two words: “everybody dies”.

As described above, this calls into question whether a future combat air system should actually be a single, multi-role aircraft. The Israel Defence Forces (IDF) may already share this view in part, as the role of close air support in the Israeli Air Force increasingly resides with its drone squadrons. Even in a stressful war against an opponent with impressive air defences, their crews will not mind hazarding aircraft close to combat when supporting ground troops. This begs a general question for armed forces around the world, and even those which may not face the acute trade-offs of a small state such as Israel. In close proximity to the enemy, do small drones, precision artillery and attack helicopters, either hiding in terrain or fleeing along the front, offer more cost-effective promise for avoiding or penetrating defences?

2.3.2 Affordability

That question of cost is important in peace and war, as modern combat aircraft take not just a great deal of time to build but also a great deal of money. Plenty of European air forces already have difficulty maintaining combat-relevant fighter fleets on parsimonious budgets.¹¹⁸ If the next stealthy multi-role multi-engine jet fighter does not meet national budgets, then smaller air forces might feel compelled

¹¹⁵ Gillian Rich, “Pentagon’s No. 2 Has This Confusing ‘Mindset’ on Lockheed’s F-35”, in *Investor’s Business Daily*, 21 December 2017, <https://www.investors.com/?p=3037303>.

¹¹⁶ US Government Accountability Office, *F-35 Joint Strike Fighter: Development Is Nearly Complete, but Deficiencies Found in Testing Need to Be Resolved*, June 2018, p. 5, <https://www.gao.gov/products/GAO-18-321>.

¹¹⁷ Mike Pietrucha, “The Myth of High-Threat Close Air Support”, in *War on the Rocks*, 30 June 2016, <https://warontherocks.com/?p=12804>.

¹¹⁸ See, for example, James Hasik, “Is Something Wrong with the Eurofighter, Or Just the Air Forces Flying It?”, in *James Hasik Blog*, 5 November 2014, <https://www.jameshasik.com/weblog/2014/11/is-something-wrong-with-the-eurofighter-or-just-the-air-forces-flying-it.html>.

to trade down to aircraft suitable for defensive counter-air missions and fighting along the front but not for penetrating missions. In their successful 2015 election campaign, the Canadian Liberals specifically assailed the F-35 as a “first-strike” asset, saying that money would be better spent on the Royal Canadian Navy, and thus the security of allied sea lanes. While the status of the C-version F-35 is still at issue for the US, on the latter point, the Canadians are beginning to deliver at least plans for the ships.

The new Canadian position is understandable: the threat to manned combat aircraft from more capable air defences has made defensive strategies more attractive simply for their inherent affordability. Some might lament the shift in strategy, but technological change may simply have upset the military balance. The cultural challenge of convincing the US armed forces to adopt a more defensive stance is rather greater. All the same, the new military-technical reality could suggest a very different and more affordable kind of FCAS for non-US buyers – e.g. with a single engine, and no central bomb bay, but a recessed conformal carriage of comparatively smaller missiles built to a common form factor for both aerial and surface attack.

2.3.3 Acceptability

“The utility of airpower”, John Andreas Olsen recently wrote, “is highly situational”.¹¹⁹ That utility also varies amongst people in different countries, and in each it is constrained by differing views of its acceptability. This third criterion demands results, tactically and strategically, but within the context of reasonable loss rates – particularly for manned aircraft. In the modern context, that requires smart application of precision weapons to economise on sorties, but also to avoid unacceptable collateral damage. Air power may substantially substitute for the mess of boots on the ground, but not wholly – and only unimpressively in wars that really matter.

This issue of utility within acceptability suggests a revealing answer to a lasting question: why does only the US maintain such a large aerial tanker fleet? It is not merely because its allies are willing to free-ride on this collection of expensive assets when sent off to war in the far corners of the globe. It is also because many of them – perhaps all, but certainly the UK and France – really do not see the point to begin with. In most countries of NATO and the EU, the acceptability of out-of-area operations remains questionable to voting taxpayers. For them, the defences of the Atlantic community ought, first and foremost, to be designed for the defence of Europe and North America. For fighting on the eastern flank of the Alliance and the Union, expeditionary assets are far less important.

¹¹⁹ John Andreas Olsen, “Airpower and Strategy”, in John Andreas Olsen, (ed.), *Airpower Reborn. The Strategic Concepts of John Warden and John Boyd*, Annapolis, Naval Institute Press, 2015, p. 2. See also T.X. Hammes, “Independent Long Range Strike: A Failed Theory”, in *War on the Rocks*, 8 June 2015, <https://warontherocks.com/?p=8218>.

Conclusion

So, what is the FCAS for the US? As noted, the US Navy and the Air Force each have their notional programmes: the NGAD and the PCA, respectively. The concepts are still being defined, but both have a common set of technological ambitions: lasers, hypersonic missiles, *more* missiles, super-cruising at extended ranges and integrated cyber-electronic warfare capability. All this suggests rather larger aircraft than the F-35, and a hefty development bill over more than a few years. Stacked against these possible developments is a serious budgetary constraint. The US Air Force and Navy have been seriously underspending the amounts that would be necessary to replace all their "teen-series" (F-15, F-16 and F-18) fighters with F-35s. Obtaining congressional approval to substantially increase this budget in the face of trillion-dollar deficits and competing military priorities may be difficult.

There is an alternative already at play: "teens" and drones. To economise on operations and maintenance costs – which have been alarmingly high for the stealthy F-22 and F-35 – the Trump Administration has recently announced plans to begin buying upgraded versions of older fighters from Boeing: the F-15X for the air force and the F-18E/F Block III for the navy. Development costs have substantially been paid by foreign buyers of F-15s and F-18s, which have continued to fund updates as either more economical or more politically palatable than the procurement of F-35s. Boeing has notably positioned the two-seat version of the F-15X and two-seat F-18F Block III as platforms for aerial command-and-control, for directing the fighting of both single-seat F-35s and unmanned aircraft – perhaps weaponised versions of Boeing's own MQ-25 carrier-based refuelling-and-reconnaissance drone.

Who will participate in a future US FCAS procurement? If the services persist with plans for fast, manned and stealthy aircraft like the presumed plans for the NGAD and the PCA, the industrial competitors are most clearly Lockheed Martin and Boeing: both have actively been promoting their enthusiasm for the hitherto vague plans for a "6th-generation" fighter aircraft. If the requirements permit creative alternatives, including a mix of unmanned aircraft, Northrop Grumman and General Atomics add themselves to the range of competitors. If upgrades to earlier designs are permitted, Boeing retains a unique advantage.

However, if anything is less acceptable to the US military than high loss rates it may be accepting the difficulty of maintaining continued aerial dominance, always and everywhere. We might take this viewpoint as a deeply ingrained matter of military culture in a country where, lately, "civilian voices have been relatively muted on issues at the center of U.S. defense and national security policy".¹²⁰ In that case, the Defence Department and Congress may continue on the current trajectory

¹²⁰ Eric Edelman et al., "Providing for the Common Defense. The Assessment and Recommendations of the National Defense Strategy Commission", in *USIP Reports*, November 2018, p. xi, <https://www.usip.org/node/113001>.

of the F-35, until some imagined PCA or NGAD or F-35F model emerges on flight lines or aircraft-carrier decks sometime in the 2040s. For a variety of reasons outlined above, such a course of action may be inadvisable, both commercially and militarily, but it would not be surprising.

Table 8 | Fighter aircraft in use in the US

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
A-10	282	AV-8	114
AC-130	27	F-5	43
F-15	454	F-16	14
F-16	977	F/A-18	991
F-22	179	F-35	78
F-35	122	TAV-8	16
Total quantity		3,297	

3. The United Kingdom

by Douglas Barrie and Bastian Giegerich*

When the British Combat Air Strategy and the “Tempest” concept design were unveiled at the 2018 Farnborough International Airshow, some observers saw it as a rushed response to Franco–German plans to explore developing a successor to the Rafale and the Eurofighter. London had, in fact, been re-examining previous assumptions as to future combat-aircraft needs since at least 2014. This included some funded technology work. The politics of both European projects, however, are linked, and governmental will, or lack thereof, may determine their respective outcomes.

3.1 The political rationale

Such was the enthusiasm of British Secretary of State for Defence Gavin Williamson for the project that he decided to name the aircraft Tempest, irrespective of any UK Ministry of Defence (MoD) and industry hesitancy. While Tempest was an overall industry-programme name, the concept design unveiled at the Farnborough Air Show had been nameless, until Williamson’s impromptu christening as he launched the government’s “Combat Air Strategy”.

The “Combat Air Strategy”¹²¹ is the foundation intended to secure the long-term prosperity of the UK’s defence-aerospace sector. Williamson told Parliament on 17 July 2018, “The future of the UK’s combat air sector is [...] not assured”.¹²² What is probably assured is that barring concerted and sustained government support, the UK’s capacity to independently design, develop and manufacture advanced combat aircraft will be lost. The strategy provides an ambitious template with which to build on the sector’s success, to allow London to retain “operational sovereignty” over key technologies, to provide the air force with a capable next-generation multi-role combat aircraft, and to provide an export successor to the Eurofighter. Two mock-ups of a concept design were built – one for Farnborough, the other for an invite-only “show-and-tell” at the Royal International Air Tattoo the weekend before the public event.

Whatever else it might indicate, it showed the defence secretary’s enthusiasm for the project. Williamson – unlike, apparently, his predecessor, Michael Fallon – fully embraced the effort. He also had political ambitions beyond the MoD; supporting a nationally important defence programme would be viewed favourably within the

¹²¹ UK Ministry of Defence, *Combat Air Strategy*, cit.

¹²² UK Ministry of Defence, *UK Combat Air Strategy: Written Statement* (HCWS859), 17 July 2018, <https://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2018-07-17/HCWS859>.

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Parliamentary Conservative Party and the wider party membership. Williamson's battles, however, were not, and will not be, with the Conservative Government's backbenchers and the party membership – nor, probably, with the left-of-centre Labour Party. The ministry of finance – the Treasury, as it is known in the UK – presents Williamson, and his successors, with arguably the biggest internal challenge. Philip Hammond, the government's finance minister – the position is known in the UK as the Chancellor of the Exchequer – had been the defence secretary from 2011 to 2014, but since then has been charged with controlling, managing and reducing government spending. There are also some within the MoD who worry about the funding impact of such a programme.

Unconditional support from Hammond and his department for the financial commitment that "Tempest" and the "Combat Air Strategy" will require was never likely. There have been suggestions, however, that the lack of enthusiasm in the Treasury went well beyond this.

This in part may be a result of timing and sequencing. The current UK Government, and its recent predecessors, have been unable to match ambition with resources when it comes to defence. It was actually then Defence Secretary Hammond who declared in 2012 that the gap had been addressed: "After two years' work, the black hole in the defence budget has finally been eliminated and the budget is now in balance, with a small annual reserve built in as a prudent measure to make sure that we are not blown off course by unforeseen events", Hammond told Members of Parliament (MPs).¹²³ The plan was "endorsed by the chiefs and by the Treasury", he added, "We have achieved this by facing up to the fiscal reality and taking the tough decisions that Labour shirked".

Hammond's optimism was unfounded. Irrespective of the capability cuts of the 2010 Strategic Defence and Security Review (SDSR) and the 2015 SDSR, which was intended to provide stability, a further review was required by 2017. Internal and external factors conspired to topple Hammond's 2012 balancing act. Planned savings were difficult to fully achieve, while a deteriorating defence and security environment meant that deferring or cutting programmes to keep within budget was politically difficult.

Hence, the National Security Capability Review (NSCR) was launched in July 2017 and was billed as a refresh of the 2015 SDSR. The NSCR was intended in part to address the continuing gap between procurement plans and available funding. Results were published in March 2018. In January of that year, however, defence was split off from the NSCR in the form of the Modernising Defence Programme (MDP), reflecting continuing funding problems. The MDP was due to be concluded prior to the parliamentary recess in July 2018 – another target that was to be missed; and as of December 2018, the MDP had not been finalised.

¹²³ House of Commons, "Defence Budget and Transformation", in *Hansard* (14 May 2012), Vol. 545, Col. 262, <http://bit.ly/2EIHsi9>.

Splitting the MoD element off from the NSCR, and the resulting subsequent delays, meant that a decision to unveil the Combat Air Strategy at the Farnborough International Airshow 2018 would be in advance of any financial realignment within the MDP. The strategy “committed” the UK to continuing to invest a total of 2 billion pounds to support the combat air ambition through to 2025. An initial commitment towards what was to become “Team Tempest” was made as part of SDSR 2015. Launching the strategy prior to the conclusion of the MDP was unlikely to have been the Treasury’s preferred scenario, given that an overall financial settlement had yet to be agreed.

British efforts to craft a way forward for its combat air sector are cast in the near term against the dark background of the UK’s 2016 decision, by a narrow margin, to leave the EU. The Conservative Government has been torn by internal division over the nature of an exit agreement with Brussels. Its ability to remain in power, at least under the leadership of Theresa May, remained in question as of the fourth quarter of 2018. Irrespective of the UK’s pending departure from the EU, there remains a rationale for a single European programme – although political and industrial issues make this a challenge.

In 2010, it all appeared very different. In November of that year, British Prime Minister David Cameron and President Nicolas Sarkozy signed the Franco–British Lancaster House Treaty that was intended to auger decades of closer military and defence-industrial collaboration.¹²⁴ The aims of the agreement included:

- “maximising [British and French] capacities through coordinating development, acquisition, deployment and maintenance of a range of capabilities, facilities, equipment, materials and services, to perform the full spectrum of missions, including the most demanding missions”; and
- “reinforcing the defence industry of the two Parties, fostering cooperation in research and technology and developing cooperative equipment programmes”.

Such lofty ambition failed to be met in the defence-aerospace realm. While European guided-weapons champion MBDA benefitted from the treaty, elsewhere, initial momentum dissipated as requirements diverged and industrial rivalries re-emerged. This was most evident in the proposed cooperation on an Unmanned Combat Air Vehicle (UCAV) as part of the wider investment in the Future Combat Air System (FCAS) programme. Even as BAE Systems, Leonardo and Rolls-Royce (from the UK) and Dassault, Thales and Snecma (from France) attempted to work together, internal and external pressures built against cooperation. Shifting requirements, funding priorities and technology-access issues worked against collaboration. When Dassault Chief Executive Officer (CEO) Éric Trappier said that the failure to move ahead with the UCAV was to do with the UK,¹²⁵ this may

¹²⁴ Treaty between the UK and France for Defence and Security Co-operation, 2 November 2010, <https://www.gov.uk/government/publications/treaty-between-the-uk-and-france-for-defence-and-security-co-operation>.

¹²⁵ Pierre Tran, “Brexit, Project Delays Jeopardize Combat Drone Project, Dassault CEO Warns”,

have been an oversimplification but it might be essentially correct. Some indicate that the UK operational requirements may have changed – perhaps with a move towards a considerably larger low-observable intelligence surveillance and reconnaissance platform, with a capable sensor suite rather than the type of UCAV in which the French MoD were interested. Despite this, it is understood that some limited collaborative activities are continuing on key technologies and concepts.

As Franco–British cooperation faltered, Paris and Berlin were meanwhile beginning to explore the possibility of their own FCAS. Germany had begun in 2016 to look at a next-generation combat aircraft, initially as a possible successor to the Tornado. By 2017, France was in discussion with Germany about the potential of a joint project – and in April 2018, it agreed to the first stage of a multi-role combat-aircraft programme.¹²⁶ The rapprochement between Berlin and Paris, extending to other capability projects beyond combat air, combined with Brexit and the failure, related or otherwise, of core elements of Franco–British cooperation in defence-aerospace, forced UK politicians to consider alternative models alongside the traditional European approach. The UK decision to leave the EU also added further strain to relations between London and Paris.

Williamson suggested, “we see this as an opportunity to collaborate with new nations that have not usually been involved in such collaborations before. The initial indications are exceptionally positive”.¹²⁷ Possible candidates could include Saudi Arabia and Japan: the former has defence-aerospace industrial-base ambitions, while the latter has a capable defence-aerospace industry. Closer defence ties between the UK and Saudi Arabia, in the short-term at least, are problematic given the murder of Saudi dissident Jamal Khashoggi.

Any potential transatlantic linkage appears unlikely given the UK’s aim of leading the project. A “Typhoon to Tempest” growth path may also prove a credible pitch in some export markets. In line with its Combat Air Strategy, the UK seems to prefer a global approach when it thinks about Tempest.

Sweden is emerging as a potential Tempest partner, with BAE Systems, Leonardo and MBDA talking to their counterparts in Saab about approaches to next-generation combat aircraft, sensors, avionics and kinetic effects. Jonas Hjelm, Head of Aeronautics at Saab, said during the 2018 Farnborough Airshow that “we are talking to everyone at the moment, and we are open to working with everyone” on the condition that technology from Saab’s Gripen E aircraft was included in any partnership.¹²⁸ Since Hjelm’s comments, relations between BAE Systems, Leonardo,

in *Defense News*, 8 March 2018, <https://www.defensenews.com/industry/techwatch/2018/03/08/brexit-project-delays-jeopardize-combat-drone-project-dassault-ceo-warns>.

¹²⁶ For a further analysis, see Chapters 4 and 5 of this report.

¹²⁷ House of Commons, “Combat Air Strategy”, in *Hansard* (17 July 2018), Vol. 645, Col. 248, <http://bit.ly/2EKmBuT>.

¹²⁸ Gareth Jennings, “Farnborough 2018: Saab Open to Fighter Partnership, if Gripen E Tech Included”, in *Jane’s Defence Weekly*, 16 July 2018, <https://www.janes.com/article/81766>.

MBDA and Saab appear to have grown closer.¹²⁹

3.2 *The military rationale*

By the beginning of this century, it appeared that the Eurofighter and the Lockheed Martin F-35B would be the UK's last two crewed multi-role combat aircraft. The then Labour Government's 2005 Defence Industrial Strategy stated, "Current plans do not envisage the UK needing to design and build a future generation of manned fast jet aircraft beyond these types [Eurofighter and F-35]".¹³⁰ Instead, UCAVs would initially complement, and in the longer term replace, the present generation of crewed types.

Such "optimism" was misplaced. UCAV development and adoption generally has been slower than anticipated, while a deteriorating European security environment, the emergence of a more assertive and antagonistic Russia and the renewed risk of state-on-state war have combined to rekindle British interest in a further generation of a crewed multi-role combat design.

London had been thinking about its next-generation combat-aircraft requirements as the Cold War ended and the Soviet Union collapsed. A successor to the Panavia Tornado was enshrined in Air Staff Target (AST) 425, while there was also a separate need to replace the Harrier family operated by the air force and navy.

AST 425 was intended to provide a follow-on to the Tornado ground-attack aircraft in the shape of the Future Offensive Aircraft (FOA), while UK interest in what was to become the F-35 was focused on a Sea Harrier Replacement (SHAR [R]), later known as the Future Carrier Borne Aircraft (FCBA). The planned entry-into-service dates of both was circa 2012. The air-defence and air-superiority role would be met by what was then called the European Fighter Aircraft – the Eurofighter.

A range of classified projects supported AST 425/FOA, including HALO (thought to be a Hawk advanced-jet trainer modified to examine signature-management techniques) and Testbed. The latter was a full-scale material and design representative model of a future multi-role aircraft, with an emphasis on the air-to-surface role. The Testbed airframe was used during the latter half of the 1990s to carry out radar cross-section measurement of the airframe in order to verify design goals. Radar cross-section pole-measurement trials were associated with the name "Nightjar". Testbed itself was not intended to fly, although a follow-on project, dubbed Experimental Aircraft Programme (EAP) Mk II, was at one point being considered. The first EAP was the precursor to the eventual Eurofighter design.

¹²⁹ For a further analysis, see Chapter 7 of this report.

¹³⁰ UK Ministry of Defence, *Defence Industrial Strategy. Defence White Paper* (CM6697), December 2005, p. 8, <https://www.gov.uk/government/publications/defence-industrial-strategy-defence-white-paper>.

The fortunes of the FOA and the SHAR (R)/FCBA projects were to diverge during the late 1990s and early 2000s. As the threat environment continued to be reassessed, and a focus on counterterrorism and counterinsurgency grew as the 2000s progressed, there was reduced emphasis on the FOA and its successor, the Future Offensive Aircraft System (FOAS).

An FOA pre-feasibility study was awarded to the then British Aerospace in 1993, with the intention of having a baseline requirement within 36 months. This was to be followed in 1997 by a feasibility study into what had by then been renamed FOAS. The name change was partly to address Treasury concerns that the previous approach had restricted focus only to a manned platform, and was indicative of a lack of enthusiasm on the part of the UK Treasury.

As conceived, the FOA was a long-range aircraft intended to meet the air-interdiction, offensive counter-air, offensive air-support, suppression-of-air-defence, anti-surface-warfare and tactical reconnaissance roles, with an entry-into-service date of around 2010. The aircraft had to be able to be operated against a high-end surface-to-air missile threat, predicated on a Soviet-era level of air defences. By the time of the 1998 Strategic Defence and Security Review, the FOA in-service date had been moved back to the end of that decade. And by 2002, the manned element of FOAS was viewed as being met by the F-35. The only new-build element of FOAS was now seen to be a UCAV. The MoD procurement office in charge of running the FOAS appears to have been closed in 2005.

The SHAR(R)/FCBA, meanwhile, had become a UK commitment to the US F-35 Joint Strike Fighter in order to meet what was now called the Future Joint Combat Aircraft (FJCA) requirement. London joined the concept-demonstration phase of what was to become the F-35 in 1995, with a contribution of 200 million US dollars. The name change to FJCA reflected the inclusion of the RAF's Harrier – which was also to be replaced. Britain was the only Tier-1 partner in the JSF Engineering, Manufacturing and Development (EMD) phase, joining in 2001. At this point, the UK requirement was for up to 150 of the short-take-off vertical-landing variant of the design, the F-35B. London's contribution to the EMD phase was to be 1.3 billion pounds, with an additional 600 million pounds to address specific British needs. Aircraft delivery to the UK was to begin in 2010.

Announcing British participation in the EMD stage of the programme, then Secretary of State for Defence Geoff Hoon declared,

JSF will not simply replace the Harrier, it will give the UK an aircraft that can take-off from an aircraft carrier and provide the agility of a light fighter with the punch of a bomber. Put simply, it will be the best aircraft of its type in the world. [...] JSF will play a crucial part in continuing our transatlantic partnership, maintaining NATO interoperability and improving European

military capability.¹³¹

The “punch of a bomber” was to be part of what, by 2004, the Royal Air Force was describing as its Future Combat Air Capability (FCAC). This was central to an RAF strategy document that considered requirements up to and beyond 2030. While the Joint Combat Aircraft would provide the manned element of a survivable air-to-surface capability, a low-observable UCAV was at the heart of what was then known as “Deep Persistent Offensive Capability” (DPOC). The latter was viewed as fulfilling the role then met by the Tornado GR4, beginning in 2018. By around a decade later, the air-to-air role was to be met by the “Air Dominance Capability” – again, provided by a UCAV. The public element of the DPOC UCAV was the Taranis UCAV technology demonstrator launched in 2006. This project built on classified work that had begun around the turn of the century. Taranis was intended to prove signature-management technology that would allow a platform to operate in airspace defended by systems such as the S-400 (SA-21 Growler) long-range SAM system, with an endurance of up to 24 hours. The Taranis demonstrator was meant to provide the MoD with the confidence to move ahead with what it termed “Initial Gate” approval for a UCAV procurement in 2011, with initial operational capability in 2018. By 2010, the projected entry-into-service date had been revised to 2025, a reflection of budgetary constraints and the decision to delay the retirement of the Tornado GR4 until then. Following the 2010 Lancaster House Treaty, Taranis was also viewed as the UK’s entry into the proposed joint development of a UCAV.

Even before the Franco–British effort unravelled, unwelcome developments in the security environment were beginning to see the UK’s air force revisit its overall planning assumptions. Russian President Vladimir Putin used his speech at the 2007 Munich Security Conference to signal that Moscow was unwilling to play a subservient role in any strategic partnership with the West, and that US hegemony was unacceptable. In 2008, Russia waged a very short war with Georgia, revealing continuing shortcomings with its military. It then launched a modernisation and restructuring programme – the “New Look”¹³² – and increased funding for defence over the 2010–20 planning period. It was, however, Russia’s annexation of Crimea and its involvement in the Ukrainian civil war that forced London to once again view Moscow as a strategic rival rather than as a sometimes awkward and irascible partner.

Russian procurement investment was also improving its military capability.¹³³ While by the latter half of the 1990s Mikoyan’s programme to develop a 5th-generation fighter had been abandoned, by the early 2000s Sukhoi had been chosen to meet

¹³¹ Quoted in “MoD Moves Forward with United States on Joint Strike Fighter Programme”, in *Defense-Aerospace*, 17 January 2001, [http://www.defense-aerospace.com/article-view/release/4167/britain-joins-jsf,-invests-\\$2.8-bn-\(jan.-18\).html](http://www.defense-aerospace.com/article-view/release/4167/britain-joins-jsf,-invests-$2.8-bn-(jan.-18).html).

¹³² See Carolina Vendil Pallin (ed.), “Russian Military Capability in a Ten-Year Perspective – 2011”, in *FOI Reports*, No. 3474 (August 2012), <https://www.foi.se/rapportsammanfattning?reportNo=FOI-R-3474--SE>.

¹³³ For a further analysis, see Chapter 1 of this report.

this need. The T-50, now known by its service designation of the Su-57, was first flown in January 2010. Moreover, the Russian Air Force responded to delays to the T-50 by also ordering the Su-35S (Flanker E) multi-role fighter, a mid-life update of the original Su-27 (Flanker B). Improved air-to-air weapons began to be fielded, while investment in advanced surface-to-air missile systems also continued to flow.

The re-emergence of the risk of state-on-state conflict in Europe and Russia's modernisation programme contributed to air-combat-capability planning assumptions being re-examined, as part of the 2015 Strategic Defence and Security Review. One part of this work was to consider options with regard to a next-generation manned combat aircraft, and UK options to begin to explore this route.

In 2017, Harriet Baldwin, then the minister for defence procurement, told the House of Commons,

The 2015 SDSR allocated a substantial budget over 10 years to the future combat air system technology initiative [FCAS TI], precisely to protect and develop key design and engineering skills in our industrial base. The money includes funding for a national technology programme to maintain the UK's position as a global leader in this area.¹³⁴

This was followed in July 2018 by the publication of the Combat Air Strategy, which placed in the public domain the military rationale for the FCAS TI:

For much of the last two decades the UK and our allies focused our attention on counterinsurgency operations in environments where we were largely unchallenged in the air domain. Investment by adversaries in highly capable systems has reduced the technological advantage that Western air forces have in achieving and maintaining control of the air.¹³⁵

While the Combat Air Strategy was open-ended as to the type of platform required beyond the Eurofighter and the F-35, the presentation of one concept mock-up at Farnborough and the other to an invited audience at the Royal International Air Tattoo provided a clear indication of the UK's thinking. Williamson's "Tempest" was a low-observable twin-engine multi-role fighter. And unlike AST 425/FOA, a central element of its notional design was meeting the need for an air-superiority aircraft as a successor to the Eurofighter from the mid-2030s onwards. That approach is different from the F-35 one, as the latter was designed from the outset as a multi-role platform but with an emphasis on its air-to-surface capability as strike fighter – a choice linked to the fact that in the USAF, the F-22 was intended to provide "air dominance".

¹³⁴ House of Commons, "Defence Aerospace Industrial Strategy", in *Hansard* (16 November 2017), Vol. 631, Col. 688, <http://bit.ly/2EJT3gZ>.

¹³⁵ UK Ministry of Defence, *Combat Air Strategy*, cit., p. 11.

3.3 The industrial rationale

Britain's aviation industry, fighting to retain its broad base of technology [...] is pressing the government for more financial encouragement in new aircraft and weapon design while simultaneously extending itself farther into cooperative Europe and U.S. efforts.¹³⁶

More than half a century after *Aviation Week* stalwart Coleman wrote the above, the same issues continue to face the sector – how to survive and thrive in a challenging, competitive and dynamic environment. The political and industrial decisions taken over the next few years, however, will not only determine the shape of the UK's defence-aerospace sector but arguably also its fate.

The design and engineering skills required to develop a low-observable multi-role combat aircraft still reside in UK industry, but without any high-end future programme these skills will dissipate. Reconstituting such a capability would be difficult, costly and time-consuming – if it could be achieved at all. The alternative, and this remains an option, would be to buy off-the-shelf while recognising and acknowledging the industrial and operational implications of such a decision. It would mark the end of the UK as a top-tier defence-aerospace manufacturing nation at platform level.

BAE Systems is the UK's resident combat-aircraft designer and manufacturer. It has been Britain's industrial lead in the Panavia Tornado and Eurofighter programmes. Similarly, Rolls-Royce has been closely involved in the design and development of the RB199 and EJ200 power plants for the Tornado and Eurofighter respectively. Leonardo's UK business unit, in its former guises of Ferranti and GEC-Marconi Avionics, led development of the ECR90 multi-mode radar for the Eurofighter. Missile house MBDA's constituent parts, meanwhile, developed weapons for both the Tornado and the Eurofighter. The four companies also form "Team Tempest", the industrial element of the FCAS TI.

BAE Systems' Warton site in the northwest of England is one of four final assembly lines for the Eurofighter, while its nearby Salmesbury site manufactures the rear-fuselage section of the F-35. The latter provides valuable manufacturing volume.

Even if the Franco-British UCAV had come to fruition, the absence of a manned combat aircraft to follow on from the Eurofighter would have meant restructuring and downsizing of the UK sector. The number of UCAV airframes to be built to meet a likely British requirement was in the order of 30–40 only.

Given the British legacy of involvement in European projects, then industry participation in a wider Continental effort has a clear rationale – even if this

¹³⁶ Herbert J. Coleman, "British Seek to Hold Technological Base", in *Aviation Week & Space Technology*, 11 March 1963, p. 275, <http://archive.aviationweek.com/issue/19630311>.

strategy contains, in part, the foreknowledge of the pitfalls and difficulties of such an approach. BAE Systems has over the past 20 years been seen at various points as a European defence-aerospace champion. In 1996, Deutsche Aerospace (DASA) chairman, Manfred Bischoff, suggested that British Aerospace (BAE) could form the core of a European combat-aircraft group. By the end of 1998, BAE and DASA were on the brink of merger to form what some dubbed a "European Aerospace and Defence Company", but a month later the deal was on hold as BAE moved to acquire Marconi, the defence business unit of GEC. BAE's shift of focus soured industrial and political relations with its jilted partner for some time. By 2011, however, the two were again in discussions over a "merger" – this time, with BAE in talks with Franco-German EADS, the successor to DASA established in 2000. It was not, however, the British who were to scupper the deal this time. Internal German politics, and EADS Chief Executive Officer Tom Enders' failure to secure top-level political backing for the deal, saw it collapse.

In the early 1990s, the UK had taken a dual-track approach to future defence-aerospace cooperation, though with France rather than Germany appearing as the preferred European option to parallel US discussions. Relations between the UK and Germany were strained in 1991–2 by the problems caused by the latter over the Eurofighter, which had risked the programme's collapse. British Aerospace and Dassault explored what they dubbed the "Next Combat Air Weapon System" while engine manufacturers Rolls-Royce and Snecma were, by 1994, in talks over the Advanced Military Engine Technology (AMET) project. GEC-Marconi and Thomson-CSF (now Thales) were also working on a radar-technology demonstrator.

Among French industrialists there was concern that London would decide to take a transatlantic path, and in doing so undermine European defence-aerospace cooperation. Serge Dassault raised this issue publicly in early 1995, and was quoted in the press as warning, "France and its defence industries are determined to work with European aircraft manufacturers. Let the best-qualified and best-suited among our European industrialists do the job on any future programme, whether in Germany, France, or elsewhere in Europe. There must be one boss."¹³⁷

By the middle of that year, then UK Minister for Defence Procurement Roger Freeman was suggesting a memorandum of understanding covering Franco-British combat-aircraft cooperation, in what appeared to be an effort to address Dassault's concern.

One problem, however, was the UK's privileged access at that time to US signature-management research and development – access that was not available to France. Within the UK defence establishment, the worry was that any suggestion, correct or otherwise, of technology leakage via an Anglo-French tie-up would jeopardise its US access. Another key function of the Testbed demonstrator was to show

¹³⁷ Gilbert Sedbon, "Dassault Lays Claim to Fighter Leadership", in *FlightGlobal*, 15 February 1995, <https://www.flightglobal.com/news/articles/dassault-lays-claim-to-fighter-leadership-22271>.

Washington that the UK was capable of developing an advanced low-observable combat aircraft independent of the US, and to use this to leverage technology access for the F-35. This approach, in retrospect, seems to have been only partly successful in securing BAE Systems an industrial role in the F-35 programme.

Alongside British Aerospace's low-observable design work on Testbed in the later part of the 1990s, Rolls-Royce was looking at propulsion needs and GEC-Marconi Avionics (now part of Leonardo) was considering sensor requirements. This included examining the extent to which conformal passive and active arrays could be used to supplement or even replace the traditional nose-mounted radar.

By the end of the 1990s, MoD interest in a next-generation crewed combat-aircraft project was on the wane, replaced by a growing enthusiasm for unmanned-systems research and development. Industry had little choice but to take the lead from its national customer. BAE Systems led the Mantis and Taranis projects in the development of medium-altitude long-endurance and unmanned combat air vehicle demonstrators respectively, and Rolls-Royce was the lead for the propulsion. Both designs underwent successful flight-test programmes using the range at Woomera in Australia.

Mantis and Taranis were the UK industry placeholders within the Franco-British Lancaster House Treaty for an Intelligence Surveillance Reconnaissance (ISR) UAV and a UCAV. Taranis provided BAE Systems with a vehicle to sustain low-observable platform research and development and Rolls-Royce, with the challenge of integrating an engine into a low-observable design, accommodated radio-frequency and infrared signature-management needs.

The proposed ISR UAV project – which was seen as considerably less important than Taranis – was shelved when it became apparent that there was not enough government funding to allow industry to pursue both projects; the UCAV was deemed the priority. The industrial rivalry that played a significant part in France quitting the five-nation European fighter project in 1985, and that Serge Dassault's comments a decade later also laid bare, was also to manifest itself in the Franco-British FCAS. And once again, industrial aspirations could not be reconciled. Notably, the current Franco-German FCAS programme is led by Dassault.

While enthusiasm for the UCAV waned, from 2014 to 2015 industry was involved in helping the MoD re-evaluate its options for a manned combat-aircraft acquisition beyond the Eurofighter and the F-35. This resulted first in Team Tempest – BAE Systems, Rolls-Royce, Leonardo and MBDA – and the planned 2 billion pound investment up to 2025. Building on this work, the UK Government released the Combat Air Strategy in July 2018, which laid out its vision for the combat-aircraft sector and the future of the UK defence-aerospace industry.

The strategy identified the sector as a valuable contributor to the national economy with an annual turnover of 6 billion pounds, directly employing 18,000 skilled workers. It also recognised that while

[r]ecent Typhoon and F-35-related work and success in Typhoon exports provides significant revenue for the UK and will sustain Typhoon manufacturing into the 2020s [... w]ithout a clear indication of future UK requirements this is not enough to stimulate the research and development investment necessary to refresh national Intellectual Property, placing key engineering skills at greater risk.¹³⁸

The UK project, however, will only move ahead as a collaborative programme – both in terms of government-to-government cooperation and industry partnerships. In pursuing these goals, the strategy set out an ambitious timeline: a strategic business case by the end of 2018; by mid-2019, a first assessment of international collaborative options; by the end of 2020, to decide on partners; and by 2025, to have in place final investment decisions. The aim would be to meet an initial operating-capability date of 2035. Given this timeframe, there remains a question as to whether the UK will buy the planned number of F-35 aircraft. So far, however, London maintains that it will acquire 138 of the type.

Whether or not a technology demonstrator will also figure in the “Tempest” development programme remains unknown. One path, however, would be to “reuse” systems now in train for the Typhoon, re-hosted in a new airframe: a kind of Tempest Mk I. AESA radar, infrared search and track, weapons, and perhaps even a variant of the EJ200 Typhoon turbofan engine could be integrated into the Tempest.

Conclusion

The CAS and Tempest effort is a coherent attempt to sustain the UK as a leading defence-aerospace nation. Were it to fail completely, then the outlook for the sector would appear to be one of decline over the coming two decades. Unfortunately for the UK Government, the decision to leave the European Union, and the thus-far messy “divorce” proceedings, are a less than ideal backdrop against which to craft a collaborative European defence-aerospace programme. Sweden and Italy are potential European partners – with the former, at least, already in discussions. London will no doubt also watch with interest the progress of the Franco–German project, given its own sometimes difficult relationship with Paris on defence projects.

There is little doubt that the UK would be more than happy to accommodate German participation, were the opportunity to arise, and Germany for its part seems willing to open up Franco–German cooperation to include the UK. The geometry becomes complicated, however, because reaching a deal that would bring France and the UK together in a pan-European programme would require far greater political and industrial guile than demonstrated hitherto. In industrial terms, it would also need

¹³⁸ UK Ministry of Defence, *Combat Air Strategy*, cit., p. 14.

BAE Systems and Dassault to be willing to compromise over programme leadership. This, unless the industrial landscape shifts, is presently difficult to envisage.

On Europe's periphery, BAE Systems is already supporting Turkey in the latter's TF-X fighter development. Technology-access issues, however, are already proving thorny. The company is also key to the UK's Salam programme with Saudi Arabia. Turkey and Saudi Arabia would also appear to be potential partners; however, this would pose the challenge of managing much more intertwined relationships with regimes than have, in the wider political context, proved increasingly problematic. Further afield, Japan has a requirement for a future combat aircraft, and Tokyo and London are looking to build closer defence-industrial relations. Full-blown Japanese participation would need to deal with challenges of geography and language – and, again, this seems less than likely. Participation in discrete subsystems, however, might be a more realistic ambition.

The Tempest endeavour represents the British Government's and industry's collective effort to "assure" the future of the UK's combat air capability. Were it to stall, recovery would be difficult indeed.

Table 9 | Fighter aircraft in use in the UK

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
F-35	13	N/A	
Typhoon FGR4/T	139		
Tornado GR4/GR4A	46		
Total quantity		198	

4. France

by Jean-Pierre Maulny*

4.1 The military rationale

The issue of the FCAS¹³⁹ concept and the tasks it will have to fulfil is complex. Accordingly, French considerations over what the FCAS might entail must consider several factors, now and in the future.

4.1.1 What is the Future Combat Air System about?

The first question that arises in France is how to frame the issue of the Future Combat Air System (FCAS). The question is not self-evident, and the answer might be contingent on timing, the policy-makers in charge of this issue at the French MoD (Ministry of Defence) and potential cooperation at the European level.

No French public strategic document has provided an official definition of the FCAS so far. Establishing the scope of what it covers thus requires the survey of the few open existing sources as well as interviews.

In his report on the 2019 budget for the French Air Force, the member of the National Assembly's Defence Committee, Gilbert Ferrara, presented the FCAS by stating that it

will primarily be a network, also called "System of systems". Organised around a combat aircraft, controlled remotely, it will rely on inter-platform connectivity: tankers, drones, intelligence aircrafts, means of other armies, etc. Given the importance of data collection, and the ability to process, exchange and analyse this data, the means of Command and Control (C2) and armaments will be at the heart of FCAS.¹⁴⁰

During the defence committee hearing at the National Assembly in October 2018, the air force chief of staff, General Philippe Lavigne, gave the following assessment: "this system of future combat will be built around a combat aircraft platform,

¹³⁹ Notably, France does not use this terminology to refer to the programme (as it resembles the name of the Franco-British initiative), and actually employs the acronym SCAF, which stands for *Système de Combat Aérien Futur*. Nonetheless, for reasons of consistency with the other chapters, as well as adopting the most commonly used terminology, the programme is named FCAS throughout the whole study, including this chapter.

¹⁴⁰ Jean-Jacques Ferrara, "Défense: préparation et emploi des forces: air", in *Les rapports législatifs de l'Assemblée nationale*, No. 1306 (12 October 2018), <http://www.assemblee-nationale.fr/15/budget/plf2019/a1306-tvi.asp>.

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manned or not, versatile, around which we will place a number of effectors, combat and non-combat drones, and weapons. Anyway, the game changer will be connectivity". The FCAS is thus conceived as a system of systems organised around a combat aircraft.

Other experts go further and provide a broader vision for the FCAS.¹⁴¹ For them, it truly is a system of systems, meaning an entire entity organised in tiers. In the first tier lie all the air assets, which actively participate in air-land combat; in a second tier there is all the equipment providing support for air-land combat; the third tier can incorporate other related equipment, even an aircraft carrier. The journalist Pierre Tran gave another view using the same perspective.¹⁴² If we do consider FCAS to be a system of systems, the main difference between the two approaches is that the first one centres on the combat aircraft and the second does not. Indeed, in the second vision, the system of systems is at the core of the FCAS, and it follows that the whole architecture with its connectivity, rather than the combat aircraft itself, must be the focus. Whoever deems the system of systems more important than the combat aircraft believes that connectivity and the increasing use of Artificial Intelligence (AI) must structure this programme. In this perspective, the F-35 is an example of a platform initially meant to include more remote functions that were then largely re-centralised on the platform. According to this point of view, we can, therefore, consider that the F-35 could have been the first 6th-generation aircraft but can only be qualified now as a "5th-and-a-quarter generation aircraft".

In this context, an "expansive" vision of the FCAS would allow for a wider scope of cooperation, which would facilitate the division of labour between different manufacturers. Accordingly, we could consider the Eurodrone programme a piece of the Future Combat Air System.

4.1.2 European cooperation could narrow the FCAS scope

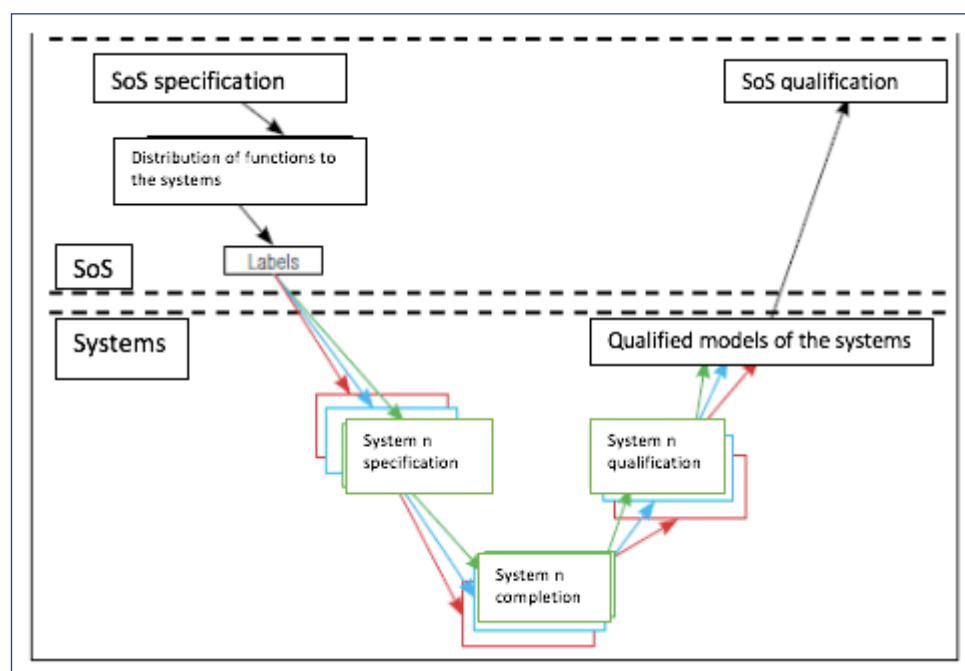
The initial scope of the French FCAS is the result of strategic planning, wherein the "architects" of force systems at the Defence Procurement Agency and operational-consistency officers at the French Military Staff jointly define the capacities. These architects and officers begin to define operational requirements at the outset by considering all capability options. Therefore, they have a comprehensive outlook on the capacities to be developed, beyond specific items of equipment, as they proceed by operational domains – i.e. land, naval and command-and-control systems. The development of the system-of-systems approach has further expanded the scope of the work undertaken by those responsible for strategic planning in France, as presented in Figure 1, below.

¹⁴¹ Interview carried out for the purpose of this study with journalist and former general officer of the French air force; Pierre Tran, "The Future Combat Air System: The View From Paris", in *SLDinfo*, 26 November 2018, <https://sldinfo.com/?p=121312>.

¹⁴² Ibid.

The design of a system of systems produces the requirements (the “labels”) that the different systems will have to fulfil in order to achieve the collaborative functions. This allocation must be anticipated prior to the completion of the systems. Similarly, the qualification of the system of systems is carried out by using qualified system copies and delivered items.¹⁴³ The resulting nested “V cycle” is shown schematically below.

Figure 1 | Development of the system-of-systems approach



Source: Elaboration by the French Institute for International and Strategic Affairs (IRIS).

According to some observers, the FCAS would entail generalising and broadening this “system of systems” approach, as the FCAS itself becomes an essential element of the military model thanks to its widespread connectivity. However, this would require the further decompartmentalisation of the architects of force systems, which is already far from easy at the national level.

The degree of international cooperation adds a layer of complexity as none of the European armies uses the same process as others to define their capabilities and operational needs, even if some are more compatible than others.

As a result, facilitating cooperation often requires the extreme simplification of capabilities and the definition of operational requirements. In the case of the FCAS, therefore, the risk is that future cooperation will focus on a combat aircraft rather

¹⁴³ Pierre-Marie Lecat and Delphine Dufourd Moretti, “Le système de système Scorpion”, in *Le magazine des ingénieurs de l’armement*, No. 109 (June 2016), p. 17, <https://ita.calameo.com/read/00000977974570c280c41>.

than on a system of systems in which the combat aircraft is only one component. The risk is twofold:

1. The system of systems will be built around a combat aircraft when the combat aircraft should be merely a component of the system of systems, leading to a "domino effect" of potential inconsistencies once all the pieces of the puzzle are developed.
2. The scope of the cooperation will be limited to a combat aircraft and not to the system of systems, with the associated risks of industrial quarrels over this new aircraft.

4.1.3 What are the operational requirements for the combat-aircraft component of the FCAS

In France, considerations concerning the FCAS are still in their preliminary phase – although most practitioners and policy-makers are now aware of the need for a study on the future system. In the aforementioned presentation given by General Lavigne, we see that whether the future combat aircraft will be manned or not is unknown. It is also notable that French officers do not like the expression "unmanned aircraft". Indeed, during his hearing at the National Assembly's defence committee in October 2018, General Lavigne described the concept of unmanned aircraft in France as follows: "In the sixth-generation aircraft, whether 'inhabited' or not, a pilot will always be present because the plane can be remotely piloted."¹⁴⁴

It is difficult to define the specific operational need for the aircraft as it will only come into service around 2040. Being able to penetrate strengthened air defences will be necessary due to the development of Anti-Access/Area Denial (A2/AD) systems. However, it is not clear what will emerge from new technologies, which represent as many opportunities as threats. Recent information – which requires further confirmation – reveals the development of a Chinese quantum radar that would overcome technologies currently used for stealth aircraft.¹⁴⁵ Therefore, the 6th-generation aircraft may have to render 5th-generation planes obsolete in terms of low observability in order to cope with future threats.

In this context, the French Defence and National Security Strategic Review published in October 2017 gives some indication as to the future capabilities of the French Air Force, and therefore – indirectly – regarding the FCAS:

In-depth strikes to the enemy's gravity centre, while limiting the exposure of our forces, requires the ability to operate remotely from the national territory, from deployed air bases, terrestrial holdings or from the sea

¹⁴⁴ Hearing of General Philippe Lavigne, Chief of the Staff of the French Air Force, on France's Finance Bill for 2019. See Assemblée Nationale-Commission de la Défense Nationale et des Forces Armées, *Compte-rendu*, No. 13 (17 October 2018), <http://www.assemblee-nationale.fr/15/cr-cdef/18-19/c1819013.asp>.

¹⁴⁵ Arthur Herman, "Winning the Race in Quantum Computing", in *American Affairs*, Vol. 2, No. 2 (Summer 2018), p. 96-113, <https://americanaffairsjournal.org/?p=1105>.

(carrier battle group). Penetration capabilities and the increasing reach of weapons systems are a determining factor. The combination of platforms (tankers where appropriate) and armaments is essential in this respect.¹⁴⁶

Moreover, at the strategic level, the latest French documents insist on “first-in” entry capacity in a national or coalition framework. The Defence and National Security Strategic Review, published in October 2017, defines the “first-in” concept as “the ability to penetrate these contested spaces and reduce the threat level to conduct military operations”. The aim is to create a favourable balance of power from the initial stages of military involvement onwards. In this context, the air force plays an important role. Thus, the review states:

Air superiority is a prerequisite for military operations. This skill encompasses the know-how and abilities required to reduce enemy air threats to a level that confers sufficient freedom of action to land and naval forces. This ability, which is not exclusive to first-in entry, presumes persistence to maintain constant pressure on the opponent. The future evolutions of the Rafale and its armaments, such as the future combat air system, should be subject to thorough feasibility studies without further delay. Moreover, they must meet this challenge by providing connectivity, capabilities integration to neutralise enemy defence systems, and the development of autonomous systems (combat drones).¹⁴⁷

4.1.4 FCAS and the renewal of the air component of deterrence

One of the specificities of the French case stems from the fact that France’s nuclear-deterrent power includes an air dimension, alongside its submarine ones. Prior to his election, Emmanuel Macron did not call into question the need to have two components for nuclear deterrence.¹⁴⁸ The dual components of French deterrence are justified in two ways: (1) the concern that technological progress will make nuclear submarines detectable in the near future; (2) the greater flexibility offered by the airborne component, which can be deployed in the outer territories allowing for diplomatic actions and pressure.¹⁴⁹

The renewal of the airborne component is considered a priority in France in view of the evolution in enemy defences – including, for example, air-to-air threats, 5th-generation fighter jets, the proliferation of the S400/500 type of defences and multi-frequency radars, and improvements in weapon systems and aircraft

¹⁴⁶ French Ministry of the Armed Forces, *Revue stratégique de défense et de sécurité nationale 2017*, October 2017, p. 82, <https://www.defense.gouv.fr/english/dgris/dgris/evenements-archives/revue-strategique-de-defense-et-de-securite-nationale-2017>.

¹⁴⁷ Ibid.

¹⁴⁸ Emmanuel Macron, *Politique de défense*, 18 March 2017, <https://en-marche.fr/articles/discours/emmanuel-macron-discours-sur-la-defense-programme-hotel-arts-et-metiers>.

¹⁴⁹ See Xavier Pintat et al., “La modernisation de la dissuasion nucléaire”, in *Rapport d’information du Sénat*, No. 560 (23 May 2017), p. 59, <http://www.senat.fr/rap/r16-560/r16-560.html>.

manoeuvrability.

An initial milestone was reached in November 2016 with the articulation of a French Military Staff objective. A direction for this programme is expected to be set by 2020,¹⁵⁰ aiming for a renewal of the carrier and the vector in 2035.¹⁵¹

As for the vector, given the need to cross hypersonic air defences, France is moving towards a hypersonic missile. It is very likely – additionally given the development cost of a heavy carrier, which could also be unsuitable for the launch of a hypervelocity missile – that Paris envisions significant modernisation of the Rafale. This goal was expressed by Dassault Aviation's CEO, Éric Trappier, in February 2018.¹⁵² For the moment, it is unclear whether or not the future FCAS, to be developed in cooperation with Germany, is expected to possess nuclear capacity, especially given the need for this hypersonic/carrier missile pair by 2035 – five years before the expected FCAS deadline.

One of the reasons that explained the need to involve Thales in the loop of this programme was the necessity of developing a nuclear-capable version that could constitute the paired hypersonic missile/carrier missile after 2050 and beyond, which seems impossible with Rafale – even in a modernised form – due to the fact that this aircraft was developed in the 1980s. Yet developing a nuclear version of the FCAS would complicate Franco-German cooperation on the future combat aircraft in terms of requirements and also of industrial sharing. Another consequence is that, for France, the nuclear version will, due to political constraints, necessarily be a manned aircraft.¹⁵³

4.2 The industrial rationale

4.2.1 The need and the capacity to be able to integrate a complex system

The aforementioned “first-in” entry capacity requires industrial and technological capacity in the French aerospace sector. Apart from deterrence, which is a matter of national sovereignty, airborne hubs are understood as being potentially subject to cooperation – be it cooperation with preservation of national competencies

¹⁵⁰ Ibid., p. 122.

¹⁵¹ Jean-Charles Larssonneur, “Défense, équipement des forces – dissuasion”, in *Les rapports législatifs de l'Assemblée nationale*, No. 277 (12 October 2017), <http://www.assemblee-nationale.fr/15/budget/plf2018/a0277-tVII.asp>.

¹⁵² Assemblée Nationale-Commission de la défense nationale et des forces armées, *Audition, ouverte à la presse, de M. Éric Trappier, président-directeur général de Dassault Aviation, sur le projet de loi de programmation militaire*, 28 February 2018, <http://www.assemblee-nationale.fr/15/cr-cdef/17-18/c1718046.asp>.

¹⁵³ Sebastian Sprenger, “With Nukes in Mind, French Officials Stake Out Must-Haves for Franco-German Warplane”, in *Defense News*, 15 November 2018, <https://www.defensenews.com/global/europe/2018/11/15/french-officials-stake-out-sovereign-bits-in-franco-german-warplane-bid>.

or cooperation with mutual dependence.¹⁵⁴ In concrete terms, the need for this significant industrial capacity explains the sustained French policy in favour of an air-systems integrator capacity at the French company Dassault. This approach explains the following:

- The financing of a stealth-drone demonstrator, nEUROn, from 2003 to 2010 with a cooperation requirement set by the French state, which was achieved with Italy, Sweden, Greece, Spain and Switzerland under the control of Dassault.
- The guarantee, given by the French state, to keep buying Rafale between 2017 and 2019 under the 2014–19 military programming law if its exports were insufficient. In the end, exports to Egypt, Qatar and India prevented Paris from having to place additional orders for Rafale.

The objective is to maintain air combat systems' integration capacity within the EU. According to the French perspective, this capacity is limited or very limited in Germany, Sweden and Italy, and the UK lost much of this capacity after the development of the Eurofighter due to British involvement in the US F-35 without any technological input. Such understanding explains the French desire to have control over the systems-integration capacity of the future combat aircraft.

4.2.2 What are the technological capabilities of the 2040 FCAS?

Beyond the need to preserve a complex air-systems integration capacity, in which field Dassault is proficient, analysis of the technological capabilities of this future system of systems is more complex to determine than in the past. In any case, there is a general understanding that specific aeronautical competency is losing its importance for several reasons:

- In the carrier/effector pair, the future main technological leap will take place in the field of effectors with hyper-velocity, which seems the best response to the development of A2/AD capabilities – and the European company MBDA possesses the relevant technological expertise.
- As mentioned above, in the coming years innovations like quantum technology could challenge stealth technology. Will the same stealthness technology be at the heart of 6th-generation aircraft as it was for their 5th-generation predecessors?
- Radar and counter-measure devices will remain at the heart of the FCAS and, most likely, of its combat-aircraft component.
- The future combat aircraft will require a more powerful engine than those of the current generation of fighter jets. In this area, France will need foreign partners.

In this context, the main question relates to the connectivity of the future aircraft and the role that AI can play in the FCAS. Undoubtedly, the question that arises today in France is whether this Information Communication Technology (ICT)

¹⁵⁴ French Ministry of the Armed Forces, *Revue stratégique de défense et de sécurité nationale 2017*, cit., p. 69.

competency already takes precedence over the aeronautical one. Thus, for some observers, the issue is whether ICT companies such as Google or Microsoft rather than the aeronautic sector will be at the heart of the next FCAS. From another viewpoint, this dependency on non-European ICT giants leads to issues surrounding strategic autonomy – whether French or European in nature.

This in turn points towards what should be European countries' primary concern about the FCAS. Ultimately, it comes back the first question related to operational requirements: is the FCAS a combat aircraft around which other systems are articulated, or is it the future combat aircraft just one component among others of a system of systems? If cooperation simply leads to mere capacity renewal and modernisation, without accounting for future developments in AI and the ICT field, the FCAS's future aircraft risks becoming obsolete even before it comes into existence.

4.3 *The political rationale*

Since France's return to NATO's integrated military command, French strategic analysis has not evolved a great deal. Currently, France sees two major threats to national security: the return of powerful and assertive states and state-to-state confrontation, especially by Russia, and the international terrorist threat.

The Defence and National Security Strategic Review cites Russia as an example of the revival of state power, arguing that the eastern and northern flanks of Europe have experienced "the resurgence of war".¹⁵⁵ The strategic review speaks of "Moscow's desire to reconstitute an area of influence" in these parts of Europe. Additionally, it describes the "destruction of the security architecture in Europe" regarding the annexation of Crimea, and the relative trouble concerning the implementation of the treaty of Conventional Forces in Europe (CFE), Open Sky and Intermediate Nuclear Forces (INF) disarmament treaties. However, while this strategic document singled out Russia it was the United States that decided, in October 2018, to leave the INF treaty by denouncing its utility vis-à-vis alleged Russian violations.

The Defence and National Security Strategic Review also referred to the possibility of direct attacks on national territory, the vulnerable nature of the Sahel-Saharan belt and a destabilised Middle East. The trauma of the 7 January 2015 and 13 November 2015 attacks remains very raw in France, which explains why threat assessment and French defence-policy guidelines are still heavily affected by the idea of counterterrorism on national soil and abroad. To sum up, if France views Russia as a potential threat with whom dialogue is nevertheless necessary,¹⁵⁶ it perceives terrorism as a current threat that must be eliminated. Finally, while France does not consider China a threat, the latter is nevertheless described as a

¹⁵⁵ Ibid.

¹⁵⁶ Ibid., p. 23.

“power with global ambitions”.¹⁵⁷

As far as its military action is concerned, France conceives of it within either a national, EU or NATO framework.

The French specificity lies in the fact that regardless of the global security environment and international crises, France stresses the need for strategic autonomy.¹⁵⁸ This position is not new but it has taken a new form in the Defence and National Security Strategic Review, which calls for the development of European strategic autonomy. However, this concept is not defined beyond the mention of “common European interests to defend”, contrary to the idea of national strategic autonomy, which is defined as follows:

Because it conditions the exercise of our sovereignty and our freedom of action, our strategic autonomy remains a primary objective of our defence policy. In an international system marked by instability and uncertainty, France must retain its ability to decide and act alone to defend its interests.¹⁵⁹

We might thus think that the scope of French strategic autonomy is broader than its European counterpart, but the reality is more complicated. Indeed, Paris is now increasingly defining its defence-procurement policy in a European cooperative framework even though in some areas, such as deterrence, the national framework is privileged. In the armaments field, this actually leads to the building of a framework for European strategic autonomy that is broader than its national strategic autonomy equivalents, as it relies on the principle of mutual dependence with other European countries – accounting for a loss of skills in France.

The French state does not use this cooperative approach towards the United States; it can, in fact, be considered as doing the exact opposite. Indeed, the objective is to limit non-European dependencies in the armaments sector as much as possible – above all, in the case of strategic equipment and components where supply disruptions may occur. France experienced this situation when it refused to participate in the military intervention in Iraq alongside the US in 2003, and does not want to repeat it.

Seen from abroad, the situation may seem paradoxical because the notion of French strategic autonomy is partly a built-in reaction to US policy. However, at the same time, France actively contributes to NATO operations, implements an active security partnership with the US in the Sahel-Saharan region – particularly in the field of intelligence, which is very satisfactory – and has set a 2 per cent of gross domestic product (GDP) spending target for its defence budget by 2025. Thus, President Emmanuel Macron’s recent speech on the European Army endeavoured

¹⁵⁷ Ibid., p. 42.

¹⁵⁸ Ibid., p. 43.

¹⁵⁹ Ibid., p. 56.

to develop the EU's military capabilities and also enhance NATO's means of collective security.¹⁶⁰ This should be considered good news by Washington as it reduces dependency on the US military, thus allowing a rebalancing of transatlantic burden sharing. Yet it was held to be terrible news by US President Donald Trump, who, in a tweet, qualified the French president's words regarding his European project as "insulting" because they allowed the French to be less dependent on Americans. Having said that, this paradox is not new: in 1998, the then US president, Bill Clinton, criticised the UK when the French and British governments decided, at the St Malo Summit, to build a European force for autonomous intervention.

In comparison with the 1990s or 2000s, the novelty of this reaction presumably stems from the many questions raised by the current US president's bombastic rants, the resulting systematic deconstruction of multilateralism and the diffuse feeling that the West could potentially no longer be a model in the world – a model of prosperity, a model of social cohesion or even a model of democracy. If this were to be the case, it would become necessary for the EU to assert itself as an independent entity, including when it comes to security, in order to defend its model and its values.

In any case, this scenario is not the main driver of Paris's current approach towards Washington. France continues to foster active operational cooperation with the United States while cautiously avoiding dependencies in the armaments sector in order to preclude losses of strategic autonomy, which would limit its freedom of action. In this sense, France will seek not to depend on the US for the FCAS, and therefore does not seek to cooperate with Washington on this system – or, at the very least, not on the most critical components of the system.

In this context, many reasons explain the choice of cooperation with Germany. First of all, despite their differences on the meaning of a "European Army", France and Germany share to a large extent the necessity for a more capable and more integrated European Union in terms of economic, foreign and defence policy. The "old school mind" of the *"moteur franco-allemand"* is still alive, even if it is more complicated today than in the 1990s because the balance of power between France and Germany is not the same and the EU, with 28 members (in the future, possibly with 27), is a different landscape than the earlier Union with 12 or 15 states.

Second, there is a common Franco-German necessity to replace the Eurofighter and the Rafale, and France is aware that it will be impossible to manage such a programme alone due not only to its cost but also to the necessity of gathering all the technological capacities available.

¹⁶⁰ "Emmanuel Macron invité exceptionnel d'Europe 1: le résumé de l'interview", in *Europe 1*, 6 November 2018, <https://eur1.fr/nADnltQ>.

Third, there is a fear in France that Germany will choose the F-35,¹⁶¹ with the risk of definitively losing the European capacity to build an air-superiority aircraft in the future, and therefore of enjoying less European strategic autonomy in the 2040s than now. So, it is important for Paris to secure Berlin's involvement in this project.

The French and German ministers of defence have agreed that Airbus and Dassault will share the leadership on a joint concept and architecture study for an FCAS, with connectivity forming part of a later study. On 7 February 2018, Florence Parly and Ursula von der Leyen awarded a two-year 65 million euro contract to the two companies to define the general architecture and the industrial organisation of the project. The contract was awarded by France's defence-procurement agency acting on behalf of both governments, while Airbus and Dassault have co-contractor status. The next step, scheduled for the Paris Air Show in June 2019, will be the award of contracts to Dassault and Safran to design and build technology demonstrators for the FCAS and its engine. The CEO of Dassault Aviation, Éric Trappier, has declared that the demonstrator will be able to fly by around 2025.¹⁶²

In this context, the Franco-German Treaty of Aix-la-Chapelle, signed on 22 January 2019, symbolises a renewal of bilateral cooperation in succeeding the 1963 Elysée Treaty. It constitutes a conducive environment for military and defence-industrial cooperation between Paris and Berlin. However, it is not the step forward hoped in France for a treaty whose negotiation began more than a year ago.¹⁶³ Therefore, its impact on the FCAS project seems more symbolic than real, even if this treaty was published at a time when Parly explained that the difficulty linked to the industrial sharing of the FCAS had been resolved.¹⁶⁴

The complex question of industrial sharing and common requirements for the FCAS system also explains why France and Germany took some time to give a definitive answer to Spain after Spanish Defence Minister Margarita Robles sent, in December 2018, an official letter to her French and German counterparts proposing that Spain join this project.¹⁶⁵ Regarding the form of the cooperation itself, i.e. bilateral or multilateral, France is very cautious because technical and operational requirements on the one hand, and political factors on the other, do not drive the decision in the same way. When it comes to technical and operational

¹⁶¹ For a further analysis see Chapter 5 of this report.

¹⁶² Jean-Dominique Merchet, "SCAF: le démonstrateur devrait voler 'autour de 2025'", in *Secret Défense*, 10 January 2019, <https://www.lopinion.fr/node/174189>.

¹⁶³ "Traité d'Aix-la-Chapelle: les élucubrations de Marine Le Pen et Nicolas Dupont-Aignan", in *Le Monde*, 22 January 2019, https://www.lemonde.fr/idees/article/2019/01/22/traite-d-aix-la-chapelle-laissez-en-paix-l-alsace-et-la-lorraine_5412668_3232.html.

¹⁶⁴ French Ministry of the Armed Forces, *Déclaration de Mme Florence Parly, ministre des armées, sur les efforts en faveur de la maintenance des avions militaires*, Bordeaux-Mérignac, 27 September 2018, <http://discours.vie-publique.fr/notices/183001908.html>.

¹⁶⁵ In December 2018, the Spanish Ministry of Defence unveiled a national plan to participate in the Franco-German initiative for the development of a 6th-generation fighter. See Gareth Jennings, "Spain Declares for Franco-German Future Fighter Project", in *Jane's Defence Weekly*, 5 December 2019, <https://www.janes.com/article/85011>.

factors, France fears that it will be complicated to find an agreement with Germany because the definition of the FCAS system of systems, and each part of that arrangement, is very complex. Obviously, it will be even more complicated if the number of participating countries increases from the beginning. Therefore, there is consensus in France on the approach of the former France's national armament directorate, Laurent Collet-Billon – i.e. of preferring to begin an armaments cooperation in a bilateral framework and to enlarge that cooperation only after the architecture of the project, the global common requirements and the scope of the main industrial sharing are defined. Such an approach explains why the first stage of the FCAS cooperation was bilateral. But Paris is also aware of the necessity of having, in the end, more EU countries in the FCAS's "loop" for political reasons: it needs to be a European programme and not a Franco-German one in order to enlarge the domestic market of the future aircraft and to share its funding with a greater number of partners – hence, the "green light" given to Spain.¹⁶⁶ It is also regarded as necessary to involve UK in the programme.

These two contradictory constraints explain the speed of the decisions to launch the studies on the architecture definition and the demonstrators of the FCAS. The objective is certainly to define all the key factors of the programme as soon as possible in order to be able to involve other countries in the project in the not-too-distant future.

Table 10 | Fighter aircraft in use in France

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
Mirage 2000	130	Rafale M F3	42
Rafale	142		
Total quantity		314	

¹⁶⁶ Gareth Jennings, "Spain Joins Franco-German Future Fighter Project", in *Jane's Defence Weekly*, 15 February 2019, <https://www.janes.com/article/86409>.

5. Germany

by Christian Mölling*

The FCAS is of outstanding military, political and industrial importance for Germany, and will have a major impact on both the country's military aviation and industry in the coming decades. Germany and its European partners – above all, France – are facing important decisions on the direction of their air forces. The nations have begun to elaborate on considerations regarding replacement of current fleets and to define requirements for future air-superiority systems. A growing range of operational scenarios of stabilisation operations, deployments in risky and highly competitive environments, and national and alliance defence are being taken as a basis for this process.

It may come as a surprise, but German thinking on the FCAS and its details, beyond a handful of experts in industry and the air force, only started developing in 2018.¹⁶⁷ What has thus far been developed is the conceptualisation of the military and industrial-technological context in which the FCAS will operate, the challenges, the need for partners and the question of the level of participation of national industry and of the contribution by the German Air Force (GAF).

There is agreement so far that the FCAS does not describe a single aircraft but rather a system of systems consisting of manned combat aircraft and unmanned drones operating together. Moreover, the FCAS cannot be seen in isolation from the overall current and future air-force fleets. Instead, the trajectory as an overall system, but also the links towards allied air forces, plays a significant role in the conceptualisation and technical design of the FCAS.

5.1 The military rationale

The military rationale for the FCAS is highly developed in the Ministry of Defence's (MoD) strategic document called *Militärische Luftfahrtstrategie* – the "Military Aviation Strategy" – from 2016.¹⁶⁸ However, current thinking is much more concerned with the context in which the FCAS will develop and arrive than in the system itself.

¹⁶⁷ Given that FCAS is rather a niche debate in Germany, this chapter has to build besides a few documents quoted, on a large number of interviews with parliamentarians, ministerial official, air force staff and industrial stakeholders. All interviews were taken under the condition of anonymity.

¹⁶⁸ German Ministry of Defence, *Militärische Luftfahrtstrategie 2016*, December 2015, <https://www.bmvg.de/de/aktuelles/verteidigungsministerium-veroeffentlicht-militaerische-luftfahrtstrategie-11506>.

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This “doctrinal” basis places the FCAS in the context of the overall development of the current and future air-force fleet. The trajectory of the air force as an overall system and the links towards allied air forces play a significant role in it.

The strategy aims to fulfil the Bundeswehr’s mission on the basis of the political guidelines and the assurance of the tasks derived from it, as well as the resulting need for capability development with special focus on the possibilities for multinational cooperation. At the same time, the strategy voices the need for “strategic flexibility”; due to the cycles inherent in the system, relevant periods are counted in decades. The key dynamic is continuous technological development. Moreover, technology is a leading factor in changing security-policy conditions.

5.1.1 Key strategic trends

The GAF sees three major trends that define the future of air forces:¹⁶⁹

1. Technological capabilities and industrial resources: the air domain depends more than other areas on a technological “cutting edge”. This dependence on technology, innovation and industry will increase.
2. Multinationality: almost all major procurement programmes are today multinational. The same is true for air fleets, as European air forces are used to daily cooperation. This trend will increase in importance.
3. Unmanned flying: unmanned aerial systems are considered a key technological and defence-industrial competence. One important step to further develop these competences would be the ability to make effective use of the European airspace.

Interestingly, the strategy highlights the national defence industry and the need to preserve leadership in the high-tech field to ensure operational performance; it thus has an explicit focus on long-term innovation and planning. Moreover, it has a clear view on preserving a relevant national dimension in the value chain, from research and technology to development and procurement up to operative use. Of course, this national preference can only become important if it does not endanger the required capabilities. In principle, it is acknowledged that a broad spectrum of capabilities comes through partnering up with allies.

The GAF aims for stronger support by industry where it is militarily and economically viable and may generate synergies. Militarily justifiable in this context means that the military can fulfil its mandate and tasks – and that operational readiness and flexibility within the alliance, as well as national interests, are not put at stake.

The GAF is looking for an equilibrium between the quality and quantity of its weapon systems: the objective is to balance technological leaps with financial and system development, and to minimise financial, temporal and technological risks. Interestingly, the GAF does not want off-the-shelf solutions.

¹⁶⁹ Ibid.

The Military Aviation Strategy aims to directly influence industry and political framing. It explicitly points out that the document shall influence work on the implementation of the Federal Government's strategy paper to strengthen the defence industry in Germany, released on 8 July 2015.¹⁷⁰ This strategy paper sets out, among other things, those key defence technologies that shall be maintained nationally or promoted at the European level. In this case, the Military Aviation Strategy aims to deepen this approach for the air domain.

The expected challenge in Germany, both for the country's armed forces and for its industry, is to form a relevant focus in terms of industrial and military capabilities given the limited resources available and recognising the European "landscape" of other air forces and industries.

Moreover, Germany's MoD should become a strategic player in air-domain technologies: it should involve itself in assessing the market situation as well as improving its "toolbox" for shaping research and technology, procurement, multinational cooperation and exports. These measures should ensure that the Bundeswehr's capability requirements are fulfilled.

5.1.2 Towards a system-of-systems approach (Systemverbund-Gedanke)

The GAF's long-term intention on capability development is to move from a still very much platform-based approach to one encompassing a system of systems. This should happen through the increase of interoperability between the individual systems. They would provide modular payloads – especially armaments, sensors and mission equipment. Such a modular approach would increase flexibility within the overall system and reduce its dependence on a specific platform. If the overall capability profile in the network is developed multinationally, this would additionally increase the capacity of the overall system. The potential for multinational cooperation could be increased, for example, via "opt-in" arrangements for smaller partners. The system network also provides the basis for meeting changing requirements despite protracted armament cycles.¹⁷¹

The FCAS in this respect would cut across the current structure of fleet capabilities and its organisational set-up. This is because the FCAS is intended to deliver on a wide range of capabilities, not only through a platform but also through a network approach.

¹⁷⁰ Federal Government, *Strategy Paper of the Federal Government on Strengthening the Defence Industry in Germany*, Berlin, 8 July 2015, <https://www.bmwi.de/Redaktion/EN/Downloads/strategy-paper-of-federal-government-on-strengthening-the-defence-industry-in-germany.pdf>.

¹⁷¹ German Ministry of Defence, *Militärische Luftfahrtstrategie 2016*, cit., p. 12-13.

5.1.3 Multinationality and FCAS go hand in hand

In particular, its military-aviation strategy underscores the strong multinational orientation of the German Armed Forces and of their FCAS definition. They are, in fact, two sides of the same coin when it comes to defining the new FCAS.¹⁷² Therefore, the question of the long-term partner countries that actively take part in the division of labour regarding developing and sharing capabilities becomes integrated with the FCAS's conceptualisation, design and production.

Hence, the FCAS is a strategic decision: it decides with whom Germany will partner up, not only today but also in 20 to 50 years. Thus, to a certain extent, the decision is about which capabilities will be a priority in the multinational system of systems: the FCAS is a decision that goes well beyond a national platform.

5.1.4 The basis for successful cooperation in armaments projects: lead nation

Arms projects in the air domain mean particularly large investments, but also huge potential for economies of scale. Cooperation is a basic condition for both: procuring the necessary level of investment, but also effective products. When it comes to Europe, the Bundeswehr has learned the lessons of the past few decades – cooperation has not always led to expected solutions. Thus, a new multinational approach is needed that should be more effective and should focus on a single, integrated project instead of many national versions. Germany therefore prefers the “lead nation” principle – i.e. there is one nation that takes the lead and responsibility for a development programme.

5.1.5 Capability requirements and the dilemma of autonomy

Air forces in the future will have to deliver effects across the full spectrum of scenarios – from stabilisation operations up to deterrence and defence in the NATO context. They have to be prepared to meet adversaries with asymmetrical as well as symmetrical capabilities and characteristics. The duration of air operations is not expected to change significantly – from some days, up to years. Effects of operations have to remain precise, scalable and prevent collateral as well as own losses.

The evolution of air-defence systems in range and ability to target stealth-capable air systems increases the need for survivability of next-generation platforms. Therefore, unmanned systems come into play as well, at least partly. They can reduce the risk for crews by taking over the dangerous parts of a mission.

This, however, points towards an upcoming political–technical decision-making dilemma with regards to the FCAS. In Germany, there is a very high level of scepticism vis-à-vis autonomous systems. They are seen as “killer robots”,

¹⁷² Ibid.

increasingly pushing the human out of the loop and lowering the threshold for deadly missions. At the same time, the protection of military personnel is a very high priority.

5.2 The industrial rationale: opportunities and competition

While the German military has a rather general view on the FCAS that focuses on its conceptual key points, the discussion in the country's industrial sector seems far more advanced. The FCAS is expected to be the largest defence programme of the coming decades. It will determine the structure of the German and European aerospace and defence industries for the long term with regard to competences, competitiveness and consolidation.

5.2.1 Setting the course for industrial cooperation

The FCAS is currently in an early phase. However, it is at precisely this point that the main actors will set the direction for the entire future course of the project. This includes the setting of basic conditions between the participating countries, politically as well as industrially.

At the same time, this situation raises a core concern: that France may be faster and more successful in establishing the conditions for cooperation, and that its industry may take the sole lead in key areas. Therefore, German industry is trying to engage the Federal Government in order to form a similar network of actors on the German side as exists on the French.

This concern is already relevant at the initial stage of the project – and German industry is faced with a domestic situation in which its government and political parties are decidedly inward-looking. Moreover, the willingness or incentive for political decision-makers to speed up their negotiations to take decisions on a highly expensive defence project – which also includes choices, or at least indications on the future of German defence export policy – is presumably low.

5.2.2 The military and technological need for openness on cooperation

German industry explicitly welcomes the German–French project to develop an FCAS as a networked European system. It identifies the need for close cooperation between Berlin and Paris, as well as with other European partners, and sees the FCAS opening up, in the near future, a unique opportunity to create a common European security and defence system.¹⁷³

Industry also points out the need for openness on cooperation. This is particularly important since the FCAS is breaking new technological ground in many ways,

¹⁷³ German Aerospace Industries Association, *Positionspapier zur Deutsch-Französischen Kooperation im Bereich Future Combat Air System*, June 2018, <https://www.bdli.de/node/46716>.

and the exact level of technological and system-related integration – and, thus, interdependence – that it will require remains as yet unknown.

Moreover, no European country and no national industry included in the FCAS has the ability to carry out such a project on its own. This can only be done by a network of industrial and political partners. This requires close political and industrial cooperation, both across national borders and between industry and politics.

5.2.3 Opportunities and risks for a single coherent European system

The FCAS offers a unique opportunity to create a largely coherent, single European air-combat system and the related economies of scale that would come with a product family that was the same across Europe. Thus, German industry is concerned as the UK aims to put a British FCAS – the Tempest – on the market. This would partly replicate the situation seen in the 1980s, when three fighter jets were designed in parallel across Europe. A repetition of this state of affairs would neither generate greater security nor make economic sense – nor would it strengthen European industrial competitiveness. German industry is obviously in favour of creating conditions that allow the UK to join the Franco–German FCAS, and the same applies to other potential partner countries such as Spain and Sweden.

5.2.4 A potential division of labour

In general, the German defence and aerospace industry perceives itself to be well prepared for the implementation of an FCAS. It would like to lead, or at least play a key role in, modern mission, communication and network systems; fighter aircraft; and unmanned aerial systems. In this field, it has been a world leader in development and production for decades and is highly experienced in international cooperation.

Germany would like to lead in the development of the system of systems, in which German industry has the skills and experience to take a primary role, while France claims the lead in the development of the new combat aircraft by Dassault. Yielding on this question would relinquish the technological design, and relegate German industry to a supplier role.

Beyond the Franco–German lead, the involvement of further European partners will be key in order to make this a truly European project. Spain should be fully and promptly included in the FCAS and, in the medium to long term, the UK should also be considered as a partner.

Figure 2 | Selected companies and research institutions in Germany



Source: German Aerospace Industries Association, *Positionspapier zur Deutsch-Französischen Kooperation im Bereich Future Combat Air System*, cit., p. 10.

5.3 The political rationale

The German political rationale behind the project comprises several aspects; they point in different directions, and thus complicate decision-making about how to progress with the FCAS. This issue has not gained a high political profile among the country's political decision-makers, partly due to the difficult situation in German domestic politics. Moreover, the time horizon of 2040 does not immediately lead to a sense of urgency and prioritisation among policy-makers.¹⁷⁴

However, in the smaller circles comprising political experts, including MPs on the Bundestag's defence and industry committees, it is recognised as a key project due to its shaping power and the amount of resources that will need to be invested in it.

¹⁷⁴ This chapter is informed by a recent paper: Christian Mölling and Torben Schütz, "Tornado-Nachfolge und FCAS: Doppelentscheidung konfrontiert Deutschland mit Zielkonflikten", in *DGAPKompakt*, No. 32 (December 2018), <https://dgap.org/de/node/31683>.

The FCAS debate is, therefore, not currently in full swing. For the moment, the multiple dimensions that need to be taken into account for decision-making create a number of loose ends that need to be pulled together – and a general sense has to be made of it. For the moment, a dominant narrative that tells a politically appealing story has not been found.

5.3.1 The key dimensions of decision-making in the German political realm

Franco–German relations, EU Cohesion and Brexit – Both Franco–German relations and EU cohesion are top of Germany's political agenda. They are interwoven in many ways: progress on EU cohesion or even integration without France is rationally impossible, and from a political symbolic point of view unwise or even destructive.

From a German perspective, the need for greater defence cooperation is currently one of a few themes that enjoy wide consensus between Berlin and Paris, as well as within the EU generally. At the EU level, significant projects are currently missing. Thus, the FCAS can link together not only France and Germany but also many other countries through military as well as industrial cooperation.

The impact of Brexit and the option to use the FCAS as a political–industrial project to keep the UK engaged in the EU is, thus far, not “on the radar” in Berlin.

Industry and technology – The FCAS is actually about two things: the participation of Germany's Defence Technological Industrial Base (DTIB) in the military-aviation industry and the degree of industrial autonomy in Europe. Traditionally, this has been an area in which most Europeans, and Germany itself, have been dependent on the US. Full independence from the US is impossible for the foreseeable future, but also politically perhaps not desirable either. The question for Berlin is about the optimum balance between European industrial autonomy and transatlantic (inter-)dependence.

The EU's political strategic autonomy and transatlantic relations – The FCAS is a cross-cutting topic for these two questions: on the one hand, Germany supports greater autonomy for the EU; on the other, it aims to demonstrate its willingness to shoulder a greater burden in transatlantic relations and move towards a 2 per cent threshold of GDP spent on defence. Beyond that, transatlantic industrial cooperation through buying US systems could be used to ease the pressure coming from Washington. Essentially, Germany is in search of a desirable balance between its national partners in Paris, European capitals and Washington as well as contributing to both the EU and NATO.

Defence exports – The French side, particularly, sees the need to agree a priori what the export destinations for the FCAS could be. This demand hits Germany at a time when it has almost completely lost track of its defence-export policy over the last few years. There is no stable compromise in Berlin so far on military exports. Hence, forcing Germany now to decide about this future issue increases

the complexity of decision-making and could result in outcomes not desired by partners.

Nuclear participation – Nuclear burden sharing would also be a topic related to the FCAS. In the longer run, there is a need to envisage whether it will play the role of a platform for nuclear weapons in the context of NATO nuclear sharing. This would mean a concept change with regard to this sharing. Indeed, so far Germany and all other European countries use either Tornado or US-made platforms for that mission. It is unlikely that France would accept opening up the FCAS system to inspection by US actors, be they from government or industry. This decision may not need to be taken now, but it will come up in future discussions. Nuclear sharing as such is a sensitive topic in Germany – and the platform question would link it immediately to the political, military and industrial dimension of transatlantic relations. Given the current state of transatlantic affairs, and the related sensitivity, German decision-makers will most likely be happy to postpone any public statement or even decision for the next few years.

Double decision-making – A complicating issue is the fact that Germany has to decide on a second military-aircraft project at the same time. This double decision-making creates tremendous problems for two reasons. First, both procurement projects have a significant impact on overriding political, military or industrial issues to which Germany is reluctant to respond, or which even constitute dilemmas and taboos for the country. These include the question of the future of transatlantic relations and how they relate to the EU's goal of strategic autonomy. It is also about arms exports and the future of the nuclear strategy, which in turn is linked to the question of transatlantic relations. Second, they are interlinked: there is obviously a certain path dependency in the industrial domain, and industry argues that if the Tornado is to be replaced by a US system this will cool down production and maintenance, and thus the knowledge base and engineering skills will simply leave the sector. Therefore, the decision about the Tornado replacement is characterised either as a bridge or a dead end on the way towards the FCAS.

Tornado replacement as such is a straightforward topic: the platform reaches the end of its life cycle and is to be replaced. Up to 90 aircraft could be purchased to replace the air force fleet. The decision to be taken has an impact on military capabilities as well as on industrial capabilities – and on their balance between Germany, Europe and in a transatlantic perspective. Moreover, it indirectly represents an intermediate step on the way to FCAS production. The impact through volume on international partners is much smaller, yet it touches on many domestic political sensitivities.

For the Tornado, despite the 15 February pre-decision by the German MoD to rule out the F-35 from the selection process, there are still in theory three principal options:

Option I: Develop the Eurofighter further – The first option for replacing the Tornados is to convert Eurofighters that the Luftwaffe is supposed to receive

anyway to dual-capable aircraft. However, the Eurofighter was not designed to penetrate a highly protected enemy airspace at low altitude. In addition, the US has not yet certified it for use as a nuclear bomber. Without this approval, these platforms would not be allowed to carry American weapons – so there would be no effective nuclear sharing. The choice of the Eurofighter would place the political importance of nuclear participation higher than the military importance of credible deterrence. At the same time, Europe's technological and industrial capacities would be secured. However, the time window for the certification of the Eurofighter is slowly closing: US approval takes about seven years, which is just about the amount of remaining life envisaged for the Tornado. Germany can counter this political risk by extending the life of the Tornado again, by turning 20–25 Tornados into a kind of "golden fleet" – i.e. one intended solely for this purpose and with access to any remaining spare parts.

Option II: F-35 Lightning II or other US aircraft – Alternatively, the Bundeswehr could buy the F-35 Lightning II from US manufacturer Lockheed Martin. Militarily, this machine would probably be best suited for the air–ground role. In addition, the question of licensing nuclear weapons has already been clarified here: the F-35 has received or will receive it. A purchase of US aircraft would strengthen the transatlantic link and, depending on the model chosen, allow cooperation with European partners such as Denmark, the Netherlands, Belgium or Italy. At the same time, however, such a decision would contradict the political goal of greater European strategic autonomy. Older US models such as the F-15 Eagle or F-18 Hornet would be neither more modern nor significantly better militarily than the Eurofighter. Their approval as nuclear carriers would also have to be renewed.

Option III: Maintaining the Tornado fleet – Germany could also considerably extend the life of the Tornado. However, its ability to survive against increasingly powerful air-defence systems is no longer assured today, and the military value of the aircraft will continue to decline. Politically, this would not be conducive either to Germany's autonomy or to its credibility. This option also offers no industrial advantages – the maintenance of an old fleet would neither preserve industrial capabilities nor provide incentives for innovation and further development of the Eurofighter. In addition, maintenance costs are expected to rise exponentially as older aircraft become more maintenance-intensive and spare parts rarer and more expensive. With the preservation of the Tornado fleet, however, Germany could at least avoid delicate political discussions about the continuation of nuclear participation and the purchase of US weapon systems.

This creates a complex decision matrix and the pressure to make decisions increases. In the worst-case scenario, Germany could delay both decisions and thus cause further political damage to itself.

5.3.2 FCAS: driving seat or back seat?

For the FCAS, Germany must decide whether it wants to take on a European leadership position together with France, or whether it prefers to lean back at

the expense of its own creative power. The first option for this project is to move forward with the planned implementation with Paris. In military terms, this would promote the maintenance of a modern and operational air force in the medium term and thus also make an important contribution to Europe's strategic autonomy. Politically, Berlin would thus strengthen the Franco-German ambitions of a united European defence policy – all the more so considering that Spain has officially requested to join the project.

A strong German–French leadership would be both a curse and a blessing. Great Britain, which does not simply want to be an observer on such a project, has already presented its own Tempest FCAS-development project. Europe is thus threatening to repeat the mistake of the past by spending resources in parallel to develop, buy and maintain very similar products. The consequence of separate projects is an enormous waste of resources not only in development, procurement and maintenance terms but also in path dependency. This path dependency will hamper closer political–military cooperation over the entire product life cycle – i.e. for at least 40 years.

When deciding on a joint FCAS programme, the project partners would also be faced with the question of who they want to export to – and who not: exports will be essential, at least for the economic feasibility of the project. Even the combined demand of Germany and France (or Europe) will not generate the economies of scale that lead to competitive prices for the world market. This is not a new situation, as Germany and France have already carried out many joint projects. Until a few years ago, the export aspect of these was regulated by the so-called Schmidt-Debré Agreement. Accordingly, one partner could not prohibit the other from exporting the jointly developed and produced equipment in accordance with its own national decisions. However, the German Government has effectively repealed this agreement. Germany's fickle arms-export policy worries its French partners. France has fewer problems with exporting to countries, whereas a public debate in Germany is likely to occur in the first instance. When deciding on an arms programme like the FCAS, the question of substantial exports that could take more than 20 years to come on stream has to be taken into consideration.

The second option for Germany's handling of the FCAS would be to withdraw from the joint project with France – or, at least, from joint development. Germany would then either buy American systems or procure the product that France develops with whichever partners. This option would result in the loss of industrial and technological competence in Germany, but the choice would then only be on whom one wants to be dependent in the future. In addition, nothing could be changed about the future export-destination countries. But if a common export policy is an important element for a common EU security policy, then Germany will not help to shape that either. The long-term consequences are serious, and stand in opposition to the current interests of shaping European foreign policy.

At the same time, European industrial consolidation will then take place without any scope for Berlin's influence. If the German "weight" is missing at the beginning

and France does not find a partner, then a complete Americanisation of the European industry and fleet could very well occur. France would no longer be in a position to compete financially against the US alone as a supplier. Industrially, the FCAS is not only relevant for capabilities in aircraft and engine construction but also for electronics and communications. Modern combat aircraft depend heavily on good electronics to operate effectively – and this will be even more important in the future. A central feature of the FCAS is the fact that it does not describe a single aircraft but rather the interaction of manned aircraft and unmanned systems. Such a system of systems, consisting of various flying elements, requires secure communication channels with satellites and other support aircraft in order to be able to operate effectively and with as little danger to the pilots as possible.

Essentially, Berlin is faced with a puzzle of many pieces in terms of its national interest. Germany's decisions will set the course for important security-policy and defence-industrial developments in Europe – if only because of the size of the project and the lifetime of such systems, i.e. several decades. Unless it opts for a very expensive solution that would please not only German interests but also the demands of all the partners involved, it will have to consider painful payoffs. However, there is a worst-case scenario: that consideration on the future of its air power drives Germany in a "Catch-22" situation, with endless debates because of changing majorities among the relevant decision-makers. Then, the course of action might resemble an accident: nobody wanted it, but many get injured in the process. Berlin could end up not deciding, and instead driving others into taking decisions that will also shape the situation for Germany itself. Berlin may find itself with an outcome that leaves the country with many national interests unaddressed and losing influence on political, industrial, technological and military developments related to European and transatlantic security and defence.

Table 11 | Fighter aircraft in use in Germany

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
Eurofighter Typhoon	123	N/A	
Tornado	88		
Total quantity		211	

6. Italy

by Andrea Aversano Stabile and Alessandro Marrone*

6.1 The military rationale

Debates concerning the development of a 6th-generation fighter aircraft are not currently under the spotlight in Italy. Yet in 2018, both the country's military and its defence industry began to reflect on the replacement of in-service platforms in a post-2040 perspective, also considering the recent developments occurred in France, Germany and the UK when it comes to the FCAS.

Among fighter aircraft owned by Rome, the AMX and Tornado have been deployed abroad in several military operations, ranging from the 1991 Gulf War¹⁷⁵ to the 2011 air campaign in Libya;¹⁷⁶ have already been retrofitted; and are planned to be replaced in the next few years by the F-35 as they are getting close to the end of their operational life.¹⁷⁷

Concerning the F-35, the initial number of 131 platforms to be procured¹⁷⁸ was reduced to 90 by the Mario Monti government's spending review, which occurred in the aftermath of the 2011 financial crisis¹⁷⁹ and also in relation to the reforms presented by the then minister of defence, Giampaolo Di Paola. In recent years, Italy has decided to reschedule the acquisition of the F-35s in order to spread the financial burden over a longer timeline while ensuring an adequate replacement of its oldest fighters.¹⁸⁰ In this context, it has been the first European country to achieve the operational capability of a squadron of 10 platforms, and a total of 30 F-35s is planned to be operational on the 2022 horizon.¹⁸¹ Against this backdrop,

¹⁷⁵ Vincenzo Camporini et al., *The Role of Italian Fighter Aircraft in Crisis Management Operations*, cit.

¹⁷⁶ Paolo Mauri, "Qual è il ruolo dell'Italia nel programma degli F-35", in *Gli occhi della guerra*, 19 August 2018, <http://www.occhidellaguerra.it/f-35-italiani>. Cf. also "I 40 anni del Tornado", in *Analisi Difesa*, 29 September 2014, <https://www.analisidifesa.it/?p=15206>.

¹⁷⁷ Ibid.

¹⁷⁸ Corte dei Conti, *Relazione speciale sulla partecipazione italiana al Programma Joint Strike Fighter F-35 Lightning II*, August 2017, p. 11-12, http://www.corteconti.it/stampa_media/comunicati_stampa/archivio_2017/dettaglio.html?resourceType=/_documenti/archivio_comunicati_stampa/2017/elem_0036.html.

¹⁷⁹ Vincenzo Camporini et al., *The Role of Italian Fighter Aircraft in Crisis Management Operations*, cit.

¹⁸⁰ Italian Ministry of Defence, *Documento Programmatico Pluriennale per la Difesa per il triennio 2015-2017*, April 2015, Allegato C, II-1.C/31, <https://www.difesa.it/Approfondimenti/Bilancino2010/Documents/DPP%202015-2017.pdf>. See also Italian Ministry of Defence, *Documento Programmatico Pluriennale per la Difesa per il triennio 2016-2018*, April 2016, https://www.difesa.it/Content/Documents/DPP/DPP_2016_2018.pdf.

¹⁸¹ In particular, Italy has received 11 F-35 aircraft, including one F-35B version used by the Naval Aviation. Additional platforms are expected to be delivered within the next months. On this issue,

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the planned retirement of 71 AMX and 68 Tornados¹⁸² within the next decade will require prosecution of the Italian participation in the F-35 programme in order to maintain an air force and navy-aviation force that are effective in performing their tasks.¹⁸³

Looking beyond the entry into service of the F-35, a key question for Italy's military planners is how to gradually replace, from 2040 onwards, the 86 Eurofighter Typhoons, which – after more than 35–40 years in service – will be slowly reaching the end of their operational life. In this context, among practitioners and experts the need has become clear to develop a 6th-generation fighter aircraft, whose aim should be to replace the Eurofighter fleet from the 2040s onwards.¹⁸⁴ Against this backdrop, it is worth mentioning some elements that are being discussed in various ways in the Italian defence community of stakeholders.

First, there are different views about the tasks that the FCAS should perform. On the one hand, the need to replace the Eurofighter points towards a focus on air defence. On the other hand, technological developments may enable a 6th-generation aircraft to simultaneously perform ground-attack and air-defence tasks.¹⁸⁵ The bottom line is the challenging international security environment facing perpetual changes, which makes it extremely difficult to estimate the economic, political and technological tensions that may arise within the next 25–30 years.¹⁸⁶ However, one clear trend seems to emerge: the increasing tendency towards state-to-state confrontation¹⁸⁷ in the context of a multipolar world in which continental powers are willing and able to combine the use of political, economic and military power to exert influence, deter adversaries and coerce both partners and competitors. Actually, some experts in Italy do underline the importance of stability operations in crisis areas across North Africa, the Sahel and the Middle East, which have an immediate impact on Italy's national interests and do not necessarily require the use of advanced air-power capabilities such as the FCAS.¹⁸⁸ However, while stability operations may well be conducted in the short and medium term, operational scenarios at the higher end of the military spectrum cannot be disregarded. Therefore, the maintenance of adequate capabilities to deter adversaries from

see Pietro Batacchi, "F-35: le novità e il punto sull'Italia", in *Portale Difesa*, 25 September 2018, http://www.portaledifesa.it/index~phppag,3_id,2547_arg,4_npp,1_npag,1.html.

¹⁸² Tornado aircraft owned by Italy differ either in the Interdiction and Strike (IDS) version or in the Electronic/Combat Reconnaissance (ECR), respectively designed to perform ground attack or air defence. On this issue, please see Renzo Sacchetti, "Italy's British Tornados", in *AirForces Monthly*, October 2003, p. 50.

¹⁸³ Alessandro Marrone, "Difesa: la Germania sceglie i caccia europei, non gli F-35", in *AffarInternazionali*, 10 February 2019, <https://www.affarinternazionali.it/?p=72909>.

¹⁸⁴ Silvio Lora Lamia, "Nuovo caccia europeo: un insidioso gioco ai quattro cantoni", in *Analisi Difesa*, 1 August 2017, <https://www.analisedifesa.it/?p=108566>.

¹⁸⁵ See Interviewees 1, 2, 6, 13 and 15.

¹⁸⁶ Interviewees 6 and 7.

¹⁸⁷ White House, *National Security Strategy of the United States of America*, December 2017, <http://nssarchive.us/national-security-strategy-2017>.

¹⁸⁸ Interviewee 4.

acting – and eventually to conduct operations to counter their actions – should be planned and funded well in advance. Metaphorically, such military preparedness, including with regard to air power, constitutes a kind of necessary insurance policy should a situation deteriorate, made even more necessary by the aforementioned trend towards an international security environment marked by “aggressive multi-polarity”.¹⁸⁹ Moreover, even in stability operations in the African or Middle East region the involvement of regional powers opposing Western intervention cannot be ruled out, thus requiring more advanced capabilities in order to ensure air superiority. Bearing in mind the high fluidity and unpredictability of future air operations, military efforts could be oriented towards the definition of a weapons system tuned to the utmost degrees of flexibility and versatility. For instance, ISTAR tasks may have to be effectively performed by the same FCAS that is tasked to air defence or ground attack – i.e. by launching not only kinetic devices but also sensors able to return to the launch pad in an autonomous fashion.¹⁹⁰

Second, the FCAS should be planned as a system of systems, intended to integrate both manned and unmanned components.¹⁹¹ Lessons learned and expertise to be acquired in the next few years through the simultaneous use of both UAS and the net-centric 5th-generation F-35 will probably help to define such teaming between manned and unmanned systems. Indeed, F-35s automatically share data in a seamless way among themselves – as well as with other nodes of the network such as space, maritime or ground-based assets – and perform data fusion, providing all pilots the same common operational picture. Building on such a basis, an FCAS may well be able to command and control a swarm of UAS and effectively act as a battle-manager platform in complex air operations. Additionally, the ever-increasing affordability of technological instruments (for instance, superconductors, miniaturisation and processing power) in terms – among others – of interconnectivity, cyber awareness, self-healing and diagnostics could be exploited to develop a twin-engine aircraft likely to achieve optimal levels of autonomy and stealthiness.¹⁹²

This connectivity falls within the concept of “system of systems” and ushers in a third element relevant for military thinking about the FCAS: the cyber dimension. Here too, there are divergent views within the Italian defence community. On the one hand, there is the idea that the cyber domain will somehow prevail over the air domain, as well as others. In other words, cyber operations will be able to disrupt

¹⁸⁹ In recent years, this kind of scenario has been considered by the review of the EU’s Capability Development Plan with respect to the air domain. A similar scenario is also presented in the IAI study on fighter aircraft. Please see Vincenzo Camporini et al., *The Role of Italian Fighter Aircraft in Crisis Management Operations*, cit.

¹⁹⁰ Interviewee 2.

¹⁹¹ Massimiliano D’Elia, “Velivolo di sesta generazione, la sfida del futuro”, in PRP Channel, 25 December 2017, <https://www.prpchannel.com/?p=19553>.

¹⁹² Joseph Trevithick, “The U.K.’s New ‘Tempest’ Stealth Fighter Project Already Faces Serious Challenges”, in *The War Zone*, 16 July 2018, <http://www.thedrive.com/the-war-zone/22190>. See also Interviewees 1 and 2.

the use of air capabilities to the point that the latter will become de facto useless. On the other hand, the prevailing view is that the cyber domain will add to other domains without replacing any of them – as happened a century ago with the first air operations during World War I. Indeed, as outlined in the other chapters, major states worldwide are looking to 6th-generation aircraft as part of their future military posture – as also happens with other capabilities beyond the focus of this study, such as rotorcraft, maritime-patrol aircraft and Medium Altitude Long Endurance (MALE) UAS. The increased role of electronics and ICT poses challenges and creates vulnerabilities across the board in all domains,¹⁹³ but it also creates opportunities for strategic military advantage. And major powers globally are keen to invest in a synergic way in both cyber and hardware capabilities.

6.2 The industrial rationale

On the industrial level, Italy could in principle play its part in the event of its entry into a project on the development of the 6th-generation aircraft. The country's national defence industry can in fact count on resources and expertise engendered by its participation in previous programmes. This is particularly so in the case of the Eurofighter, to which Italian industries have contributed through their competencies in the domains of airframe, engines, electronics, avionics and the structural integration of systems.¹⁹⁴ Thanks to this constructive engagement, Italy's national defence industry has been able to play a significant role in the Eurofighter consortium – in the light, too, of the share of 36 per cent of the overall value of the programme granted to Leonardo.¹⁹⁵ In a similar vein, Italy may bring added value in the development phase of the future aircraft by relying on lessons learned and expertise gained through participation in the F-35 programme. More precisely, Leonardo played a pioneering role by producing wings and components of the central fuselage as well as by assembling the whole F-35 aircraft in the Final Assembly and Check Out (FACO) plant at Cameri.¹⁹⁶ Interestingly enough, this site enhances the industrial relevance of Italy abroad since it constitutes the only FACO in Europe.¹⁹⁷ The Dutch F-35s are also assembled there, and it is the main candidate for a European hub for Maintenance Repair Overhaul and Upgrade (MRO&U) activities.¹⁹⁸ As regards hubs located on Italian soil, the Amendola military

¹⁹³ For instance, in the land sector see: Alessandro Marrone, Michele Nones and Alessandro R. Ungaro (eds), *Technological Innovation and Defence: The Forza NEC Program in the Euro-Atlantic Framework*, Rome, Nuova Cultura, 2016 (IAI Research Papers 23), <https://www.iai.it/en/node/6335>.

¹⁹⁴ Paola Casoli, "Eurofighter Typhoon: facts & figures. Cos'è, chi lo fa e chi lo compra", in *Paola Casoli Blog*, 14 September 2015, <https://www.paolacasoli.com/2015/09/eurofighter-typhoon-facts-figures-cos-e-chi-lo-fa-e-chi-lo-compra>.

¹⁹⁵ Stefano Pioppi, "Eurofighter, intesa con l'Arabia Saudita per 48 velivoli", in *AirPress*, 9 March 2018, <https://www.airpressonline.it/?p=31491>.

¹⁹⁶ Enzo Vitale, "F-35, Ali e parte della fusoliera si costruiscono in Italia, a Cameri il superjet di quinta generazione", in *Il Messaggero*, 21 July 2018, https://www.ilmessaggero.it/tecnologia/scienza/f35_1_italia_partner_d_eccellenza_con_gli_usa-3604483.html.

¹⁹⁷ Vincenzo Camporini, "Cameri, un successo da consolidare", in *AffarInternazionali*, 12 December 2014, <https://www.affarinternazionali.it/?p=29020>.

¹⁹⁸ See Stefano Pioppi, "Italia? Eccellenza globale dell'aeronautica. Parola di Lockheed Martin", in

centre of excellence embodies further added value for Italy when it comes to the development of a 6th-generation platform, in the light of lessons learned from extensive training of UAS pilots.¹⁹⁹

Whereas the industrial sector in Italy could afford to put itself on an equal footing with its foreign competitors, such a position cannot hold in the next few years if Rome does not decide how to position itself with regard to the development and subsequent procurement of the FCAS. In such a scenario, the worst consequences would affect companies standing at the technological forefront in their respective sectors, since they would be excluded from the project. Notable cases in point are represented by Avio Aero for the development of engines, drawing on the virtuous example of the Eurofighter;²⁰⁰ Elettronica, as leader regarding the interception or disruption of signals/systems;²⁰¹ small and medium-sized enterprises (SMEs) such as Aerea; and, above all, Leonardo in the domains of avionics, sensor systems, communications, radar systems and electronics as well as training aircraft, release of weapons systems and cyber capabilities.²⁰²

The last-named company deserves a separate discussion since its subsidiary in the United Kingdom, recently renamed Leonardo MW Ltd,²⁰³ has been selected by the British Government to team up with BAE Systems, MBDA and Rolls-Royce to finalise the first phase of the Tempest initiative, which includes prototype demonstrations and technological-evaluation activities.²⁰⁴ Nevertheless, the involvement of Leonardo MW Ltd does not necessarily imply concrete participation on the part of the whole Italian company, in the light of the UK policy of jealously guarding the technological and operations sovereignty of items produced on British soil thanks to government funding.

Building on these reflections, participation of the national industry in a project to develop a 6th-generation aircraft would guarantee renewed lifeblood to the technological advancement of this strategic high-tech sector, both in the short and the long run. Whichever option is pursued with respect to other FCAS efforts in Europe,²⁰⁵ Italian participation in ongoing or future initiatives cannot neglect a

AirPress, 27 January 2018, <https://www.airpressonline.it/?p=29601>. See also Interviewee 7.

¹⁹⁹ See Michela Della Maggesa, "Amendola: Operativi F-35 E Simulatore APR", in *AirPress*, 5 March 2018, <https://www.airpressonline.it/?p=31221>. See also Interviewee 10.

²⁰⁰ See Gianni Dragoni, "Eurofighter, nuovo contratto", in *Il Sole 24 Ore*, 15 December 2004, <https://www.disarmo.org/rete/a/8636.html>. See also Interviewee 6.

²⁰¹ Charles Alcock, "EuroDIRQM Promises Protection Against Manpad Missile Threat", in *AINonline*, 18 July 2018, <https://www.ainonline.com/node/279531>. For more information, please see the official website of the company: <http://www.elt-roma.com>.

²⁰² See also Interviewees 11 and 12.

²⁰³ Rossana De Simone, "Dalla grande Finmeccanica all'improbabile genio di Leonardo fino al Banco dei Medici", in *PeaceLink*, 28 March 2017, <https://www.peacelink.it/disarmo/a/44229.html>.

²⁰⁴ Fabio Savelli, "L'italiana Leonardo progetta il nuovo jet militare della Raf inglese", in *Corriere della Sera*, 16 July 2018, https://www.corriere.it/economia/18_luglio_17/italiana-leonardo-progetta-nuovo-jet-militare-raf-inglese-8accb9c0-8929-11e8-b6ba-4bfe4aefe0a3.shtml.

²⁰⁵ For a further analysis see Chapter 8 of this report.

crucial precondition – namely, the joining of a project as an equal partner, able to retain decision-making power for the set-up of military requirements to be met as well as for the design of system architecture and crucial elements. The definition of such a status depends on a strategic dialogue that needs to be to be conducted by Italy in a comprehensive way – linking its military, industrial and political dimensions.²⁰⁶

Moreover, an Italian decision about whether to promote industrial engagement in one project or another should be the outcome of a wide-ranging analysis, including both the industrial organisational model adopted and the foreseen compatibility of respective national industries according to their functional specialisation. First, Italy should be aware of the challenges and opportunities arising from the logic of either “cost-share equals work-share” or “best value for money” approaches – the former requiring a match between government resources allocated at the initial stage of a project and returns in occupational and industrial terms,²⁰⁷ and the latter disavowing this link on the basis of open competition while introducing remedies to produce balanced results.²⁰⁸ At the present stage, it seems that neither emerging project in Europe for future aircraft is oriented to grant equipment-design responsibilities to foreign partners,²⁰⁹ thus breaking with the pattern set on programmes designed for the Tornado and Eurofighter.²¹⁰ For this reason, Italy and its industrial sector should be ready to act promptly in order to avoid being relegated to the role of mere suppliers of components, building on the lessons learned by the F-35 programme and shaped by the best-value-for-money approach.²¹¹ In turn, Italy may also lean towards the conferring of assembly activities on its national industry – thus contributing to the exploitation of knowledge and expertise acquired through the Cameri FACO and without losing ground to partners in terms of economic returns.²¹² Generally speaking, Italy should explore new models of balanced cooperation, for instance based on industrial joint teams and/or governmental sharing of non-recurrent investments and related technological benefits.

6.3 The political rationale

Italian involvement in a project leading to the future acquisition of a 6th-generation aircraft rests ultimately on a political decision – one which has not yet been taken.

²⁰⁶ Interviewee 2.

²⁰⁷ Baudouin Heuninckx, *The Law of Collaborative Defence Procurement in the European Union*, Cambridge, Cambridge University Press, 2017, p. 28.

²⁰⁸ Nicola Dimitri, “‘Best Value for Money’ in Procurement”, in *Journal of Public Procurement*, Vol. 13, No. 2 (Summer 2013), p. 149-175, http://www.ippa.org/images/JOPP/vol13/issue2/Article_1.pdf.

²⁰⁹ Interviewees 2, 6 and 7.

²¹⁰ On this issue, please refer to Panavia website: *SDR (System Design Responsibility)*, <https://www.panavia.de/aircraft/overview/sdr>; and to Airpower website: *Eurofighter Typhoon*, <http://eurofighter.airpower.at/technik-avionik.htm>.

²¹¹ Vincenzo Camporini et al., *The Role of Italian Fighter Aircraft in Crisis Management Operations*, cit.

²¹² Interviewee 7.

The decision-making will probably be influenced by elements of both continuity and change with regard to Italian defence policy.

In terms of continuity, Italy's politico-institutional leadership is used to multinational programmes for procuring the most advanced capabilities in the aerospace domain. There is a widespread mind-set in favour of it, which is deep-rooted in decades-long experience encompassing the Tornado, Eurofighter, F-35 and – in the rotary-wings sector – the NH90. As happens for the military and industrial actors, the country's political leadership is keen on multilateral efforts that frame Italy's national interest, military requirements and industrial demands. Both European and transatlantic frameworks are usually considered, in line with the basic tenets of the "Atlanticism" and "Europeanism" of Italian foreign and defence policy, which remained stable during and after the Cold War despite changes in the Italian political landscape.²¹³ Such tenets are reflected in the 2015 White Paper for International Security and Defence,²¹⁴ which includes a number of guidelines on procurement and – broadly speaking – on defence-industrial policy. In doing so, it codifies and further develops Italy's traditional approach in the light both of lessons learned from recent cooperative endeavours and of the current international security environment.

In particular, bilateral or multilateral cooperation is seen as a necessary *modus operandi* for sharing the financial burden of expensive procurement programmes that are not affordable on a national basis. It is also deemed crucial in connecting the country's national defence technological–industrial base to the most advanced industries in the West, in order to improve its competitiveness, innovation and strength. Moreover, commitments as regards international cooperation have often been used at a political level to shelter procurement programmes from recurrent pressures to cut military expenditure. All these elements make reasonable, and likely, an Italian decision to join one of the FCAS initiatives being developed by its closest allies.

In recent years, F-35 transatlantic defence cooperation has been heavily criticised at the political level for a variety of ideological and concrete reasons,²¹⁵ while the same fate has not been shared by European cooperative programmes such as Eurofighter, despite a comparable allocation of economic resources. Moreover, while the F-35 programme has been key to maintaining Italy's military air power and aerospace industry at a time when Europeans did not jointly invest in a 5th-generation aircraft, its "best value for money" approach proved to be a significant challenge in terms of technological and industrial returns for Italian companies.

²¹³ See, among others, Gianni Bonvicini and Alessandro Colombo (eds), *La politica estera dell'Italia. Edizione 2011*, Bologna, Il Mulino, 2011.

²¹⁴ Italian Ministry of Defence, *White Paper for International Security and Defence*, April 2015, http://www.difesa.it/Content/Pagine/Libro_Bianco.aspx.

²¹⁵ See Srdjan Vucetic and Kim Richard Nossal, "The International Politics of the F-35 Joint Strike Fighter" in *International Journal*, Vol. 68, No. 1 (Winter 2012-13), p. 3-12.

Italy's participation in F-35 has remained stable and resilient for more than two decades, under several different governments and despite domestic political opposition to the project. Even the Five Star Movement (M5S), which opposed F-35 procurement for years, once in a government coalition did not backtrack from Italian commitments to the programme. While the M5S undersecretary of defence, Angelo Tofalo, made explicit reassurances on the issue,²¹⁶ the M5S minister of defence, Elisabetta Trenta, seems to be leaning towards a rescheduling of the aircraft acquisition, aimed at spreading the financial burden over a greater number of budgetary years and appeasing internal protests from members of her own party about the resources allocated to the programme.²¹⁷ In 2019, the minister would in fact finalise the procurement of only six aircraft, out of the 10 for which an option had been signed by the former executive.

When it comes to Italy's relationship with the US, the Trump Administration has made it more difficult for Rome to balance the "Atlanticist" and "Europeanist" pillars of its defence policy because of transatlantic tensions on a number of dossiers, ranging from trade to the Iranian nuclear deal. While the long-lasting debate on the F-35 and the features of Trump's presidency do not rule out a possible US-Italian collaboration on the FCAS, they make such an option very unlikely and difficult to propose at the political level.

Considering its national tendency to join multinational procurement programmes and the current difficulties of doing so in partnership with the US, two options remain on the table for Italy's decision on the FCAS: the British Tempest or the Franco-German initiative. In July 2018, Italian politicians and industrialists participating in the Farnborough Airshow exhibition were interested in the Tempest presentation.²¹⁸ Then in September, Undersecretary Tofalo declared that Italy "should joint Tempest immediately in order to be at the forefront of cooperation with the UK".²¹⁹ Such a clear position is very much in line with the preferences informally expressed within institutional, military, industrial and expert circles.²²⁰ Not surprisingly, rumours about Rome's favourable attitude towards the London Tempest have been reported in the Italian press,²²¹ while no expression of interest

²¹⁶ Michele Arnese, "F35, ecco le ultime capriole di Di Maio e Tofalo su Leonardo-Finmeccanica e Lockheed Martin", in *StartMag*, 20 December 2018, <https://www.startmag.it/innovazione/f35-leonardo-finmeccanica-lockheed-martin-di-maio-tofalo>.

²¹⁷ Dino Martirano, "Compromesso sugli F35: saranno sei anziché dieci", in *Corriere della Sera*, 20 December 2018, https://www.corriere.it/politica/18_dicembre_20/compromesso-f35-saranno-sei-anziche-dieci-d5ae6946-0496-11e9-9823-64286d9a7340.shtml.

²¹⁸ Stefano Pioppi, "L'Italia a Farnborough e nel nuovo caccia inglese. Parla Crosetto", in *AirPress*, 16 July 2018, <https://www.airpressonline.it/?p=34450>.

²¹⁹ "Difesa: sottosegretario Tofalo, 'doveroso' entrare nel programma Tempest", in *Agenzia Nova*, 26 September 2018, <https://www.agenzianova.com/a/0/2084972/2018-09-26/difesa-sottosegretario-tofalo-doveroso-entrare-nel-programma-tempest>.

²²⁰ Interviewees 1, 2, 5, 6, 7, 10, 11, 12, 13, 14 and 15.

²²¹ Franco Iacch, "L'Italia ha scelto il caccia Tempest come velivolo di sesta generazione", in *Il Giornale*, 5 December 2018, <http://www.ilgiornale.it/news/mondo/litalia-ha-scelto-suo-caccia-sesta-generazione-1611754.html>.

in the Franco–German initiative has appeared in the country’s media. Interestingly enough, the official press release of the Spanish Ministry of Defence (MoD), while confirming Madrid’s will to participate to the Franco–German project, even mentioned Italy – together with the Netherlands – as a member of the UK-led consortium.²²²

Against this background, a third option is possible – that is, simply postponing the decision on the FCAS, and thereby losing (by default) the opportunity to actively join any form of international cooperation in this regard. A number of elements may lead to this scenario, which is quite strongly related to the changes brought about by Italy’s 2018 general election and the subsequent formation of the M5S–League government. First, while support for European defence cooperation and integration, including Permanent Structured Cooperation (PESCO) and the European Defence Fund (EDF), remains high at the political level across the government and the opposition parties,²²³ defence is ranked very low on the political agenda of the current executive. In more general terms, defence policy has rarely been the priority of Italy’s political leadership, but – at least under previous governments – the mainstream attitude in favour of multilateralism, partnerships and institutions – including the EU and NATO – did help, for example, to raise the importance of procurement and military operations abroad. In contrast, the nationalistic attitude of both M5S and the League weakens this political driver for defence – since, for instance, the 2 per cent GDP target for defence spending agreed within NATO or PESCO commitments within the EU resonate very little politically within the ruling coalition. This is not to say that the current Giuseppe Conte Government is bringing radical changes to Italian defence policy. On the contrary, it is likely to show pragmatic continuity – but with less political enthusiasm than in the recent past for the “business as usual” option.²²⁴

Second, within this more nationalistic approach the focus is on security rather than on defence. On the one hand, countering illegal immigration is a top priority for the deputy prime minister and minister of the interior, Matteo Salvini, who proposed, among other things, an increase in police personnel. On the other hand, minister Trenta, has repeatedly emphasised the dual-use character of the country’s armed forces and equipment, by stressing the government’s support for the Italian Civil Protection Department in the case of natural disasters²²⁵ or

²²² Spanish Ministry of Defence, *España insta su participación como socio de pleno derecho en el futuro caza europeo*, 3 December 2018, <http://www.defensa.gob.es/gabinete/notasPrensa/2018/12/DGC-181203-caza-europeo-ngws.html>.

²²³ Alessandro Marrone, “PeSCo: The Italian Perspective”, in *ARES Group Policy Papers*, No. 30 (September 2018), <http://www.iris-france.org/notes/pesco-the-italian-perspective>.

²²⁴ Alessandro Marrone, “The Conte Government: Radical Change or Pragmatic Continuity in Italian Foreign and Defence Policy?”, in *IAI Commentaries*, No. 18|33 (June 2018), <https://www.iai.it/en/node/9232>.

²²⁵ Italian Ministry of Defence, *Linee programmatiche del Dicastero: audizione del Ministro Trenta*, 26 July 2018, https://www.difesa.it/Primo_Piano/Pagine/linee-programmatiche-dicastero-audizione-ministro-trenta.aspx.

their efforts to protect sensitive sites from terrorism or organised crime. Such an emphasis on dual-use and internal security is thought to somehow represent a way of reconciling the pacifist attitude of most M5S activists with the completely new government's responsibilities in the defence domain.²²⁶ M5S is gradually changing its previous anti-establishment positions, growing more favourable towards Italy's commitment to European defence cooperation²²⁷ – as was also epitomised by the robust projects presented in November 2018 by the Italian MoD within the second wave of PESCO initiatives.²²⁸ Notably, this normalisation trend matches the support for the national defence industry, military spending and European defence cooperation that is repeatedly expressed by the League's undersecretary of defence, Andrea Volpi.²²⁹ Moreover, recent debates within the Italian Parliament's defence committee underlined the need for the country to maintain an adequate level of military spending.²³⁰ However, as a whole, both M5S and the League remain very cautious about the defence budget, and would prefer to avoid new significant investments by instead prioritising resources on security or other dossiers.

A third element in favour of postponing a strategic decision on the FCAS is indeed constituted by budgetary constraints. Once again, the issue is not new: the Italian MoD has been living with defence expenditure ranging around 1.1 per cent of GDP for the last decade. Yet under previous governments, there was resistance to political pressure to cut this budget line in order to accommodate the NATO pledge to reach 2 per cent of GDP and to improve the quality and efficiency of military expenditure through reforms²³¹ – in particular, those regarding personnel and infrastructures – thereby investing more in equipment and operational costs. Notably, 2018's defence spending increased by 700 million euro in comparison with that of 2017. In contrast, today the need to satisfy extremely expensive promises in terms of retirement age and unemployment subsidies puts Italian military expenditure under greater pressure than in recent years. The first procurement programme to be negatively affected by such pressure has been the CAMM-ER missile system, whose 500 million euro budget – spread across 13 years – was stopped in 2018 by Deputy Prime Minister and M5S leader Luigi Di Maio despite Trenta's support for it.²³² According to the MoD's multi-annual programmatic document, Italy's defence

²²⁶ Alessandro Marrone, "Politica di difesa italiana: duplice uso e resilienza", in *AffarInternazionali*, 12 October 2018, <https://www.affarinternazionali.it/?p=71260>.

²²⁷ Alessandro Marrone, "PeSCo: The Italian Perspective", cit.

²²⁸ Andrea Aversano Stabile and Alessandro Marrone, "Ue: nuovi progetti Pesco, impegno attivo dell'Italia", in *AffarInternazionali*, 22 November 2018, <https://www.affarinternazionali.it/?p=71726>.

²²⁹ Gianandrea Gaiani, "A rischio il programma per la difesa aerea CAMM ER?", in *Analisi Difesa*, 28 September 2018, <https://www.analisedifesa.it/?p=118823>.

²³⁰ Italian Chamber of Deputies, *Audizione sulla pianificazione dei sistemi di difesa e sulle prospettive della ricerca tecnologica, della produzione e degli investimenti*, 24 January 2019, <https://webtv.camera.it/evento/13608>.

²³¹ Vincenzo Camporini et al., "The White Paper: A Strategy for Italy's Defence Policy", in *Documenti IAI*, No. 15|09e (May 2015), <https://www.iai.it/en/node/4239>.

²³² Michelangelo Colombo, "Leonardo-Finmeccanica, ecco come Di Maio silura Mbda e Trenta con i missili Camm?", in *StartMag*, 27 September 2018, <https://www.startmag.it/mondo/leonardo-finmeccanica-missili-dimaio-mbda>.

budget will subsequently slightly decrease in both 2019 and 2020.²³³ These figures present a number of challenges for Italy's ability to cooperate with its European partners,²³⁴ and their practical implications for procurement programmes are not yet clear.

In this context, reflection on the FCAS investments has been slowed by the priority to review the financial commitment on the F-35 for the next three years, as well as by the turnover at the top of the Italian military – with the appointment of a new Chief of Defence Staff, National Armament Director and Chief of the Air Force, as well as the incoming replacement for the Chief of the Navy. Against this backdrop, it is crucial for Italian decision-makers to properly consider all the pros and cons of the options on the table in a forward-looking and comprehensive manner, in order to make the best strategic choice on such a fundamental issue for the future of Italy's military and defence industry.²³⁵ It is also crucial not to postpone the decision because, as explained in the final chapter of this study, an eventual non-participation in any of the current initiatives to jointly develop and procure an FCAS would constitute the worst-case scenario for the safeguarding of Italian national interests.

Table 12 | Fighter aircraft in use in Italy

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
AMX	71	AV-8	14
Eurofighter Typhoon	96	TAV-8	2
F-35A	10	F-35B	1
Tornado	68		
Total quantity		262	

²³³ In particular, while Italy's 2018 defence budget increased compared to 2017, with expenditures hovering at 1.19 per cent of GDP, in 2019 the ratio will decrease to 1.15 per cent and again to 1.10 per cent in 2020. See Italian Ministry of Defence, *Documento programmatico pluriennale per la difesa per il triennio 2018-2020*, 15 October 2018, https://www.difesa.it/Content/Documents/DPP_2018_2020_15_ottobre_2018.pdf.

²³⁴ Andrea Aversano Stabile and Paola Sartori, "Italy's Defence Expenditure: What Impact on EU Defence Cooperation?", in *IAI Commentaries*, No 18|68 (December 2018), <https://www.iai.it/en/node/9801>.

²³⁵ For a further analysis, see Chapter 8 of this report.

7. Sweden

by Per Olsson*

As of 2018, the Swedish Government has not officially taken any decision regarding the development of the FCAS or on its participation in either of the two current European FCAS projects. Both the British Tempest and the Franco–German project present aspects that would be attractive to Sweden. The UK has unique experience with 5th-generation fighter technology, as the only Tier-1 partner in the US F-35 programme. The UK and Sweden also have established defence-industrial ties. For instance, 30–35 per cent of components for the JAS 39 Gripen come from the UK.²³⁶ On the other hand, the Franco–German project will have the financial backing of two of the largest military spenders in Europe and will have greater access to EU defence funds, such as the EDF. Additionally, France and Sweden cooperated in the development of the nEUROn unmanned combat aerial vehicle.

Both the UK Tempest and the Franco–German project have political support from their respective governments, which is an essential element for any cooperation. However, both projects also face some challenges. Brexit will undoubtedly complicate access to European funds for the UK Tempest project. On the other hand, neither France nor Germany took part in the F-35 project. The defence company Saab has expressed an interest in cooperating with the UK but does not exclude the possibility that common technology developments could be used for two separate combat aircraft.²³⁷ Sweden's official position on any potential FCAS project is to keep "all doors open". Regardless of its eventual choice, the Swedish Government will need to coordinate policy efforts with Saab as well as the country's armed forces, Defence Materiel Administration (*Försvarets Materielverk* – FMV) and Defence Research Agency (*Totalförsvarets Forskningsinstitut* – FOI).

The FCAS will become important for Sweden as technologies from such a project will most likely be incorporated into the upgrade or replacement of the JAS 39 Gripen E multi-role fighter sometime after 2040. Gripen E is the version of JAS 39 currently being introduced into the Swedish Air Force. In 2015, the Swedish Government identified combat air capability as an essential security interest.²³⁸ This decision signals a political commitment to maintain and develop military, technological and industrial capabilities with regard to aerial combat. The development of FCAS capabilities will be necessary for Sweden, both in order to meet new military threats

²³⁶ According to Saab's CEO Håkan Buskhe. See Tomas Augustsson, "Saab vill bygga stridsflyg med Storbritannien", in *SvD*, 26 July 2018.

²³⁷ Ibid.

²³⁸ Swedish Government, *Försvarspolitisk inriktning – Sveriges försvar 2016-2020* (Prop. 2014/15:109), 23 April 2015, p. 100, 47, <https://www.regeringen.se/t/70543>.

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and to maintain the ability to develop and produce combat aircraft.

7.1 The military rationale

Sweden views Russia's increased military capability, together with the Russian leadership's greater willingness to use that capability for political goals, as the main regional security threat. The war against Georgia in 2008, the annexation of Crimea in 2014 and subsequent military intervention in Eastern Ukraine are examples of Russian aggression in Eastern Europe. Sweden identifies these actions as the greatest challenge to the European security order since it was established a quarter of a century ago. In 2015, the Swedish Government stated that a military threat against Sweden could not be ruled out, but that a military conflict in the country's neighbourhood would probably involve several nations.²³⁹ In 2017, the Swedish Defence Commission went a step further by stating that a military attack on Sweden could not be ruled out.²⁴⁰ Russia's aggression against neighbouring countries has sparked a debate in Stockholm about the urgent need to improve military capabilities. After decades of decreased defence budgets and meagre materiel investments, there is currently strong political support in Sweden for strengthening the country's defences.

Following the end of the Cold War, Sweden saw steady cuts in its military spending, which decreased by 12 per cent between 2000 and 2017.²⁴¹ The consequence has been a drastic reduction in the volume of military equipment and personnel within the country's armed forces. Reductions were unevenly distributed between the various branches of the forces: as Sweden moved away from large-scale defence against a territorial invasion, its army saw more substantial decreases than the navy or air force. Nevertheless, the number of combat aircraft was also reduced, from 134 in 2000 to 97 in 2018.²⁴² This trend is similar to what happened in many other Western European nations over the last two decades. However, during the same period, Russia started to rebuild its military capability.

Russia's military spending increased by 171 per cent between 2000 and 2017.²⁴³ A substantial part of these funds has been directed towards ambitious modernisation efforts under the state armament programme, GPV-2020.²⁴⁴ This has enabled Russia to improve its already formidable ground-based anti-air capability, and to

²³⁹ Ibid., p. 46–47.

²⁴⁰ The Swedish Defence Commission is a parliamentary committee representing the parties of the Swedish Parliament (*Riksdag*), tasked with outlining cross-party consensus regarding defence policy. Swedish Ministry of Defence, *Motståndskraft. Inriktningen av totalförsvaret och utformningen av det civila försvaret 2021–2025* (Ds. 2017:66), December 2017, <https://www.regeringen.se/t/189628>.

²⁴¹ SIPRI Military Expenditure Database: *Data for 1949–2017*, <https://www.sipri.org/databases/milex>.

²⁴² IISS, *The Military Balance 2018*, cit., p.153; and *The Military Balance 2000*, p. 104.

²⁴³ SIPRI Military Expenditure Database: *Data for 1949–2017*, cit.

²⁴⁴ Susanne Oxenstierna, "Russian Military Expenditure", in Gudrun Persson (ed.), "Russian Military Capability in a Ten-Year Perspective – 2016", in *FOI Reports*, No. 4326 (December 2016), p. 133–150, <https://www.foi.se/rapportsammanfattning?reportNo=FOI-R--4326--SE>.

commission an increased number of ship-based missile systems. Russia has also developed a 5th-generation aircraft, the Su-57, and made strides with regard to UAVs. There is also a stated ambition to develop a 6th-generation aircraft.²⁴⁵ These developments pose challenges to Sweden, and create a need to look towards FCAS solutions. While Russian spending is set to decrease in the coming years, the country's military capability is predicted to continue increasing.

For Sweden, the need for the FCAS is not just linked to Russia. Indeed, Stockholm still participates in international peacekeeping operations and, while these rarely include combat aircraft, the Swedish JAS 39 Gripen participated, for example, in the enforcement of the no-fly zone over Libya in 2011 – mainly with surveillance tasks.

Currently, the JAS 39 Gripen E is undergoing tests and should to be introduced between 2019 and 2026. The Swedish Government currently plans to acquire 60 Gripen E, which will remain the main combat aircraft for Sweden until the 2040s.²⁴⁶ The original plan was to use parts from Gripen C/D versions in the production of the E version, but the deteriorating security environment has prompted a rethink. Currently the C/D versions are set to continue, being part of the Swedish Air Force's inventory; parts will instead be taken from the older, scrapped A/B version.²⁴⁷ In a report from 2014, the Swedish Defence Commission recommended that the number of JAS Gripen Es should be increased from 60 to 70,²⁴⁸ but the government has yet to decide on additional aircraft.

The *Perspektiv studie*, a study by the armed forces envisioning Sweden's military development up to 2035, also identifies a need for an increased number of combat aircraft – between 90 and 120, depending on the scenario.²⁴⁹ While the study points to the JAS Gripen 39 multi-role fighter to fill the main part of the air force's ranks, it also opens for a combination of manned and unmanned aircraft. While no details on future acquisitions are set yet, the identification of combat air capability as an essential security interest signals a commitment from the government to maintain and develop this area. From a Swedish military perspective, the development of the FCAS, by cooperation or otherwise, is about getting the most suitable operational requirements. Any cooperation between Sweden and larger nations facing different

²⁴⁵ Daniel Brown, "Russia Is Testing a New Drone Similar to the CIA's Stealthy RQ-170, and Wants to Turn It Into a Sixth-Generation Fighter", in *Business Insider*, 24 July 2018, <https://www.businessinsider.com.au/russia-says-its-turning-this-drone-into-a-sixth-generation-fighter-2018-7>.

²⁴⁶ Monica Kleja, "Saab skissar på ersättare till Gripen", in *NyTeknik*, 13 June 2016, <https://www.nyteknik.se/fordon/saab-skissar-pa-ersattare-till-gripen-6579329>.

²⁴⁷ Craig Hoyle, "Gripen E Production Tweak Safeguards Swedish Fighter Fleet", in *FlightGlobal*, 2 January 2019, <https://www.flightglobal.com/news/articles/gripen-e-production-tweak-safeguards-swedish-fighter-454732>.

²⁴⁸ Swedish Defence Commission, *Försvaret av Sverige. Starkare försvar för en osäker tid* (Ds 2014:20), May 2014, <https://www.regeringen.se/t/17453>.

²⁴⁹ Swedish Armed Forces, *Tillväxt för ett starkare försvar. Slutredovisning av försvarsmaktens perspektivstudie 2016-2018*, February 2018, <https://www.forsvarsmakten.se/siteassets/4-om-myndigheten/dokumentfiler/perspektivplan/slutlig-redovisning-av-perspektivstudien-2016-2018.pdf>.

operational requirements will probably entail some degree of compromise.

From a military perspective, the production of the FCAS is mainly related to security of supply and the availability of spare parts and skilled personnel to maintain the systems. This does not mean that every component necessarily needs to be produced in Sweden, however; the issue could also be solved through maintaining stock or via guarantees from reliable suppliers.

7.2 The industrial rationale

Sweden has a long tradition of producing combat aircraft, going back to the 1920s, and today is the only other European country, alongside with France, operating a fighter aircraft entirely produced on a national basis. Since the late 1930s, the Swedish aerospace industry has been dominated by Saab. The company was founded in 1937 with encouragement from the Swedish Government. Saab produced propeller-driven fighters and bombers for the Swedish Armed Forces throughout World War II, and constructed its first jet-engine fighter in 1947. The company has since produced combat aircraft such as the Tunnan, Lansen, Draken, Viggen and Gripen. Today, Swedish Saab is the only company, together with French Dassault, which can claim to be a sole prime contractor for combat aircraft in Europe. The other European competitor to Saab's Gripen and Dassault's Rafale is the Eurofighter, produced by a consortium consisting of Airbus, BAE Systems and Leonardo.

Sweden currently operates 97 combat aircraft in the form of JAS 39 Gripen C/D. The C/D versions have recently been upgraded in order to integrate the Meteor air-to-air missile.²⁵⁰ Not all components for the JAS 39 Gripen are domestically developed or produced. As stated above, roughly a third have UK origin for instance. Similarly, to earlier versions, it is unlikely that all components for the JAS Gripen E version will be domestically produced. For instance, it will contain a substantial share of transatlantic components as its engines are currently set to be delivered by US General Electric. Brazil has placed an order with Saab for 28 JAS 39 Gripen E and 8 two-seated-version Gripen Fs, of which 15 are set to be assembled in Brazil.²⁵¹ Saab also won a contract, together with Boeing, to deliver the new advanced training aircraft T-X to the US Air Force. But the Swedish company also has strong European links, since it participated in developing the nEUROn unmanned combat aircraft together with Dassault, and then EADS (now Airbus). Saab has drawn up some ideas on basic concepts for the FCAS,²⁵² but has also expressed an interest in potential cooperation with the UK.²⁵³ Notably, when it comes to propulsion systems, the

²⁵⁰ Swedish Armed Forces, *Ett nytt lyft för Gripen – Förmågehöjning till världsklass*, 23 May 2016, <https://www.forsvarsmakten.se/sv/aktuellt/2016/05/ett-nytt-lyft-for-gripen>.

²⁵¹ Saab has also exported the earlier JAS Gripen C/D version: 12 to Thailand, 14 to the Czech Republic and 28 to South Africa. Hungary leases 14 JAS Gripen C/Ds.

²⁵² Monica Kleja, "Saab skissar på ersättare till Gripen", cit.

²⁵³ Tomas Augustsson, "Saab vill bygga stridsflyg med Storbritannien", cit.

engines for the C/D-version are made by GKN in Sweden under US licence. The engines for the E version are designated to be made by General Electric.

From an industrial perspective, the FCAS is of importance to Sweden in order to maintain and develop its capabilities regarding research and technological development, and system integration – as well as ensuring a continuing skilled labour pool. For a small country like Sweden, which wants to keep all options open, protectionist tendencies in the US and the potential fallout from Brexit will prove challenging. Indeed, some form of cooperation will in all likelihood be necessary for Sweden to maintain and develop its own combat aircraft capabilities.

7.3 The political rationale

As mentioned above, the Swedish Government has identified combat air capability as an essential security interest. This decision has allowed an exemption from EU competition law through EU Article 346 the Treaty on the functioning of the European Union for the designated acquisition of JAS 39 Gripen E from Saab. This enables Sweden to maintain and develop its combat air capability together with its associated technological and industrial capabilities. While it is not entirely clear what is included in the concept of “essential security interest” in this context,²⁵⁴ the decision does signal a political commitment to combat air capabilities that extends into the future.

The Swedish armed forces and Defence Materiel Administration are also tasked with supporting the industry’s export efforts. However, Swedish legislation discourages arms exports to countries engaged in war or at of risk becoming so. The legislation also states that human rights should be taken into consideration.²⁵⁵ Sweden has historically exported to countries in both South East Asia and the Middle East. However, legislation was enacted in 2017 that makes democratic status a condition for arms exports.²⁵⁶ This may have consequences for the design of future cooperation on FCAS projects, as both the UK and France will probably wish to sell future aircraft to traditional export costumers in the Middle East.

The identification of combat air capability as an essential security interest addresses several political objectives for Sweden. First and foremost, the decision is linked to the military, strategic and operational importance of combat air capability for national security. Second, the ability to maintain domestic production is linked to the issue of security of supply. Third, it is part of the country’s industrial policy to keep unique knowledge and skilled labour in Sweden. Fourth, it serves to

²⁵⁴ Per Olsson et al., “Strukturella utmaningar inom det militära försvarets materiel- och personalförsörjning”, in *FOI Reports*, No. 4593 (May 2018), <https://www.foi.se/rapportsammanfattning?reportNo=FOI-R--4593--SE>.

²⁵⁵ Swedish Government website: *Svensk exportkontroll*, updated May 2015, <https://www.regeringen.se/t/5748>.

²⁵⁶ Swedish Government, *Skärpta regler för vapenexporten*, 26 June 2017, <https://www.regeringen.se/t/172169>.

maintain technology in combat air capability as a bargaining chip in international cooperation. The existence of two European FCAS projects creates a conundrum for Sweden, as the country values both European cooperation and its transatlantic relationship. Currently, Sweden wants to keep all options open regarding cooperation while continuing to explore the most feasible and suitable option for an FCAS capability.

Table 13 | Fighter aircraft in use in Sweden

Air Force		Naval Aviation	
Basis model	Quantity	Basis model	Quantity
JAS 39C/D Gripen	97	N/A	
Total quantity		97	

8. Europe, FCAS and Italy's strategic choice

by Alessandro Marrone and Paola Sartori*

8.1 Towards two European FCASs in Europe

Analysis of approaches to the FCAS in the UK, France, Germany, Italy and Sweden outlines a complex but relatively clear picture. In London and Paris, reflection on this future air capability is more advanced than in other European countries across all the considered dimensions – military, industrial and political. This is not surprising, especially considering the two nations' levels of ambition, armed forces' tradition and defence-technological industrial base; the F-35 experience in the UK; and the political will to maintain strategic autonomy in France. Each country is willing to lead a project aimed to balance, in different ways, national sovereignty and the partnership necessary to ensure economic sustainability. In particular, the UK has done a substantial amount of work in recent years on military requirements, also building on the F-35 experience, and has put together an industrial "Team Tempest" encompassing BAE Systems, Leonardo MW, Rolls-Royce and MBDA, with an initial budget provision of 2 billion pounds to develop the FCAS's technologies. This industrial ensemble represents a significant critical mass of technologies and a certain degree of autonomy from both European and US partners. Having said that, London is looking for partners in Europe – including but not limited to Italy, Sweden and the Netherlands – and beyond, e.g. Turkey and Japan, in order to share the financial burden.

Berlin is cooperating with French partners but does not yet have a clear vision on the FCAS, as it has to face simultaneously pressing choices regarding the future of its fighter-aircraft fleet – with the upcoming phase-out of the Tornado – and the need to comply with the NATO nuclear commitment to dual-capable aircraft.²⁵⁷ This may affect both composition of Germany's combat fleet and country's commitment to cooperation with France. As of February 2019, Paris and Berlin appear to agree on a general division of labour: Dassault will lead the work on the manned next-generation fighter at the centre of the FCAS concept, with Airbus as junior partner – including the integration of the future weapon system – while Airbus will also be responsible for the integration of fighter aircraft with other interconnected aviation and space assets. Development of the engines will be led by Safran Military Engines, with Germany's MTU Aero Engines as a junior partner. Finally, Berlin seems likely to leverage its lead on Eurodrone in order to procure a substantial role in the UCAV component of the system of systems. However, problems and disagreements persist on military requirement – in particular, considering high-

²⁵⁷ Michael Rühle, "NATO's Next Nuclear Challenges", in *Strategic Europe*, 16 March 2018, <https://carnegieeurope.eu/strategieurope/75818>.

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end demands coming from France and unclear vision in Germany. The two parties also seem to disagree on the approach to FCAS potential exports.²⁵⁸ In this regard, it is interesting to note that the Treaty of Aix-la-Chapelle addresses this aspect and calls for a common approach on armaments export.

Moving northwards, Stockholm keeps all cooperative options open – except repeating a national-only effort after Gripen – but seems definitively to lean towards London rather than Paris, benefitting also from the close industrial relationship between BAE Systems and Saab.²⁵⁹ Meanwhile, Spain has joined the Franco-German initiative, in line with its military requirement to replace the F-18 by 2030 and the Eurofighter in the following decade – as well as with its industrial stake in Airbus – by investing 25 million euro over the next two years.²⁶⁰ Conversely, the Netherlands seems to be interested in the London-led initiative.²⁶¹

As a result, two European projects are unfolding to develop and procure an FCAS in Europe – one totally located within the EU, and the other across the North Sea. Their trajectories may vary in the medium term; on the other hand, their future convergence in a single pan-European project is not impossible.

Such an eventuality would bring several advantages for Europe in terms of synergies of industrial and technological assets; economies of scale; the volume of its domestic markets; security of supply; ability to compete in export markets; and, in the end, Europe's strategic autonomy. Yet, such a marriage seems to be difficult and unlikely considering the fact that the two main actors in the process – France and the UK – failed to work together on the FCAS in the favourable political conditions set up by the Lancaster House Treaty, despite years of efforts and 180 million US dollar invested. The reasons that prevented a Franco-British FCAS project from getting off the ground then are still valid, including the structural rivalry between BAE Systems and Dassault. Moreover, a single European FCAS implies a clear division of labour and may potentially lead to progressive consolidation and rationalisation as well as the elimination of unhelpful redundancies, which will be difficult for all the major participating countries to accept. If such division of labour and rationalisation are not accepted, as happened in the case of previous multinational programmes, then the old adage that "cost increase is directly proportional to the square of the number of participant member states" may

²⁵⁸ Sebastian Sprenger, "Export Constraints Emerge As Sticking Point for Future German-French Combat Aircraft", in *Defense News*, 28 October 2018, <https://www.defensenews.com/global/europe/2018/10/28/export-constraints-emerge-as-sticking-point-for-future-german-french-combat-aircraft-report>.

²⁵⁹ See Interviewee 15.

²⁶⁰ Spanish Ministry of Defence, *España insta su participación como socio de pleno derecho en el futuro caza europeo*, 3 December 2018, <http://www.defensa.gob.es/gabinete/notasPrensa/2018/12/DGC-181203-caza-europeo-ngws.html>.

²⁶¹ Joseph Trevithick, "Eurofighter Consortium 2.0 Takes Shape As Spain Set to Join Franco-German Stealth Jet Program", in *The War Zone*, 4 December 2018, <http://www.thedrive.com/the-war-zone/25279>.

well come into play.²⁶² Finally, the implementation of such a merger would face the additional hurdle of how to reconcile the contributions of those industrial segments with experience in 5th-generation fighters (Italy and the UK) and those without it (France and Germany) in a balanced way. On top of this, the Brexit path will complicate cooperative endeavours between the UK and any EU country, while facilitating and enhancing Franco–German cooperation in various ways.

As a result, in the short to medium term the most likely scenario sees France and the UK leading two parallel mini-lateral initiatives to develop and procure an FCAS in Europe, each in competition with the other. Only in the medium to long term will awareness of the increasing gap between the European aerospace industry and its US counterpart, as well as the risk of being overtaken by China, act as a trigger towards industrial consolidation in Europe – including the merger of the two initiatives into a truly European FCAS.

Alternatively, after some work on FCAS technologies, the UK may decide to open negotiations with the US in order to launch a cooperative joint venture across the Atlantic. That choice would probably allow the British military to be at the technological frontier of air power by relying on the huge investments made by the US, as well as counting on Washington to shoulder risks, delays and cost overruns.²⁶³

Yet, again, such a marriage appears very difficult and unlikely, mainly because of the imbalance between the two actors. The US enjoys another order of magnitude in terms of military, economic and industrial resources, and is far too advanced on a number of FCAS-related technologies to appreciate a deal with the UK that would not place Washington squarely in the lead. Suffice it to mention in this respect the New Generation Air Dominance system for the US Air Force and the B-21 long-range bomber. This is even more likely bearing in mind the actions of the nationalistic and assertive Trump Administration – although it will probably be a distinctive feature of any future US presidency, building on the advantage already acquired by the US on 5th-generation aircraft as well as in the UAS sector. As a result, the organisational model for any possible US–UK industrial cooperation would probably be the F-35. This model worked well overall to deliver a 5th-generation aircraft; however, it satisfied its American prime contractor, Lockheed Martin, rather more than its British industrial partners, who complained about their limited achievements in comparison, for instance, with what has been achieved by Israel through foreign military sales. Alternatively, as mentioned in the first chapter of this report, the F-35 “fatigue” experienced by Washington because of the complexity, delays and cost overrun of such a large multinational programme may lead to the adoption of a US-only project for the next-generation aircraft. Actually, US preliminary studies point towards a very expensive and advanced FCAS – intended also to meet fairly unique US operational requirements (range

²⁶² Interviewees 8 and 12.

²⁶³ Interviewee 15.

and weapons load, which dictates size and weight) – that may be too much for UK ambitions and budget and too technologically sensitive from an American point of view to be shared with allies – as, in fact, happened with the F-22.

As a result, in both cases – a US-only programme, and a cooperation based on the F-35 experience – the chances of London securing a workable deal with Washington on the FCAS are far lower than the possibilities of it achieving satisfactory results with its other European partners.

8.2 A strategic choice for Italy

In the end, the most likely scenario will see, on the one hand, a Franco–German “pole”, with France in the lead and Spain taking up an ancillary role, and a UK-led project, probably in partnership with Sweden – and, perhaps, the Netherlands. Accordingly, Italy will soon have to choose one of these two sides, also considering that it is the only “fighter aircraft country” in Europe not yet having committed itself. From an Italian perspective, a proper assessment of the pros and cons, challenges and opportunities of each side should consider at least the following eight elements: (1) military alignment of air-combat fleets; (2) experience of 5th-generation aircraft; (3) industrial room for manoeuvre; (4) mid-/long-term adaptation; (5) recent EU initiatives in the defence domain; (6) Brexit implications; (7) political circumstances; (8) Negotiating positions.

In making such a choice, Italy has to bear in mind the fact that its national defence industry requires a long-term, international, high-tech and wide-ranging procurement programme in order to remain competitive, drawing on the lessons learned since the 1970s with the Tornado and then with the Eurofighter and F-35.²⁶⁴ Failing to join either of the two unfolding FCAS projects, or postponing such a choice too long, would imply an inevitable and steady decline for the Italian aerospace industry and would deliver a serious blow to the country’s military air power. Rome is indeed at a crossroads: it can maintain, for the medium to long term, a robust presence in a strategic sector or it can abandon it altogether – bearing all the negative consequences in operational, industrial and technological terms. For this reason, a timely government decision is crucial to protect and promote the country’s national interests. Italy’s strategic decision to fully participate in the FCAS development is particularly urgent considering the fact that Spain has joined the Franco–German project, while Sweden is considering participating in the Tempest one: the current circumstances for joining either of these two FCAS teams may rapidly change, placing Rome in a weaker position than it is in today.

8.2.1 Military alignment of air-combat fleets

From the military point of view, Italy and the UK are the two most closely aligned countries in Europe when it comes to air-combat capabilities. Both have developed,

²⁶⁴ Interviewee 16.

procured and operated the Eurofighter, and have participated from the beginning in the F-35 procurement programme with a significant role. Consequently, their fleets will experience a similar operational life cycle,²⁶⁵ by allowing a long-term effort to prepare the replacement for the Eurofighter on the post-2040 horizon.

This sort of alignment does not exist between Italy and France, as their air-combat fleets are completely different. Moreover, as regards the modernisation of, respectively, the Eurofighter and the Rafale,²⁶⁶ France feels a greater sense of urgency to replace its air-superiority platforms around 2035²⁶⁷ while Italy can prolong its platforms' operational life cycle well beyond 2040. Such a difference in terms of phasing out may be somehow managed and mitigated, but this would be difficult because Rome – like London – can count on the F-35 until the 2050s to complement and support its air defence while Paris cannot. At the same time, both Italy and Germany procure and operate the Eurofighter, and the two countries share similar timelines for the end of their Tornados' operational life.²⁶⁸ Interestingly, according to the latest decisions, Germany seems to lean towards an upgraded version of the Eurofighter to replace its ageing Tornados.²⁶⁹

8.2.2 Experience of 5th-generation aircraft

From both a military and an industrial point of view, Italy and the UK are the only two major European countries with access to a 5th-generation aircraft such as the F-35. British and Italian air forces and naval-aviation forces are testing and already operating the aircraft, and this experience brings with it a number of tactical, operational and "doctrinal" innovations – for example, when it comes to net-centric and stealth capabilities – notwithstanding the strong US limitation on technology transfer. On the one hand, the UK is the only Tier-1 partner within the F-35 programme, with a significant role played by BAE Systems and the possibility to benefit from preferential access to American interlocutors. On the other hand, Italy, as a Tier-2 partner, manages the only F-35 FACO in Europe – besides building the central fuselage and the wings, as well as providing a number of components.

²⁶⁵ Stefano Pioppi, "Tutti i dettagli su Tempest, il nuovo fighter del Regno Unito (con Leonardo)", in *AirPress*, 16 July 2018, <https://www.airpressonline.it/?p=34456>. See also Tim Robinson, "UK Mulls Sixth Generation Fighter Project", in *Aero Society*, 3 July 2018, <https://www.aerosociety.com/news/uk-mulls-sixth-generation-fighter-project>.

²⁶⁶ Michel Cabirol, "La France lance une nouvelle modernisation du Rafale", in *La Tribune*, 22 March 2017, <https://www.latribune.fr/entreprises-finance/industrie/aeronautique-defense/la-france-lance-une-nouvelle-modernisation-du-rafale-668953.html>. See also "Airbus vuole anche la Francia nel progetto del futuro caccia europeo", in *Fly Orbit News*, 12 June 2017, <https://wp.me/p7AKj8-9BE>.

²⁶⁷ Interviewee 15.

²⁶⁸ Tobias Buck and Peggy Hollinger, "Germany Heads for Political Dogfight Over Replacing the Tornado", in *Financial Times*, 10 July 2018, <https://www.ft.com/content/8a3ef664-8373-11e8-96dd-fa565ec55929>. See also Franco Iacch, "Italia, quanti F-35A saranno destinati all'attacco nucleare?", in *Il Giornale*, 27 April 2018, <http://www.ilgiornale.it/news/mondo/italia-quanti-f-35a-saranno-destinati-allattacco-nucleare-1520129.html>.

²⁶⁹ Sebastian Sprenger, "Germany Officially Knocks F-35 Out of Competition to Replace Tornado", in *Defense News*, 31 January 2019, <https://www.defensenews.com/global/europe/2019/01/31/germany-officially-knocks-f-35-out-of-competition-to-replace-tornado>.

This arrangement applies not only to the platform's avionic aspects but also to sensors; electronics; and, notably, propulsion systems – whereby the UK's Rolls-Royce benefits from its technological and industrial involvement in cooperative projects with the US. Such a level of access constitutes for both countries a basis from which to look to the 6th generation in military and industrial terms – although its development without US partnership would surely be a challenging leap. On the contrary, France lacks substantial military or industrial experience with 5th-generation aircraft, although it has made technological progress with nEUROn, and Germany has had no access to the F-35 thus far. Generally speaking, UK has made more progresses than France towards the next generation of fighter aircraft. Such a relative weakness makes achieving the technological and industrial jump from the 4th to the 6th generation, in a reasonable timeline and budget, much more difficult for Paris and Berlin than for the UK and Italy. The risk for France and Germany is that of developing a few hundred 5th-generation FCASs by 2035–40, at a time when thousands of F-35s will be available to provide similar or better performance at a lower cost than the Franco–German FCAS – and thus prevailing in export markets both inside and outside Europe.²⁷⁰

8.2.3 Industrial room for manoeuvre

From an industrial point of view, Italy's choice cannot leave aside a strategic assessment of the room for manoeuvre that national industries could have in the FCAS development and production phases, as well as in the whole life cycle of the platform. In comparative terms, the added value of the Tempest programme lies in the participation of Leonardo MW Ltd, which would help Italian industry to be more involved in the next steps related to a number of key technologies and components, such as avionics, cells, sensor systems, communications, radar systems and electronics as well as training aircraft, integration and the release of weapons systems and cyber capabilities.²⁷¹ In other words, there would be a “mass effect” in technological, industrial and financial terms, which could ensure on certain components an Italian role even greater than in the Eurofighter consortium.

Conversely, according to the guidelines defined for the Franco–German initiative, as analysed in the previous chapters, an eventual Italian engagement with Paris and Berlin may lead to problems in terms of compatibilities and the division of labour. In particular, the acknowledgment of major responsibilities attributed to Dassault may not suffice to accommodate the industrial role that Germany deserves. Moreover, Thales' involvement regarding the FCAS's electronics creates, by default, obstacles to the involvement of its competitor Leonardo; this is not the case with the Tempest project, in which Leonardo MW Ltd is already responsible for these aspects. As a consequence, in spite of competitive advantages held by

²⁷⁰ Interviewee 15.

²⁷¹ Gianandrea Gaiani, “Londra presenta il Programma Tempest, l’erede (un po’ anche italiano) del Typhoon”, in *Analisi Difesa*, 17 July 2018, <https://www.analisedifesa.it/?p=116885>. See also Interviewees 11 and 12.

Italian industry in various sectors, the country's entry into the Franco-German consortium after its requirements have been defined and the allocation of works between French and German industries established would drastically reduce the possibility of adequate industrial and occupational returns for Italy.²⁷²

Furthermore, should Rome team up with Paris and Berlin, the presence of Leonardo MW Ltd on the Tempest programme only from the UK side is likely to produce several negative effects for Italy. First, an eventual Italian industrial participation in two competing projects will inevitably raise suspicions among all partners about the real commitment of Rome to either initiative, and place its national industries in a more difficult and weaker position when it comes to expertise sharing and the division of labour. Second, the non-involvement of Italy in the Tempest project may end up as a less than optimal investment for Leonardo because of the absence of adequate economic returns in terms of Italian MoD procurement. Finally, it should be noticed that Avio Aero is used to working with Rolls-Royce on aircraft-propulsion systems, while such cooperation does not exist with its French counterpart, Snecma: on the contrary, having the US company GE as major shareholder of Avio Aero would further complicate a possible cooperation with Paris. Generally speaking, the role of major French companies in this project is even more important considering the relative weakness of the German aerospace sector, due to a lack of significant government investment over the last two decades.

8.2.4 Mid-/long-term adaptation

When it comes to procurement and defence-industrial policy, once a strategic decision is made continuity and reliability are key to obtain results for both the military and industry. Therefore, any choice that Italy makes regarding the FCAS will require consistent implementation over the years. Also, a stable, whole-of-government approach is needed to favour the necessary synergies between institutional and private actors in such a long-term and complex endeavour. However, this positive continuity does not prevent mid-/long-term adaptation from taking place. Indeed, as mentioned before, the trajectories of the two FCAS initiatives in Europe may converge. Such a convergence would be desirable from both a European and an Italian point of view, but Rome would have to deal with this transformation by protecting its assets and role in the programme at the political, military and industrial levels.

By that time, should Italy be in a consortium with the UK – and perhaps Sweden and the Netherlands – it will probably be better able to adapt. Indeed, by contributing to defining the military requirements and the system architecture – thanks to the alignment of combat fleets, experience of 5th-generation aircraft and industrial room for manoeuvre – it could effectively frame its national interests within the position of this consortium of countries negotiating with France and Germany towards a pan-European solution. In contrast, should Italy accept an ancillary

²⁷² Interviewee 1.

position in the Franco–German project, it will probably be the weaker partner whose interests could be sacrificed to make room for the marriage. The experience of nEUROn does constitute a notable precedent in this regard. That project – led by Dassault with the participation of Leonardo (to the tune of 22 per cent), Saab and partners from Spain and Greece – began in the early 2000s in order to demonstrate UCAV technologies.²⁷³ However, the flight tests performed between 2012 and 2016 did not lead to a joint procurement programme. On the contrary, by also building on the nEUROn's technological basis, France attempted a bilateral FCAS cooperation first with the UK and now with Germany, neither of whom were partners on nEUROn.

A different form of adaptation could be required in the medium to long term, should the UK decide to try negotiating a partnership with the US on an FCAS cooperation. In this scenario, both London and Rome may find it convenient to present themselves – and other European Tempest partners – as a European bloc thus increasing the chance to obtain fair conditions from Washington. Such an opportunity was largely missed at the beginning of the F-35 procurement, and a very limited cooperation between European participants took place only at later stage with the Dutch–Italian cooperation on FACO.²⁷⁴ Lessons learned from the F-35 experience should lead participating European countries to avoid another application of divide and rule logic within a transatlantic cooperative procurement process. Should it be already part of the Tempest team, Italy would then be better positioned to face the challenges and opportunities of a new transatlantic venture.

8.2.5 Recent EU initiatives in the defence domain

FCAS technological and industrial efforts could be eligible for financial support through newly established European initiatives such as the EDF,²⁷⁵ which is going to invest 13 billion euro over the 2021–7 timeframe for cooperative projects. However, considering the nature of the FCAS – lying, as it does, at the highest end of the spectrum of combat capabilities – it may be politically difficult to receive funds from the EU, a political “novice” in the defence field until a few years ago.

Considering the fact that the EDF will spend 4.1 billion euro in the aforementioned research window – by covering at least 80 per cent of eligible costs – this is not a marginal incentive.²⁷⁶ Notably, the inclusion of Spain in the Franco–German

²⁷³ “New French minister gets close-up look at nEUROn”, in *Air & Cosmos International*, 6 September 2017, <http://www.aircosmosinternational.com/new-french-minister-gets-close-up-look-at-neuron-99601>.

²⁷⁴ Michele Nones, Giovanni Gasparini and Alessandro Marrone, “Europe and the F-35 Joint Strike Fighter (JSF) Program”, in *IAI Quaderni English series*, No. 16 (July 2009), <https://www.iai.it/en/node/2560>.

²⁷⁵ Stefano Pioppi, “Orgoglio nazionale e scenario globale. Ecco la strategia di Leonardo”, in *AirPress*, 5 September 2018, <https://www.airpressonline.it/?p=35090>.

²⁷⁶ Cemal Karakas, “European Defence Fund. Multiannual Financial Framework 2021-2027”, in *EPRS Briefings*, November 2018, [http://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI\(2018\)630289](http://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI(2018)630289).

initiative makes it compliant with the criteria of three participating EU member states set up by the draft EDF regulation. When it comes to capability windows, the EDF's 20 per cent co-funding for demonstrators and prototype activities will probably be more difficult to achieve.

Against this backdrop, the eventual eligibility of the initiative as a PESCO project would increase Brussels' contribution to an additional 10 per cent, thereby reducing the burden of expenditure for participant member states and representing an additional incentive.²⁷⁷ The inclusion of Eurodrone in the second wave of PESCO projects approved by EU ministers of defence in November 2018 shows a trend towards the acceptance of more robust and ambitious procurement projects in this framework.²⁷⁸ In the end, the defence-industrial policies of major EU members will push towards greater EU financial support for the European defence industries, and this is likely to become a structural trend that needs to be taken into account.²⁷⁹

The Tempest situation in relation to both the EDF and PESCO is more complex. The Fund's draft regulation does allow participation of entities from third countries with certain restrictions – particularly, regarding security of supply, management of sensitive information, non-interference by third governments, etc.²⁸⁰ Therefore, projects involving both British companies and the UK Government may theoretically apply for EDF co-funding, provided the EU funds only finance project activities performed by EU-based entities. This would still be a not-inconsiderable incentive for the development of FCAS-related technologies by a consortium made up of, say, British, Italian, Swedish and Dutch partners. However, the devil is in the detail: the regulation may be implemented or interpreted in a more or less restrictive way with respect to the UK, probably depending also on the outcome of the Brexit process.

The same goes for PESCO. Its governance rules allow for the participation in specific projects of third parties provided that they bring "substantial added value", "contribute to strengthening PESCO and the CSDP" and "meet more demanding commitments"²⁸¹ – all stipulations that the UK could easily meet. However, the future evolution of PESCO and the real possibility for third-party contribution will also be affected by the Brexit process. Overall, it is important to note that the closeness of the UK's relations with the EU in the defence domain is also related to the kind of agreement that London will strike with the European Defence Agency.

²⁷⁷ Alessandro Marrone, "Permanent Structured Cooperation: An Institutional Pathway for European Defence", in *IAI Commentaries*, No. 17|26 (November 2017), <https://www.iai.it/en/node/8508>.

²⁷⁸ Andrea Aversano Stabile and Alessandro Marrone, "Ue: nuovi progetti Pesco, impegno attivo dell'Italia", cit.

²⁷⁹ Interviewee 15.

²⁸⁰ Paola Sartori, "I nodi da sciogliere del programma comune", in *AirPress*, No. 90, June 2018.

²⁸¹ Council of the European Union, *Council Decision (CFSP) 2017/2315 of 11 December 2017 establishing permanent structured cooperation (PESCO) and determining the list of participating Member States*, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017D2315>.

8.2.6 Brexit implications

As of February 2019, the outcome of the Brexit process is far from clear. On 15 November 2018, Theresa May's government and the EU negotiators' team, led by Michel Barnier, reached a deal on the UK's exit from the Union. The deal has been signed by the 27 EU heads of state and government, but it was rejected by the British Parliament on 15 January 2019. With the deadline for the negotiations still scheduled as 29 March 2019, several scenarios remain possible.

On the one hand, the UK may exit the EU without any deal. In the short term, this would probably lead to a series of problems and delays – if not disruption – affecting all economic activities across the Channel. In the short to medium term, it may create further social, political and even security problems in Northern Ireland, as well as reinvigorating Scottish secessionism. In such a scenario, it is likely that the British economy and state budget would suffer, while politics in the UK would be absorbed with managing such turmoil. As a result, defence would probably be deprived of political and economic impetus, leading to cuts and/or the postponement of major procurement programmes, including the FCAS. In the medium to long term, being a third country without any form of free-trade agreement with the EU would pose a number of problems and challenges for defence-industrial cooperation, which will endure at least until a trade arrangement could be negotiated – that is, considering previous negotiating experiences, in a number of years' time.

Generally speaking, in this scenario the UK's relationship with the EU will probably be characterised by open competition.²⁸² Such an atmosphere would negatively affect cooperation and even foster the development of diverging approaches, not only in economic terms but also in the defence sector. For instance, this outcome would lead to the introduction of obstacles to market access, reduced freedom of circulation for technologies and additional costs for industries in terms of both tariffs and non-tariff barriers – thus leading to higher prices.²⁸³ In fact, in the light of the complexity of defence products and their related supply chains, with frequent movements of some components across the EU/UK border, non-tariff barriers (including several administrative and customs procedures) could result in delays and additional costs.²⁸⁴ Changes in the economic relationship would also have a major impact on European defence companies with a large footprint in the UK. This could affect decisions on how to structure their business model. A no-deal scenario could influence future investment behaviour and even lead certain companies to consider relocation to other European member states in order to maintain access to the benefits of the Single Market, EU funds and the EU-wide

²⁸² On different scenarios and their implications for European defence industry, see Paola Sartori, Alessandro Marrone and Michele Nones, "Looking Through the Fog of Brexit: Scenarios and Implications for the European Defence Industry", in *Documenti IAI*, No. 18|16 (July 2018), <https://www.iai.it/en/node/9341>.

²⁸³ Paola Sartori, "Brexit and European Defence: What to Expect from a 'No-Deal' Outcome?" in *IAI Commentaries*, No. 18|40 (July 2018), <https://www.iai.it/en/node/9378>.

²⁸⁴ Ibid.

supply chain.²⁸⁵ In a similar vein, Brexit outcomes will also deeply affect Anglo-Italian cooperation from the export-control side. According to amendments dating from 2012 to Law 185/1990, a simplified procedure has been established for the exchange of defence equipment and components involving only EU member states – but not NATO members that are not part of the EU, such as Norway.²⁸⁶ In the event of harsh leaving conditions, the UK will fall in the EU's third-country categories – making Italian exports into British markets more difficult.²⁸⁷ In such a scenario, working with London on the FCAS would be more problematic for Rome.

However, as underlined by some experts and practitioners,²⁸⁸ EU countries, including Italy, do cooperate well with non-EU companies and governments – *in primis* in the US case. Moreover, France continues to cooperate with the UK on missile, counter-mines and nuclear sectors, i.e. through the Sandhurst Treaty signed well after the Brexit referendum, and this bilateral cooperation is played by Paris alongside other bilateral – i.e. with Germany – and EU cooperation, following the traditional French *a-la-carte* approach. Moreover, the UK is leaving the EU but not Europe – thus maintaining its stake and interest in Europe's security and economy, as well as in defence cooperation and industry. The country has proved to be resilient to major shocks and crises, and would most likely also overcome the contingency of a no-deal outcome and a period of instability until London established its new relations with the EU. Accordingly, the feasibility and utility of teaming up with the UK on the FCAS would, to a certain extent, be negatively affected by a no-deal scenario, but not drastically reduced.

A second scenario would see the British Parliament make a U-turn and approve the government's deal before the leave date of 29 March 2019, also in order to avoid the aforementioned short-term turmoil. Finally, a third scenario would see a postponement of this deadline for exiting the EU – which, by chance, would also allow the UK to unilaterally revoke the decision to leave the Union, as recently stated by the European Court of Justice.²⁸⁹ In both these cases – deadline rescheduling and deal approval – avoiding a "cliff-edge" exit would ensure a further period of regulatory status quo for economic relations across the Channel, create a less uncertain scenario for both public finances and the private sector – including with regard to defence. In particular, accepting the deal would entail almost two

²⁸⁵ Matthew R.H. Uttley and Benedict Wilkinson, "Contingent Choices: The Future of United Kingdom Defence Procurement and Defence Industries in the Post-Brexit Era", in *Global Affairs*, Vol. 2, No. 5 (2016), p. 499.

²⁸⁶ Legislative Decree No. 105 of 22 June 2012, amending Law No. 185 of 9 July 1990 on New Provisions on Controlling the Export, Import and Transit of Military Goods, https://www.esteri.it/mae/resource/doc/2017/06/legge_09_07_1990_n185.pdf.

²⁸⁷ Interviewee 13.

²⁸⁸ Interviewees 2, 6, 10, 11 and 12.

²⁸⁹ Jon Stone, "UK Can Cancel Brexit by Unilaterally Revoking Article 50, European Court Advocate General Says", in *Independent*, 4 December 2018, <https://www.independent.co.uk/news/uk/politics/brexit-court-case-latest-article-50-cancel-overturn-european-justice-ruling-verdict-a8666016.html>.

years of transition, which may be further renewed once, and then a backstop option ensuring no “hard” border in Ireland until a deal is re-established.²⁹⁰ In this context, ongoing and future cooperative-procurement programmes involving the UK and EU countries would find a more favourable environment, greater political and financial support, and improved opportunities to access the EDF and PESCO frameworks. Either rescheduling the deadline or accepting the deal may, in turn, lead to different outcomes, including an agreement about a customs union or a free-trade deal. In the end, two opposing scenarios may also materialise: the no-deal, or a complete U-turn on the decision to leave the Union.

8.2.7 Political circumstances

Brexit and EU initiatives like PESCO and the EDF heavily affect not only the defence market, industry and procurement but also, broadly speaking, the defence and foreign policy of major European countries. Should the UK exit the EU in a very controversial way, this will probably put London in a weaker position than it is in today because of both internal troubles and the need to build some bridges with the major EU powers. Accordingly, Tempest competition against the Franco-German FCAS may prove difficult to shoulder for London in political, military and economic terms. This may press the UK to make greater concessions to other European partners, or to undertake a strategic negotiation with either Washington or Paris and Berlin in order to join efforts. At the same time, an EU without the UK will politically boost defence cooperation and integration, possibly linking them with the vision of a “European army” already relaunched by the French president and the German chancellor.²⁹¹ The aforementioned Treaty of Aix-la-Chapelle, signed by France and Germany, would probably be a driver towards this outcome. As a result, within the Union there will be stronger political pressure for exclusive intra-EU cooperation on the FCAS, which may help to overcome military and industrial controversies between Paris and Berlin and act as a catalyst for others to join the initiative. In this context, should Rome side with London on the Tempest project, this will add another element of political divergence to relations between Italy and the Franco-German driver for EU integration. Such divergence would not be sufficient reason *per se* to prevent Anglo-Italian cooperation on the FCAS. Yet it would complicate the management of such a cooperation effort within the broader framework of Italy’s defence and foreign policy.

8.2.8 Negotiating positions

Finally, also in order to prevent wishful thinking, a sober political assessment of the negotiating position demanded by the two initiatives is necessary. The UK seems

²⁹⁰ John Campbell, “Q&A: The Irish Border Brexit Backstop”, in *BBC News*, 13 December 2018, <https://www.bbc.com/news/uk-northern-ireland-politics-44615404>.

²⁹¹ Maïa de La Baume and David M. Herszenhorn, “Merkel Joins Macron in Calling for EU Army to Complement NATO”, in *Politico*, 13 November 2018, <https://www.politico.eu/article/angela-merkel-emmanuel-macron-eu-army-to-complement-nato>.

to be open to cooperation with Italy on the FCAS, and informal signals have already been exchanged between the two countries' militaries.²⁹² This willingness is part of a broader British effort towards finding partners with which to share burdens. It is probably also motivated by the need to maintain and develop military-industrial partnerships with EU members in order to offset the negative effects of a disengagement from the EU framework at a time when the Union is stepping up its defence dimension. In this light, by weakening London's position on the European geopolitical landscape, Brexit is likely to further enhance British political will to cooperate with EU member states, such as Italy, in this field. This is not to say that the resulting dialogue with London on military requirements and industrial work-sharing will be easy, but at least there would be a positive starting point in terms of negotiating positions. In fact, the preconditions exist for building an important Italian role on Tempest, as well as pushing to enlarge the pool of partners to other European countries willing and able to join – without excluding a priori a future convergence with the Franco-German project.

Similar preconditions do not exist in the case of the initiative launched by France and Germany. Paris is following a consolidated approach in order to first define a bilateral deal with Berlin and then to open up to other partners on predefined conditions in military and industrial terms. Moreover, the Brexit process has enhanced France's pivotal position within the arena of European defence – a position further exploited through the European Intervention Initiative – thus increasing Paris's deep-rooted attitude for leading rather than compromising. Italy could "play the card" of a relatively significant procurement, which is desperately needed by a limited Franco-German-Spanish pool of acquisition in order to ensure the economic sustainability of the project. However, in the end Rome's proposal would be considered by Paris only after the military requirements had been set up and the industrial architecture designed, with little room left to accommodate Italian requests. As a result, Italy would most likely become the "importer" of an FCAS, the high-tech components of which were produced and mastered by French defence industries that would be in open competition with Italian ones.²⁹³ This is not to say that achieving a satisfactory compromise with France is impossible, but it will certainly be much more difficult and unlikely than reaching a deal with the UK. In the end, it takes "two to tango".

8.3 Negotiating an FCAS deal with the UK

In conclusion, from the Italian perspective the eight aforementioned elements can be summarised as follows. On the one hand, the alignment of Italy's combat fleet with that of the UK, the common experience with 5th-generation aircraft through the F-35 project, the greater industrial room for manoeuvre, the better mid-/long-term adaptation and the more favourable negotiating positions all decisively point towards participation in the Tempest programme. On the other hand, it is also true

²⁹² Interviewee 3.

²⁹³ Interviewees 6, 7, 10, 11, 12 and 13.

that possible EU co-funding could be easier for FCAS-related projects presented by France, Germany, Italy and Spain. Nonetheless, even a project submitted by Italy, the Netherlands and Sweden – and including the UK as third-country partner – could be eligible for EU funding. In addition, the political circumstances surrounding Rome's possible participation in Tempest are complicated but manageable. The real question mark relates to Brexit and its possible negative implications, broadly speaking, on the UK's role when it comes to defence-industrial cooperation in Europe – although such implications do not remove the need for close cooperation with London on shared defence interests.

As a whole, Tempest represents the best strategic choice for Italy according to a military, industrial and political rationale. Such an evaluation is likely to be endorsed by both the Italian military and the country's defence industry, and should be taken into account by the government in order to protect national interests.

Should policy-makers eventually decide to pursue Italian participation in the Tempest project, the following key elements need to be considered when negotiating an FCAS deal with the UK: (i) a timely decision to negotiate; (ii) partnership within the Eurofighter programme; (iii) synergies with the F-35; (iv) Tempest's European character; and (v) the parallel enhancement of intra-EU defence cooperation.

8.3.1 A timely decision to negotiate

When it comes to timing, the sooner its government takes the decision to negotiate participation in the Tempest programme, the better it will be for Italy. Indeed, from an Italian perspective, the added value stemming from some of the current favourable circumstances may fade as early as the next few months. First, timely participation by Italy would help its military to contribute to shaping the project's operational requirements in the light of national needs and visions. On the contrary, a belated move would most likely reduce Italian leverage. Second, should Sweden join Tempest before Italy does, Saab is likely to position itself in certain technology areas that also constitute a priority for Italian industries such as Leonardo – thus reducing the technological and industrial "return" for Rome. The same would be true, although to a lesser extent, for Italian SMEs should the Netherlands enter the Tempest consortium before Italy and bring to the table the excellence of its competitive defence technological–industrial base. Third, Rome siding with London would substantially increase the pool of users for Tempest, as well as its footprint within the EU. This would add credibility and make the initiative more appealing to other European countries: from an Italian perspective, wider European participation would benefit the success of the project.

Moreover, while any serious FCAS initiative will entail substantial and stable investments over decades by participating countries such as Italy, the Tempest timeline does not require immediate significant expenditure by Rome – and this advantage would add to the project's aforementioned positive elements. Indeed, the feasibility studies and the first technological demonstrators are likely to be affordable by the Italian defence budget without the need for substantial

expenditure increases, which would instead become necessary later on when entering the prototype and production phases.

Notably, a timely expression of political will to join Tempest should not translate into immediate and unconditional participation, by paying “a blank cheque” to the UK leadership on the project. On the contrary, Italy should rapidly start to negotiate with London in a wise manner, with no rush, in order to achieve a lasting and satisfactory agreement for both parties. For instance, negotiations should also encompass the cooperative dynamics within the Eurofighter programme.

8.3.2 Partnership within the Eurofighter programme

The Eurofighter has represented, and continues to represent, a fundamental cooperative endeavour for both the militaries and the industries of the countries concerned – namely, Germany, Italy, Spain and the UK. Yet Rome has to recognise that the decision taken by Berlin and London, then followed by Madrid, has already divided this grouping and clearly shown that it is not their intention to continue on the same path together. While the long-term goal of having a single European FCAS project should remain on the Italian agenda, in the near future its pursuit lies through the establishment of a clear, structured and balanced partnership with the UK within the Eurofighter programme, based on mutual transparency and support. From an Italian perspective, this is an important element in the negotiations with London. The aim should be to develop together components and technologies that could also be included in the Tempest programme. Even allowing for the possibility that Germany could change its mind about cooperation with France, there is no point for Italy in waiting for such an eventuality. Enhancing the Anglo-Italian partnership within Eurofighter towards Tempest enhances the appeal of the latter – thus also supporting a future, desirable convergence into a single European FCAS. Moreover, the development of FCAS-related technologies by British and Italian industries would benefit also future Eurofighter’s upgrades, an advantage which would not take place in case Italy joins the Franco-German project because of the foreseeable opposition by France in light of its necessity to promote Dassault’s Rafale.

8.3.3 Synergies with the F-35

As mentioned above, their unique experience with the only 5th-generation aircraft worldwide represents a competitive advantage for both the UK and Italy, as they are thus better positioned to face the technological challenges of the 6th generation. Rome should profit from this asset, especially considering that the Cameri factory is the only F-35 FACO in the world outside the US, and it will continue to increase its role concerning not only the aircraft’s assembly but also the MRO&U of F-35 fleets in Europe – starting with the Italian and Dutch ones. For Italy, the F-35 and the Tempest are not actually alternatives to each other but, rather, are seen as complementary. Italy was already, in 2018, the first European country to reach F-35 initial operational capability, and the platform will be phased in gradually over the next two decades by both the country’s air force and its navy in order to replace

the Tornado, AM-X and AV8B platforms. By contrast, the Tempest – according to the usual pace of a large, multinational procurement programme – will enter into service to replace the Eurofighter in the 2040s – that is, more than three decades after the first F-35 took off from an Italian military base. Such phasing management makes the two procurement programmes complementary and synergic for Italy, both in military and industrial terms – and also considering that several lessons learned with F-35 could benefit Italy's participation in Tempest.

8.3.4 Tempest's European character

Whatever the results of the Brexit process may be, while joining Tempest Italy should stress the European character of this cross-Channel endeavour. First, it includes half of the Eurofighter consortium – the larger and most successful example of European fighter-aircraft procurement thus far. Second, Tempest's desirable enlargement to include Sweden and the Netherlands means that – together with Italy – at least three EU member states would be in the programme. This number matches the eligibility criteria for submitting FCAS-related technological projects for EDF funding and co-funding. Notably, the EU may decide to finance technologies for both FCAS projects in order to strengthen its DTIB competitiveness by avoiding an excessive concentration of industrial capabilities – and this would ease the financial burden for all participating countries, including Italy. Moreover, in political terms, such wider participation would confirm the European dimension of the Tempest programme within both Italy and the EU. This would be particularly relevant if the enlarged consortium encouraged other EU countries to join the initiative. Such a European profile, in turn, would ease the management of the political circumstances for Rome, especially with respect to the concurrent Franco-German initiative, and would pave the way for a possible future convergence of the two projects. Tempest's European character also makes Italy's participation an added value, even from a British perspective at a time when London is seeking to enhance its bilateral and mini-lateral cooperation with EU member states in order to offset its abandoning of the Union.

8.3.5 Parallel enhancement of intra-EU defence cooperation

Participation in the Tempest project could be better managed and strengthened if it were to be part of a broader strategy aimed at additionally reinforcing intra-EU defence cooperation. In this regard, the Eurodrone programme – as well as other robust PESCO²⁹⁴ projects in the space, land and naval sectors – could serve as perfect test beds to show an enhanced Italian commitment to a stronger European defence. This could help to shelter Rome from possible criticisms about siding with the UK on Tempest, as it would reinforce Italy's credibility and reliability within the EU.

²⁹⁴ Andrea Aversano Stabile and Alessandro Marrone, "Ue: nuovi progetti Pesco, impegno attivo dell'Italia", cit.

In conclusion, when it comes to Italy's strategic choice on the FCAS, all in all, joining Tempest is the best strategic option and is economically sustainable in the current circumstances; therefore, it should be rapidly pursued by Rome. In negotiating a deal with the UK, Italian national interests would be better served by developing the partnership within the Eurofighter project; exploiting synergies with the F-35; stressing the European character of an enlarged Tempest consortium; and, at the same time, showing enhanced commitment to intra-EU defence cooperation. This choice and the subsequent approach are crucial for the future of Italy's air power and defence industry – two fundamental pillars of the country's defence and foreign policy.

Updated 20 February 2019

List of interviewees

Interviewee 1: Rome, 23 October 2018, by Andrea Aversano Stabile

Interviewee 2: Rome, 16 October 2018, by Alessandro Marrone

Interviewee 3: Rome, 9 October 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 4: Rome, 7 November 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 5: Rome, 7 November 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 6: Rome, 8 November 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 7: Rome, 9 November 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 8: Rome, 9 November 2018, by Alessandro Marrone

Interviewee 9: Rome, 17 October 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 10: Rome, 16 November 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 11: Rome, 22 November 2018, by Andrea Aversano Stabile

Interviewee 12: Rome, 21 November 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 13: Rome, 20 November 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 14: Rome, 23 November 2018, by Alessandro Marrone and Andrea Aversano Stabile

Interviewee 15: Rome, 23 November 2018, by Alessandro Marrone

List of acronyms

A2/AD	Anti-Access/Area Denial
ADVENT	Adaptive Versatile Engine Technology
AESA	Active Electronic Scanned Array
AETD	Adaptive Engine Technology Development
AHCA	Advance Heavy Combat Aircraft
AI	Artificial Intelligence
AMCA	Advanced Medium Combat Aircraft
AMET	Advanced Military Engine Technology
AST	Air Staff Target
AURA	Autonomous Unmanned Research Aircraft
BAE	British Aerospace
C2	Command and Control
CEO	Chief Executive Officer
CFE	Conventional Forces in Europe
CSBA	Center for Strategic and Budgetary Assessments
DASA	Deutsche Aerospace
DPOC	Deep Persistent Offensive Capability
DTIB	Defence Technological Industrial Base
EADS	European Aeronautic Defence and Space Company (now Airbus SE)
EAP	Experimental Aircraft Programme
ECR	Electronic/Combat Reconnaissance
EDF	European Defence Fund
EMD	Engineering, Manufacturing and Development
FACO	Final Assembly and Check Out
FCAC	Future Combat Air Capability
FCAS	Future Combat Air System
FCAS TI	Future Combat Air System Technology Initiative
FCBA	Future Carrier Borne Aircraft
FGFA	Fifth Generation Fighter Aircraft
FJCA	Future Joint Combat Aircraft
FMV	Försvarets Materielverk (Sweden's Defence Materiel Administration)
FOA	Future Offensive Aircraft
FOAS	Future Offensive Air System
FOI	Totalförsvarets Forskningsinstitut (Sweden's Defence Research Agency)
GDP	Gross Domestic Product
ICBM	InterContinental Ballistic Missile
ICT	Information Communication Technology
IDF	Israel Defense Forces
IDS	Interdiction and Strike
INF	Intermediate Nuclear Forces
IS	Islamic State
ISR	Intelligence Surveillance Reconnaissance

ISTAR	Intelligence Surveillance Target Acquisition and Reconnaissance
JSF	Joint Strike Fighter
KAI	Korean Aerospace Industries
LRS-B	Long-Range Strike Bomber
M5S	Movimento 5 Stelle (Italy's Five-Star Movement)
MALE	Medium Altitude Long Endurance
MDP	Modernising Defence Programme
MoD	Ministry of Defence
MRO&U	Maintenance Repair Overhaul and Upgrade
NGAD	Next Generation Air Dominance
NSCR	National Security Capability Review
PAK-FA	Prospective Aviation Complex of Frontline Aviation
PCA	Penetrating Counter-air Aircraft
PESCO	Permanent Structured Cooperation
RAF	(British) Royal Air Force
RDT&E	Research, Development, Test and Evaluation
SAM	Surface-to-Air Missile
SDSR	Strategic Defence and Security Review
SHAR (R)	Sea Harrier Replacement
SME	Small or Medium-sized Enterprise
SoS	Systems of Systems
TAI	Turkish Aerospace Industry
UAE	United Arab Emirates
UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial Vehicle
UCAV	Unmanned Combat Air Vehicle
USAF	United States Air Force

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