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The European Land Force Commanders Organisation

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WRITTEN BY
SEBASTIAN MORABITO

EDITED BY
JONAS HEINS

SUPERVISED BY
STEPHEN CROWLEY

Introduction

European defence planners are facing a technology sovereignty issue: the dependence on foreign combat systems. The recent kill switch controversy surrounding the U.S.-built F-35 fighter confirms this concern (Gilli et al., 2025, para. 12). Rumours posited that the Pentagon could remotely disable allied F-35s[JH1] ' software, raising fears in Europe about a hidden veto over their use (Cenciotti & D'Urso, 2025, para. 4). U.S. officials have debunked the existence of any such kill switch and affirmed that allied operators retain full control of their aircraft, but the episode has amplified European anxieties over military sovereignty (Finnerty, 2025, para. 3). This strategic backdrop rationalises European efforts to develop indigenous sixth-generation fighters and makes a case for ensuring those new systems interoperate seamlessly.

Europe now has two flagship sixth-generation combat air projects, the Global Combat Air Programme (GCAP) led by the United Kingdom, Italy, and Japan, as well as the Future Combat Air System (FCAS) led by France, Germany, and Spain. Both aim to bolster European strategic autonomy by reducing reliance on U.S. technology (D'Urso, 2025, para. 5). [JH1] However, if these programs evolve in isolation or become technologically siloed, Europe risks a fragmented airpower posture undermining the very autonomy it seeks (Ünsaldi, 2025, para. 6). European leaders recognise that future conflicts will demand coalition air operations, so GCAP and FCAS must be able to communicate from day one. As French Air Force Major General Jean-Luc Moritz, head of the FCAS program, remarked, "My dream is tomorrow [the UK's] Tempest could take control of a [French] NGWS asset" (Martin, 2023, para. 2).

In short, Europe's strategic autonomy imperative makes interoperability between GCAP and FCAS a critical priority. If these sixth-generation fighters cannot share data and operate as one networked force, Europe may see its goal of strategic autonomy compromised (Beaucillon, 2023, p. 423).

This paper begins by defining sixth-generation system-of-systems air power and tracing how the combat cloud recasts the fighter from stand-alone platform to network node. It then maps where GCAP and FCAS data architecture already converge, such as NATO Link 16, ESSOR HDR waveforms, EICACS data schemas and EPIIC cockpit interfaces. It then identifies where staggered timelines, industrial turf and EU–UK/Japan fault lines could still pull them apart. Next, it weighs the implications that fragmentation would impose on Europe's strategic autonomy, before outlining three track recommendations in the form of joint waveform trials, a federated digital twin lab chain and a standing GCAP FCAS interoperability board, all aimed at translating study insights into flight-verified standards by 2030.

1. System-of-Systems and the European Combat Cloud

Both GCAP and FCAS are conceived as sixth-generation system-of-systems, meaning they extend beyond a single fighter platform to an integrated network of manned and unmanned assets. Sixth-gen features include advanced stealth airframes, artificial intelligence (AI) for decision support, sensor fusion, and loyal wingman combat drones (Larson, 2024, para. 6). Unlike past fighters that largely operated as standalone weapon systems, these next-generation jets will function as command nodes in a web of sensors and shooters, connected through a pervasive data network often described as the Combat Cloud (Kit, 2025, para. 7). The goal is an "open, scalable, service-oriented architecture" that will allow even future platforms like the A400M transport or Eurofighter to integrate into the network (Airbus, para. 2). In essence, sixth-generation air power is defined by collaborative combat with platforms "informed as one and [acting] as one" (Paskowski, as cited in Airbus DS, 2023, para. 10) through constant data-sharing.

A shared European combat cloud can improve effectiveness across domains. The tactical or combat cloud is the latest manifestation of Network-Centric Warfare (NCW), intended to secure information and decision-making superiority through pervasive networking (Gros, 2019, p. 1). Indeed, analysts find that deploying a combat cloud can substantially strengthen a state's capacity to fight in both kinetic and hybrid environments (Fiott & Calcara, 2025, p.12) Real-time connectivity enables information superiority pooling sensor data to generate a more complete situational picture than any one platform could achieve (Indra, para. 2). This leads to decisional superiority, as AI-driven fusion of shared data allows commanders to make faster, better-informed decisions (Indra, para. 2). All nodes must speak the same language of data and trust the network. Security is paramount: communications need to be encrypted and resilient to cyberattack, prompting planners to even discuss quantum-secure communications for the combat cloud (Ünsaldi, 2025, para. 3).

To support stealth operations, data links must use low-probability-of-intercept methods. Fifth-generation jets like the F-35 had to introduce new covert links because standard radio transmissions like Link 16 would expose their location (Everstine, 2018, para. 5). Sixth-gen systems face a similar requirement: the combat cloud should transmit high volumes of data without giving away positions.

A pan-European combat cloud would represent Europe's answer to network-centric warfare, a distributed system-of-systems spanning air, land, sea, space, and cyber domains (Leonardo, para. 6). Harnessing the networked capabilities of all platforms, the combat cloud will enable allied forces to operate as a unified organism, with improved situational awareness and speed of command (Airbus, para. 7). For this vision to materialise, GCAP and FCAS must build their architectures on shared principles and compatible standards from the outset.

2. Overview of GCAP & FCAS: Parallels and Points of Divergence

GCAP and FCAS have emerged as Europe's twin initiatives to field sixth-generation fighters, each with its own consortium and timeline. GCAP was launched in 2022 as a tri-national project by the UK, Italy, and Japan, now formalised under a GCAP International Programme Office and treaty-based agency (Martin, 2023, para.5). It aims to deliver a new combat aircraft, often referred to as Tempest, by 2035, an ambitious schedule that reflects lessons from earlier programs (D'Urso, 2025, para. 30). The first GCAP demonstrator is on track for a flight in 2027 (Martin, 2023, para. 13). On the other side, FCAS is a French-German venture initiated in 2017, with Spain joining in 2019, to develop a Next-Generation Fighter and its allied systems by 2040 (D'Urso, 2025, para. 24).

Despite sometimes being portrayed as rival projects, GCAP and FCAS are better seen as complementary flagships that will serve alongside each other in Europe's future force mix. Both programs share core design principles. They emphasise an open systems architecture to facilitate upgrades and integration of new technologies over decades of service (Larson, 2024, para. 9). GCAP's fighter will replace or augment Eurofighters in Italy and the UK and operate alongside American F-35s, so it must be compatible with NATO standards (D'Urso, 2025, para. 9). Likewise, FCAS is planned to interoperate with existing fleets, with a phased rollout that will first link upgraded Rafales and Eurofighters via a new combat cloud in the 2030s, before the brand-new FCAS fighter arrives around 2040 (Airbus, para. 4). In practice, this means GCAP and FCAS will share European skies and likely undertake joint missions during NATO air campaign. Such scenarios highlight why interoperability is imperative, not optional.

There are, of course, notable differences. GCAP's inclusion of Japan gives it a broader geopolitical scope, linking European and Indo-Pacific security interests (Ünsaldi, 2025, para. 4). FCAS, in contrast, is anchored in EU strategic ambitions, but faced higher domestic opposition causing delays. FCAS Phase 1B R&D only began in 2022, and a demonstrator is unlikely to fly before 2029 (D'Urso, 2025, para. 23). As a result, analysts claim FCAS is five years behind GCAP in timeline (D'Urso, 2025, para. 23). This stagger means GCAP might enter service and start setting certain standards earlier, requiring FCAS to align with.

TThe risk of divergence is real, as having two parallel 6th-gen programs could fragment Europe's defence efforts if not carefully coordinated (Ünsaldi, 2025, para. 6). However, there are also potential benefits. Europe's dual-track approach can diversify strategic risk and create healthy competition, as long as the two projects remain interoperable and complementary. The leadership of GCAP and FCAS have already initiated some cooperation. British and French officials confirm robust technology cooperation on certain communications technologies and a joint approach to future weapons (Martin, 2023, para. 7). European industry is also overlapping companies like MBDA are developing common weapon systems like the next-gen FC/ASW cruise missile, that both GCAP and FCAS could employ (Vavasseur, 2025, para. 3).

3. Existing Standards & Initiatives: Link 16, ESSOR, EICACS, EPIIC

Building a seamless interoperability bridge between GCAP and FCAS will rely on and stretch beyond today's communications standards. At the moment, NATO air operations lean on Link 16, a tactical data link in service since the late Cold War, to connect aircraft from different countries (Gonzales et al., 2005, p. 22). However, Link 16 was not designed with stealth in mind, and it constantly emits in UHF frequencies, making aircraft using it potentially detectable. Indeed, the U.S. F-22 Raptor was built without Link 16 transmit capability. To protect its stealth, it could only receive Link 16 data and relied on a bespoke encrypted link (IFDL) to talk to other F-22s (Everstine, 2018, para. 5). Similarly, the F-35 uses a Low Probability of Intercept (LPI) link (MADL) for stealth-to-stealth communication because standard Link 16 transmissions would give it away (Everstine, 2018, para. 5). These efforts highlight that legacy links are insufficient for sixth-gen systems requirements.

Europe has taken steps toward that next generation. One major effort is the European Secure Software Defined Radio (ESSOR) program, a multinational initiative under the EU´s PESCO framework to improve interoperability of tactical communications and allow various countries' radios to run the same waveform (OCCAR, para. 1). A flagship achievement of ESSOR is its High Data Rate Waveform (HDRWF), co-developed by six European nations (OCCAR, 2023, para. 1). In 2023, NATO formally adopted this ESSOR waveform as STANAG 5651, making it an interoperability standard available to all Allies (Indra, 2023, para. 1). The ESSOR HDR waveform operates in the UHF band (225–400 MHz) and supports data rates up to ~1 Mb/s with mobile ad hoc networking and anti-jam features (Indra, 2023, para. 2). While 1 Mb/s is modest by civilian telecom standards, it represents a significant improvement over legacy links and comes with modes like radio silence (emission control) and spectrum sharing that are valuable for combat scenarios (Indra, 2023, para. 4). Yet, ESSOR mainly targets current generation needs. Its scope is now expanding to air-specific waveforms and even a study for a next-gen Multifunctional Information Distribution System for data links (Indra, 2023, para. 6). ESSOR alone may not fulfill all requirements of a sixth-gen combat cloud, but .created a European culture of cooperation and a baseline waveform standard that could be built upon for GCAP/FCAS interoperability. EICACS (European Initiative for Collaborative Air Combat Standardisation), a project co-funded by the EU under the

European Defence Fund, represents another tool. It was launched in late 2022 and coordinated by Dassault Aviation, and explicitly aims to define future interoperability standards for collaborative air combat (European Defence Fund, 2023, para 1). This three-year study brings together 37 industry and research partners from eleven EU countries to define the standards that will allow diverse air assets, new and legacy, manned and unmanned, to "operate… ever more effectively in coalitions" (Dassault Aviation, 2023, para 4). In other words, EICACS is tackling the exact challenge of connecting systems like FCAS and GCAP. The ambition is to cover the full spectrum, common communication protocols, mission data formats and AI support methods (EICACS, para. 1). Focusing on open standards, EICACS should enable a future where a Tempest fighter could securely interface with an NGF (New Generation Fighter) and its accompanying drones on joint missions. As noted in the project's description, the outcome should allow heterogeneous manned and unmanned assets to share sensor information efficiently, yielding the predictability and trust in AI-enabled decision support needed for high-tempo collaborative combat (Indra, 2023, para. 3). EICACS represents Europe's attempt to ensure that when GCAP and FCAS enter into service, they will not be separated by incompatible data architectures. The challenge will be translating EICACS study results into concrete technical standards and getting all partners, including non-EU ones, to adopt them.

Under Regulation (EU) 2021/697, EDF grants are meant to strengthen the Union's own defence-industrial base, so only entities that are established inside the EU or an associated country and not controlled by a non-associated third-country parent are eligible for support (EURLex, 2021, Recital 15). However, EU-based subsidiaries of third-country groups may exceptionally take part if they pass a stringent security-of-supply review, disclose all facilities and assets involved, and obtain unanimous Member-State approval (EURLex, 2021, Recital 16). The rule therefore puts EU and associated participants on a fast-track while relegating non-EU players, which are consequently not formally part of initiatives like EICACS, to narrow conditional derogations. For Italy, working with the UK and Japan on GCAP, any know-how it gains from these EDF projects can be passed to London and Tokyo only if the other Member States and EU institutions agree to it. That clearance matters because the Franco-German-Spanish FCAS should still be able to plug into GCAP even though the latter includes one European country outside the Union (the UK) and a partner from beyond Europe altogether (Japan).

A related effort, under the EDF, is EPIIC (Enhanced Pilot Interfaces & Interactions for Fighter Cockpit). It is not directly about communications between aircraft but is developing the next-generation human-machine interface technologies, such as advanced pilot helmets, cockpit voice and gesture controls, and even brain-computer interfaces that will feature in sixth-gen fighters (Indra, para. 1). Its relevance to interoperability is more indirect yet important

A standardised cockpit design philosophy enables pilots of different nations to understand shared data and coordinate actions. If GCAP and FCAS cockpits both leverage similar augmented reality displays or AI assistants as EPIIC explores, those pilots can achieve common situational awareness faster. EPIIC is a collaborative project with partners from France, Italy, Spain, notably excluding the UK , running through 2025. It can be viewed as an effort to ensure that whether flying a GCAP Tempest or an FCAS NGF, European pilots will interface with their system-of-systems in a comparable way, reducing the human interoperability gap (Gamble & Letcher, 2016, para. 24).

In summary, Europe is creating a set of tools to improve data interoperability. Link 16 remains the legacy backbone but is insufficient alone; ESSOR is delivering improved common waveforms for current radios; EICACS is crafting the future standards specifically for new air combat systems; and EPIIC is aligning the human integration aspect. Each has limitations. Link 16 will need complete replacement or a major redesign for sixth-gen use. ESSOR's new waveform, while an excellent start, must evolve to much higher bandwidth and LPI characteristics for the combat cloud, possibly necessitating a brand-new Combat Cloud Waveform beyond UHF radio. EICACS and EPIIC, as study projects, produce recommendations but not hardware and their success depends on GCAP and FCAS partners implementing those standards in real systems. Also, the institutional divide (EU vs non-EU) [JH1] means results from these EU initiatives must be actively shared with the UK and Japan to avoid a fragmentation. Currently, a lack of formal UK/Japan involvement in EU-led standardisation is a weakness that must be overcome via NATO channels or bespoke agreements. The next section will propose how to bridge these gaps, building on the momentum of current initiatives to ensure GCAP and FCAS form a truly unified system-of-systems for Europe.

4. Recommendations

GCAP and FCAS must converge on a shared combat cloud protocol covering data schemas and an adaptable low probability of intercept waveform family. NATO and EU frameworks such as ESSOR and EICACS provide a practical baseline, yet GCAP nations, especially the UK, require full involvement from the outset. A NATO-sponsored technical task force could draft a Combat Cloud Waveform 2040 and unified tactical data model open to allied air forces. Officials have warned against tackling connectivity in isolated silos "doing too much on a bilateral basis" (Berthon, 2023, as cited in Martin, 2023, para. 10) and instead urge including all partners to solve interoperability issues collectively. As the Dassault-led consortium stated, the aim is to "define… the future interoperability standards for collaborative air combat" across Europe (Dassault Aviation, 2023, para. 4). Both programs are already embracing digital engineering and simulation, such as Leonardo's Battle Lab for GCAP and

Airbus's simulation labs for FCAS (Leonardo, 2024, para. 5). A federated digital-twin environment linking national laboratories would enable continuous protocol assessment, early detection of incompatibilities, and mission design before hardware even exists. Modern model-based engineering makes this feasible. A virtual integrated battlespace can be flown before any physical prototype exists (Leonardo, 2024, para. 14). Routine coalition scenarios would verify that a GCAP fighter can accept FCAS remote-carrier data, pass tracks to an AWACS, and train mixed crews. Leonardo's concept of a project digital twin shows how a realistic virtual model can be used to assemble and test components long before physical assembly (Leonardo, 2024, para. 19).

A permanent GCAP–FCAS interoperability board would give this technical effort political backing. Representatives from the six core nations joined by observers from other European and NATO air forces, would align requirements, budgets, and schedules. The body would integrate outputs from EU projects, liaise with NATO standardisation offices, and plan milestones such as a late-2020s demonstrator flight linking Tempest, NGF, and unmanned systems. Its dispute-resolution role would prevent the type of divergence that separated Eurofighter and Rafale. Over time it could evolve into a European Combat Air Interoperability Directorate, supervising standards upgrades through the fleets' life cycles and signalling that European sixth-generation airpower will operate as one networked force. Because Japan sits outside EU and NATO structures, the board would need a parallel liaison channel formalised through GCAP-specific memoranda of understanding and embedded liaison officers so that Tokyo can follow developments and draw standards from the joint framework with its European partners.

Conclusion

Europe's pursuit of two parallel sixth-generation fighter projects is a bid for technological edge and strategic autonomy. To fulfil that promise, GCAP and FCAS cannot operate in isolation, and they must form the twin pillars of a unified European system-of-systems.

Analysis of programme architecture showed convergence. Both consortia adopt an open approach linking manned aircraft, loyal wingmen and legacy fleets through a combat cloud. Shared requirements cover low-observable waveforms, AI fusion and resilient encryption. ESSOR HDR, now STANAG 5651, delivers a common radio baseline, while EICACS offers a pan-European protocol roadmap. Industry overlap, typified by the FC/ASW missile, reinforces unity.

Convergence underpins collective defence. Early agreement on data models and a shared waveform lets either fighter command mixed formations, granting commanders freedom without hidden vetoes. Digital twins linking national laboratories surface problems in simulation, trimming cost and speeding schedules.

A permanent GCAP-FCAS board backed by NATO can translate studies into binding standards and stage a demonstration flying in unison before decade's end. Europe has the opportunity to positions its next-generation fleets to operate as one networked force from their first operational deployment, moving one step closer to strategic autonomy. The lesson from the F-35 debate is clear sovereignty grows when partners design interdependence on their own terms, not when dependence is imposed.

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