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Combat Air Power 2021: Competing Visions for the Future

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I. Context and Intent

EVOLVING PEER THREATS, new budgetary pressures and national industrial imperatives are fuelling fierce competition among combat aircraft developers. The Combat Air Power 2021: Competing Visions for the Future conference, held online on 24 March 2021, examined the key next-generation combat air approaches, including the Anglo-Italian Tempest, the Franco-German-Spanish Future Combat Air System/Système de Combat Aérien du Futur (FCAS/SCAF) and the US Next Generation Air Dominance (NGAD) programme. These three different programmes all outline an intent to eventually field a family of air vehicles which will work as an integrated system of systems to deliver future air power effects. Exactly what form this system of systems will take remains unclear in each case, although throughout the conference there were hints as to how these ideas are slowly becoming clearer in each programme.

In the US, debates remain active about whether the NGAD effort should centre around an ambitious new fighter – often referred to as 'Penetrating Counter-Air' – or existing manned designs and a range of unmanned combat aerial vehicles (UCAVs). The announcement by former US Air Force Chief of Acquisition Will Roper in September 2020 that a physical NGAD demonstrator had already flown suggests a far more rapid pace than previously predicted.[1] Meanwhile, US Air Force Chief of Staff General Charles Q Brown Jr has openly discussed the potential need to reduce the number of F-35s purchased by his service, and has asked for analysis to be conducted on the option of a hypothetical clean slate – a new multirole fighter with less ambitious capabilities – to replace much of the existing F-16 fleet instead.[2] Development of the B-21 Raider long-range stealth bomber/multi-mission aircraft also continues at pace, but with little public information available. Furthermore, the US Navy has announced the start of its F/A-XX next-generation combat aircraft effort, with additional purchases of F/A-18E/F Super Hornet Block III and EA-18G Growler continuing for now.

Team Tempest is the centrepiece of the UK's future Combat Air Strategy, but debate continues over the prominence of a piloted fighter as the core air vehicle. Italy has joined the Tempest programme, and Sweden has signed a trilateral agreement on future combat air cooperation. This means that both Italian and Swedish operational requirements and industrial capabilities will also shape the eventual weapons system(s). Within the FCAS/SCAF programme, Dassault has a dominant industrial position and is unambiguously aiming to develop a new fighter. Germany has been given the lead for the systems architecture and remote weapons carriers – a politically interesting choice given German public opinion. Here, too, the exact requirements and how the future family of systems will be developed to fit around a future fighter that replaces Rafale and Eurofighter are still unclear. However, the programme has also been beset by disagreements

1. John A Tirpak, 'Roper Reveals NGAD Has Flown, But Doesn't Share Details', *Air Force Magazine*, 15 September 2020.
2. Harry Lye, 'Reports of F-35's Demise Are Greatly Exaggerated', *Airforce Technology*, 26 February 2021.

over industrial workshare, investment levels and operational capability prioritisation, leading to rumours that the core Franco-German partnership driving the FCAS/SCAF may not last.[3]

This conference hosted presentations and debates between experts, capability planners and stakeholders from the UK, the US, France, Germany and Sweden, shedding light on the different emerging visions of future combat air within NATO. Since the threat picture is constantly evolving as Russia and China seek to erode the West's airpower edge, the latest trends from outside NATO were also examined in a separate panel. The coming year will see more major decisions shaping the next 30 years of NATO air capabilities, making it all the more vital to improve the common understanding of the potential for cooperation and divergence both inside the Alliance and out.

3. Justin Bronk, 'FCAS: Is the Franco-German-Spanish Combat Air Programme Really in Trouble?', RUSI Commentary, 1 March 2021.

II. Key Takeaways

A KEY THEME WHICH united all of the presentations during the conference was that it would not be possible to achieve the levels of survivability and lethality demanded by the likely threat environment in the 2030s and 2040s on individual 'fighter'-type platforms at a sustainable cost. The common answer to the problem was a distributed system of systems, wherein (probably) piloted fighter-type aircraft would work closely with a variety of unmanned systems such as UCAVs, remote weapons, decoy and electronic warfare payload carriers, and smart standoff munitions and sensor constellations. The hope is that by distributing the component capabilities in such a way, a combat-capable system of systems could achieve the required levels of lethality and survivability in aggregate to operate against the most lethal threats, and at a significantly lower cost than attempting to achieve these attributes with a single next-generation airframe.

The UK's Minister for Defence Procurement Jeremy Quin gave the opening keynote speech, during which he outlined the threat environment that has driven both the UK's Integrated Review[4] and also investment in the Tempest programme to provide a future replacement for the RAF's Typhoon fleet. A key element of this threat assessment was that in future combat operations air superiority cannot be guaranteed but remains essential, and thus the UK needed to invest £2 billion in the early development of the Tempest system out to 2025. He also drew attention to the UK's Mosquito UCAV demonstrator programme, which aims to produce a flying prototype by 2023.[5] Above all, he stressed the need to revolutionise the traditional relationship between government and the aerospace industry, working collaboratively from the start and leveraging digital design techniques to reduce costs and programme risk. The minister ended by emphasising the mutual benefits of the existing international partnerships with Italy and Sweden, and the fact that the UK and the wider consortium remain open to other partners joining the programme.

Air Commodore Jonny Moreton, the RAF's programme director for the Future Combat Air System (the core air vehicle within Tempest), opened the main panel discussion about Tempest by pointing out the key operational requirements driving the RAF's perspective on the programme. At the most basic level, something must be ready to replace the Typhoon force on Quick Reaction Alert to defend UK and NATO airspace past 2040. There is also a need to move to a defence-owned, sovereign digital architecture for the system so that future weapons and capability upgrades can be more rapidly and cheaply integrated as needed. The operational focus for the new system is very clearly on the air-superiority mission set, but with an explicit

4. HM Government, *Global Britain in a Competitive Age: The Integrated Review of Security, Defence, Development and Foreign Policy*, CP 403 (London: The Stationery Office, 2021).
5. Kelsey Reichmann, 'Project Mosquito Provides £30 Million Investment for UK Fighter Drone', *Aviation Today*, 2 February 2021.

acknowledgement that with the technologies and performance implied, the system should provide significantly wider multirole utility once in service. A key requirement for the system will be a significant level of dynamic autonomy in both internal systems and the loyal wingman/additive (UCAV) elements. A robust and honest discussion of how this is integrated and what the implications are for lethal autonomy is needed. Moreton closed with a summary of the ambitious challenge that has been set for Tempest – to deliver in half the time and at half the cost of legacy combat air programmes.

The Italian vision for Tempest, given by the Italian Air Force's Deputy Chief of the Non-Conventional Capability Office Colonel Michele Cesario, was strongly aligned with that laid out by Moreton. The ability to operate a stealthy, all-domain fighter to replace the Italian Typhoon force for operations from main bases and forward-deployed locations is the perceived driving need. Once again, an open software architecture to facilitate integration and interoperability between the different system of systems components was identified as essential. There was also strong agreement between the Italian and UK presenters on the central role of reliable, low probability of intercept (LPI), high-bandwidth networking capabilities to make the Tempest concept work. However, within the Italian view, an optionally piloted core air vehicle configuration was suggested as desirable, alongside a highly efficient aerodynamic layout and the option for novel future powerplants to enhance persistence in flight. Consideration of these ideas will no doubt form part of the initial option-scoping work on Tempest between 2021 and 2025.

Programme Manager for Combat Air and Senior Advisor at the Swedish Ministry of Defence Colonel Björn Wollentz noted the confidence shown by the initial investment by the UK and Italy in Tempest as a very encouraging sign for Sweden. Despite the Gripen E/F being acquired throughout the 2020s for the Swedish air force, Sweden has agreed to cooperate with both the UK and Italy on the concept and requirements work for Tempest. The planned technologies could be used to enhance the Gripen E/F as additives, just as the RAF and the Italian air force hope to use them to enhance Typhoon capabilities prior to Tempest's introduction into service. Sweden will also need to replace its existing Gripen C/D fleet in the late 2030s, with Tempest seen as a strong option for this. Furthermore, due to Saab's experience with digital design, development and manufacturing on the Gripen E/F, it can bring extremely relevant expertise and experience to the table.

On the FCAS/SCAF programme, there was a markedly less optimistic tone. Due to the tensions and sensitivities surrounding the programme at the time of the conference, official participation from the French Air and Space Force and the German Air Force was not possible. However, Ulrike Franke from the European Council on Foreign Relations and Philippe Gros from the Foundation for Strategic Research provided excellent think-tank perspectives on the project.

As Gros described, France brings distinct and specific operational requirements to the FCAS/SCAF programme, centred on the nuclear delivery, long-range strike and carrier power projection missions. These operational requirements mean that for the FCAS/SCAF to meet French needs, it must have a broader and more strike-oriented design focus than the primarily air superiority-focused Tempest project. Like the Tempest consortium, the intent of FCAS/SCAF

is to develop a system of systems, but one explicitly designed around a core fighter-type, almost certainly piloted, aircraft – now called the New Generation Fighter (NGF). The French primes Dassault and Saffran have design leadership for the NGF airframe and engines, respectively, with Germany's Airbus Defence and Space and MTU Aero Engines relegated to junior partners. The NGF is currently envisioned as larger than the Rafale, with a combat weight of at least 30 tonnes to give the range, internal weapons and sensor carriage required. The other main component of the system of systems will be 'remote carriers'. These will carry weapons, sensors and electronic warfare capabilities to augment the NGF and to cover tasks requiring the deepest penetrations into heavily defended airspace. MBDA is working on smaller, short-range carriers that fit into the category of intelligent, potentially reusable munitions. Meanwhile, Airbus has design lead for the larger, longer-range remote carriers – in other words, loyal wingman-type UCAVs. Just as for Tempest, the need for a robust LPI, high-bandwidth datalink system to network together the various components of the FCAS/SCAF is clear. However, Gros also noted that it was vital that the remote carrier components should have the capacity to complete their missions in conditions of heavy electronic interference where connectivity was denied – necessitating significant levels of AI-enabled autonomy.

As Franke explained, however, the lethal autonomy implied within the remote carrier concept is a major political problem for Germany, which cannot even achieve political consensus on arming traditional remotely piloted UAVs. Given this, the fact that Airbus has the notional lead on the remote carriers is a source of significant potential issues within the FCAS/SCAF group.[6] The nuclear delivery role for the FCAS/SCAF is also politically problematic due to the core French requirement for standoff delivery, and the potential requirement for an eventual German NATO nuclear-sharing delivery role, which would require US certification. While conceived primarily as a vehicle to cement Franco-German friendship and cooperation, the FCAS/SCAF project is currently proving to be a source of friction and disagreement. For Germany, the programme is political and industrial, with operational requirements a distant third consideration – almost the polar opposite of the French perspective. However, despite the friction, Germany's approach may prove to be the saving grace for the project, since the failure of the cooperative effort would be seen as a political failure by German politicians. Therefore, while France is committed to the FCAS/SCAF because it absolutely requires an operational successor to Rafale, Germany is politically committed to it as a symbol of European unity.

On the threat side of the future combat air spectrum, Douglas Barrie from the International Institute for Strategic Studies and Justin Bronk from RUSI laid out the developmental trends underway in Russia and China on air-launched weapons and combat aircraft, respectively. The dominant trend emerging in both fields is one of an increasingly clear Chinese lead in most areas – even in traditional areas of Russian speciality such as the Su-27/30/35 'Flanker' series of heavy fighters. Chinese advances in AESA (active electronically scanned array) radar, passive sensor and long-range air-to-air missile (AAM) technology are being combined in platforms such as the J-16 and J-10C to produce light- and heavyweight fighters which already outperform their Russian Su-35S and MiG-29SMT equivalents on most significant metrics. Russian missile

6. Bronk, 'FCAS'.

development is concentrated on overcoming more than a decade of stagnation following the Cold War and shows notable improvements with the R-37M long-range heavy AAM for the MiG-31BM and potentially the Flanker series interceptors, but AESA and imaging IR seekers are still an aspiration. Meanwhile, China has developed the highly potent PL-15 long-range AAM and regularly deploys it on frontline aircraft; it also has design work underway on a very-long-range ramjet-powered AAM and an ultra-long-range anti-AWACS and tanker AAM for use on the J-16. These Chinese AAMs also benefit from using fixed array AESA seekers, with improved performance, reliability and countermeasure resistance.

In terms of stealth technology, Russia's Su-57 offers a means to overcome most of the inherent limitations of the Flanker airframe in terms of radar and IR signature, as well as moving to an AESA sensor. However, it is still not mature, and does not offer a sufficiently low radar cross-section to compete directly with US or – increasingly – Chinese fifth-generation fighters. By contrast, the J-20A is already stealthy enough to be hard to detect against the background 'noise' of any clash between China and its regional rivals, and has the range, AESA radar and long-range PL-15 missile armament to effectively threaten US and other allies' AWACS and tanker enablers at strategically significant distances. Another important point about Chinese combat air developments is the rapid rate of iterative development, which ensures that the J-20, long-range AAMs and other capabilities, including the stealth UCAVs such as GJ-11 currently under development, will only become more impressive relative to their competitors over the next decade.

In the US, the problem is not so much the risk to any one central programme, but rather that there are too many competing requirements and programmes to fit a variety of mission sets. Director of Government Programmes at the Mitchell Institute Mark Gunzinger explained how the US requirement to be able to conduct all-domain warfare in contested environments from the outset of any conflict with major powers through to termination is driving future airpower planning choices. Both Russia and China deploy formidable integrated air defence systems (IADS) and long-range precision-strike capabilities that can threaten airbases far from their territories. These render many of the current generation of US multirole and unmanned systems ineffective in a peer conflict, except as standoff support assets. However, while the acquisition costs for F-35 are now comparable to or lower than advanced fourth-generation assets, their operating cost is much higher. The US Air Force already faces a significant fighter shortfall against identified national security requirements and the prospect of major attrition in the opening weeks of any peer clash. Therefore, strategic choices must be made around whether to prioritise replacing fourth-generation inventory with as much fifth-generation as possible, attempting to focus more on leveraging UCAVs teaming with penetrating and standoff piloted assets, or developing new air dominance capabilities to augment and eventually replace the F-22. The realities of budgets mean that these various approaches cannot all be pursued adequately. Therefore, Gunzinger's core recommendation was to shift away from the current cost–benefit analysis focus on platform numbers to an approach that focuses on cost-per-battlefield-effects. This is particularly relevant for the Indo-Pacific, given the tyranny of distance that constrains the effective sortie rate over many targets with existing aircraft types. While the US Air Force *needs* a predominantly fifth-generation fighter fleet by the late 2020s and through the 2030s, as well as a successful

NGAD outcome to augment and then replace the F-22 and a wide array of attritable, reusable UCAV-type capabilities, budgetary realities and programme constraints mean that in practice they are likely to fall well short of these needs. Hard decisions and trade-offs beckon.

Brad Martin from the RAND Corporation outlined the roots and consequences of the US Navy's focus on large carriers for maximum sortie rate generation with an embarked air group, both via the *Nimitz* class as well as its ultimate expression in the new *Gerald Ford*-class supercarriers. Air groups suited to generating a very high sortie rate over relatively short ranges to deliver direct attack, or at least short-range standoff munitions, have been the focus since the First Gulf War. However, the increasing standoff ranges in a peer conflict mandated by sophisticated adversary IADS and anti-ship capabilities make this a serious limitation in great power conflict. Relying on surface or subsurface assets for long-range precision-strike capabilities for the task group as a whole will conflict with the need to use limited available vertical launch cell volume for defensive missiles. In contrast to the penetrating asset focus of the US Air Force, the US Navy is likely to explore additional long-range standoff weaponry for carriage and launch by the tactical fighters. However, for F-35s these would have to be external and would thus destroy the stealth properties of the jet for that sortie. Big *Ford*-class carriers are likely to remain the dominant focus and shaping influence on future air wing capacities given the US Navy's intent to maintain a relatively self-sufficient integrated air wing with airborne early warning, aerial refuelling and electronic attack capabilities – in addition to strike fighters – well into the 2030s.

Returning to the UK to close the discussions, the RAF's Deputy Commander (Capability) Air Marshal Andrew Turner explained the four major shifts to emerge from the Integrated Review and Defence Command Paper from the RAF's perspective.[7] First, the establishment of Space Command; second, the expansion of combat air mass through assets such as the uncrewed Mosquito low-cost combat aircraft and 216 Squadron trialling swarming UAVs; third, an increased focus on leveraging networking technologies and approaches; and fourth, the increasing use of synthetic environments for both training and design and development work. In particular, the use of UAVs and UCAVs to increase combat mass was emphasised, in the context of the RAF's intent to move to as high a mix as 80/20 uncrewed/piloted combat air assets by 2040. Alongside the goal of boosting affordable combat mass, Turner also laid out the centrality of networked architectures to the future force plan, stressing that if something was not able to connect to the network, it should not be fielded. The intention for synthetic training to constitute the majority of training for Tempest, F-35 and other emerging capabilities is an additional part of the plan to increase affordable combat mass through reduced operating costs. However, it is also central to the security of their capabilities in a future likely to be dominated by highly capable multispectral sensor constellations that make live exercises impossible to hide from sophisticated adversary analysis.

7. HM Government, *Global Britain in a Competitive Age*; Ministry of Defence, *Defence in a Competitive Age*, CP411 (London: The Stationery Office, 2021).

Conclusions

ULTIMATELY, ALL THE next-generation combat air programmes explored during the conference face difficult choices in terms of prioritising the most critical mission sets and capabilities and accepting that certain desirable attributes are not affordable at the scale required by force modernisation, and within the funds available. The UK and Italy are betting heavily on the transformative power of digital design techniques and a new relationship between defence and industry. France and Germany are approaching the FCAS/SCAF from diametrically opposed positions in terms of driving priorities, but both see the project as essential for their own reasons. The French focus on operational requirements in particular means that the NGF component of the FCAS/SCAF is already better defined conceptually than Tempest or NGAD. The US faces a herculean task in modernising its large legacy combat air fleets, while also pushing the boundaries of capability with the NGAD project, B-21 Raider and a host of UCAV technologies.

Eventually, something will have to give, and priorities will need to be chosen, likely well short of an ideal solution. Russia faces many of the same constraints, although with a significantly smaller budget, weaker industrial base and lower level of operational ambition. For China, however, the race to match and exceed current fourth- and even fifth-generation US combat air capabilities is well underway, and the ambition to continue at the current impressive rate of improvement is not in doubt. In spite of formidable technologies, the ubiquitous system of systems approach being adopted across the board as well as generations of experience, the developers of the next generation of Western combat air will have to work hard to compete.

About the Author

Justin Bronk is the Research Fellow for Airpower and Technology in the Military Sciences team at RUSI. He is also Editor of the *RUSI Defence Systems* online journal.

Justin's particular areas of expertise include the modern combat air environment, Russian and Chinese ground-based air defences and fast jet capabilities, unmanned combat aerial vehicles and novel weapons technology. He has written extensively for RUSI and a variety of external publications, and appears regularly in the international media.

Justin is a part-time doctoral candidate at the Defence Studies Department of King's College London and holds an MSc in the History of International Relations from the London School of Economics and Political Science, and a BA (Hons) in History from York University. He is also a private glider and light aircraft pilot.