# C2 Air multi domain or the art of mastering complexity.

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Military operations are most often represented through the prism of actions on the field. These lend themselves more to the narrative because they give strength to the images. The armies are quite comfortable with this approach, which puts the combatants in the spotlight. In the shadows, however, there are other military personnel whose activity is decisive for the final outcome of the conflict: present at all levels of responsibility, the decision-makers have an essential responsibility for the conduct of military operations. It is at their level that the fate of crises, and even wars, is decided.

Military leaders operate within command structures, commonly referred to as C2s[1], which allow them to make decisions that frame the actions of combatants. These decisions are the result of formalized processes that include various factors, not only military ones. Command performance is described by the recent force employment concept as one of the nine factors of operational superiority[2]. Its credibility is essential in the French logic of engagement of forces, where the role of the President of the Republic, the head of the armed forces, is central. There can be no doubt in his mind about the effectiveness of military leaders, as General de Gaulle reminded us: "It is

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**1.** Command and Control: to command (give orders) and control (follow) their execution.
**2.** The other eight being: fortitude, understanding, agility, influence, endurance, lightning, credibility, mass.

still necessary (for the military leader) to have a clear enough plan himself to support his resolve. Nothing provokes interference from above more than a lack of confidence from below[3].

More specifically, C2 Air is the focus of particular attention in the context of multi-domain thinking, as it reflects our ability to design and conduct tomorrow's operations in the ecosystem that this neologism evokes. The French air operations command structure is the result of an evolution that began 30 years ago with the first Gulf War[4], and is now a reference for Western air forces. Despite the current performance of the French C2 Air Force, the challenges ahead raise questions about the future of air operations command. The French Air Force is already working on this issue, both at the conceptual level, through the dissemination of an exploratory concept on multi-environment/multi-field and connected collaborative air combat, and at the technical level, as part of the work on FCAS (Future Combat Air System).

**The result of a rich operational history: a mature and efficient contemporary Air C2**

Similar to what happened at the level of the joint forces, the chain of command for operations within the Air Force underwent a real transformation after the 1991 Gulf War. Until then, the armed forces, and in particular the Air Force, were very much focused on the protection of the homeland, but this conflict made it clear that progress had to be made in order to command operations that could involve them thousands of kilometers away from France. In this respect, while the 1972 White Paper was that on deterrence, the 1994 White Paper was clearly on deployment and projection. Published in the aftermath of the Gulf War, twenty-two years later, it represents a turning point in the French strategic vision.

The Air Force and its operational command then shifted away from the use of conventional combat aircraft, which were largely reduced to support ground forces in the face of the Soviet divisions that were expected to pour through the Belfort gap.

The exercise of command at the time was based more on the quality and experience of the leaders than on the actual structures and processes at their disposal. Therefore, in 1994, the Air Force created the Air Defense and Air Operations Command (CDAOA), grouping together the planning and conduct of operations to protect the national airspace, and to conduct air operations. The air operations chain of command [5] subse-

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**3.** C. De Gaulle, *Le fil de l'épée*. Paris, Plon, 1996, p. 127
**4.** L. Péna "Between geostrategy and technology, the evolution of the command and control of French air operations since 1991", *Revue historique des armées*, n° 301, vol. 4, 2020, p. 2-14
**5.** This article only deals with conventional air operations.

quently continued to perfect its operating methods, in keeping with the reality of operations. In 1999, the war in Kosovo highlighted the need for robust targeting, as their characteristics and their vulnerabilities became a necessity for the coalition. In the aftermath of this war, France created the CNC (National Center for Targeting), a joint unit under the command of an Air Force officer. Later, operations in Afghanistan underlined the need for command structures capable of managing fire support missions over a geographically vast area and for the benefit of a multitude of actors on the ground and in the air. In this respect, after Kosovo, the engagement in Afghanistan demonstrated the operational value of UAVs[6].

In 2011, as part of Operation Harmattan, the Air Force operations chain of command conducted strikes around Benghazi. Throughout this operation, it demonstrated its ability to fight with the air support systems of the French armed forces, the Navy Air Force and the French Army's Light Aviation (ALAT), as well as its ability to work within the NATO command structures. This capability was confirmed the following year when they assumed responsibility for the NATO alert by implementing the Air C2 of the Nato Response Force (NRF). When Operation Serval was launched in 2013, the French Air Force responded to the urgency of the situation by planning the strikes that stopped the rebel columns heading towards Bamako in the very early hours of the engagement, carried out by aircraft that had taken off from the French mainland. Since then, it has operated a single command center, located on Mont Verdun North of Lyon, from which all conventional air operations conducted by France are now commanded, specifically long-distance missions such as exercise Skyros, air operations in the Sahel, but also, in 2018, the Hamilton mission against Syrian infrastructures.

Over the years, the French C2 Air Force has expanded to encompass the use of all types of vectors, and the planning and conduct of missions assigned to a modern air force, using satellite-based resources. Air C2 is systematically involved in joint and even international operations, and is well versed in command methods, both the highly vertical methods of French joint command and the more horizontal methods of cooperation between various components. Its processes are fully compatible with those of the upper levels and those of our main NATO allies, since they are modeled on them. The chain of command of an army is one of the factors of operational superiority that sets it apart. Today, the French Air Force has a proven command capability, which, on a daily basis, plans and conducts operations on or from national territory, sometimes thousands of kilometers away from mainland France; "this capability makes the Air Force a major military force, without equivalent in

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**6.** The Air Force acquired Israeli *Hunter* drones in 1995.

Western Europe".[7]

But this superiority factor is not "rust-proof" since performance is constantly being called into question by the reality of operations. Just as our Air C2 has continued to adapt since the Gulf War, it must continue to evolve to meet future challenges (changing geostrategic context, extension of conflicts to cyber and exo-atmospheric arenas, impact of new technologies, etc.). These developments will eventually form a new ecosystem that strategists will have to harness to rethink air warfare. This lies at the heart of the rationale governing the chain of command, which must conceptualize the military problem posed, place it in contemporary and future contexts, and imagine the appropriate responses, considering the levers available - whether military or not. The objective to be reached, the challenge that structures the whole approach, is therefore not the definition of the *multi-domain*, which is quite secondary[8]. The real purpose of the initiatives that the French armed forces must now implement is to identify all possible synergies between direct and indirect approaches[9] in this new ecosystem, whose effects can be applied in both tangible and intangible areas of confrontation, in order to command operations and win conflicts in the coming decades. For the French Air Force, this translates into the ability of C2 Air to command and fight in the era of FCAS, i.e., by 2040. Over the next 20 years, our command structure will have to adapt to the requirements of operations in a multi-domain operational environment, in an uncertain geostrategic context and with increasingly high-performance technological resources.

**The vision of the French Air and Space Force**

Like all Western armed forces, the national French armed forces are already examining this issue. In keeping with French military culture, the Air Force's approach is initially conceptual and not based solely on technological promises. As a technological army, born of the industrial revolution, the Air Force knows the risks of blindly relying on the temptations of technology. In parallel with work on FCAS, it has published an exploratory concept on "Connected Air Combat"[10], which includes the Global Air Combat System (GACS) and the *Rafale F4*, which will ensure the transition to FCAS.

Concerning multiple domains, the Air Force and Space Force use the distinction between environments and fields as outlined in the Force Employment Concept published in December 2020. There are the five classical environments – land, air, sea, space and cyberspace – the first four of which

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**7.** M. Forget, *L'armée de l'Air face à ses épreuves*. Paris, Economica, 2020, p.11
**8.** The expression "multi-domain" is only a semantic facility: we must be careful not to become lost in complex discussions that lose sight of the crux of the matter: how to command operations in the future?
**9.** Termed hard power and soft power.
**10.** Document #00501068/ARM/EMAA/SCPA/BPLANS/NP dated April 2020.

are subject to physical laws (Newtonian, Archimedean, Keplerian, to name but a few). To these five environments are added two others, the information and electromagnetic fields. In the French conception of the subject, the multi-domain approach thus encompasses seven spaces for maneuvers and confrontation, five of which are also environments.

At first glance, it may seem difficult to distinguish between the concepts of environments and fields. The main characteristic common to all five environments is that they have a permanent command structure that has been established or is being developed. These midfield C2s are thus able to give orders, carry out actions and generate effects[11]. A multi-domain C2 must be able to find the best synergy between these effects, obtained in one or more of the seven domains of confrontation, in order to dominate the adversary. On the other hand, the levers of action constituted by information or the electromagnetic spectrum are not used by a dedicated command structure; there is no information or electromagnetic spectrum command like the CDAOA or COMCYBER for example. However, they are fully integrated into the planning of staff working on these environments, and into the planning work of operational or strategic level command structures.

The number of combinations of possible modes of action increases as the number of areas of confrontation is extended. In the not so distant past, one fought on land, in the air or on the sea with combinations of actions coming from these three environments, to which can however be added the manipulation of public opinions through propaganda. More recently, these traditional environments have refined their modes of action by using products from space (images, telecommunications, etc.), by mastering more and more the electromagnetic spectrum (electronic warfare, detection, stealth, laser, etc.) and by investing in the field of perceptions[12]. From now on, the multi-domain approach offers staff officers the prospect of imagining new modes of action, more difficult to counter by the adversary, because they can produce a wider range of effects in a greater number of domains. If, traditionally, a C2 seeks to pose more problems to the enemy than it can solve, multi-domain fits perfectly into this perspective. Multi-environment/multi-field combat is announced as that of controlled complexity, which we seek to impose on the adversary without suffering it in return. Imagining the most disruptive modes of action is one thing, having the means to implement them is another. The SCAF promises to be formidable in this respect, with the New Generation Weapon System (NGWS). Comprised of a New Generation Fighter (NGF), Remote Carrier (RC) unmanned air vehicles and an Air Combat Cloud (ACC), it offers a wide range of possibilities. RCs in particular combine consumable vectors, which can be used in massive

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**11.** In terms of planning, actions generate effects that cause a change of state in the opponent.
**12.** For example, through psychological actions.

numbers and/or in swarms, and UAVs that are true NGF team members (the loyal wingman concept) with valuable capabilities (reconnaissance, offensive jamming, etc.). The scope of application of these capabilities is immense and flexible. In this respect, FCAS, with its first-entry capability, brings complexity to the heart of the adversary's system.

The modes of action developed by a command structure are expressed mainly through targeting. At the strategic level, it may be a matter of defining the best option (direct or indirect) for imposing one's will on the adversary in all or several areas of confrontation. At the operational level, targeting can be translated into an optimal synchronization of effects obtained through physical destruction and psychological actions. At the tactical level, it can be expressed by the destruction of certain parts of a complex system, such as a communications system, for example. It is undoubtedly in the targeting process that the prospects offered by the extension of the fields of conflict and technological developments will provide the most decisive operational gains. In the context of a multi-domain C2, this know-how must be mastered and used at all levels of command. This requires the implementation of a single targeting process, common to all levels, guaranteeing a coherent joint approach and facilitating interoperability.

The multi-domain dimension is not the prerogative of the strategic or operational levels of command, since it is the C2s of the environments, confronted with the reality of the adversary's systems, that will detect and exploit opportunities in and through the seven defined domains. However, acting in this ecosystem does not seem compatible with an approach that would be satisfied with juxtaposing environment solutions. Thus, thinking about multi-domain must give C2 environments a joint dimension that they have too little of today. Much progress has been made in recent years in the joint design of operations. Recent engagements – Hamilton, Barkhane – leave little doubt about the need to pool the know-how and capabilities of each of our armies. But this integration must be taken further, in particular by standardizing working methods. The use of a common grammar is necessary to facilitate exchanges between armies, between levels of command, but also with our allies. The bases of this common language exist; they are practiced and taught by the French  operational referent, the French Command for Joint Operations  They are generally known to the armed forces, but are used in different ways. This method is sufficiently flexible to envisage its application in a multi-domain environment. It natively integrates the principles of the global approach, which considers a crisis through perspectives other than the sole military prism, and integrates by nature all the levers available to respond to the problem to be resolved. This methodology, inspired by NATO's, applied by the French Air and Space Agency, offers the best basis for developing processes adapted to the multi-domain environment, where,

for example, simulation, serious gaming and artificial intelligence can constitute interesting auxiliaries.

Beyond the method, all national armies are moving towards greater digitization of their combat tools. In its "Connect@Aero" concept, the French Air Force is developing the idea of a cloud that will enable the pooling of useful information for all its vectors. The Air Force is considering interoperability and interfacing its future tool with those of other armies and its allies. Interoperability is essential to the joint multi-domain approach. This takes on its full meaning in the search for a shared, joint-level vision of the multi-domain operational situation, which would be permanent. The Air Force advocates the permanence of the multi-domain model. It is not a matter of "doing multi-domain" at the start of a campaign or in the context of a major engagement, and then returning to a traditional form of command afterwards, when the advantage is gained or during "rustic-type" engagements. The essence of tomorrow's C2 is not going hybrid, high intensity or counter-terrorism; it is all of these. It must be able to deal with any type of threat by evolving in, and with the help of, the seven confrontation domains.

The multi-domain approach must preserve the flexibility of adapting C2 to the changing status of a crisis, and even to the type of crisis itself. We can therefore imagine a joint[13] *master cloud*, which can be adapted to different situations*, in the *form* of *theater or contingency clouds[14]*, based on the needs of clouds of different armies, as required. The basic idea is to be able to have a permanent assessment of a multi-domain situation. Technology offers us the possibilities to meet this ambition, to permanently "scan" the battlefield in all domains. The capacity to process information rapidly and massively, as promised by artificial intelligence and quantum computing, leads us to believe that real-time management of the multi-domain space is no longer really science fiction; having an operational vision of moment-by-moment and permanent interests is now accessible.

As can be seen, thinking about the multi-domain approach is leading to changes in the traditional scope of an service C2. The most significant of these changes concerns its ability to handle effects, whereas until now a tactical C2 was more restricted to actions.

**The future principles of command**

The French Air and Space Force is also considering revamping their own command principles. The command of French operations is centralized at the strategic level and induces an essentially vertical flow of information[15],

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**13.** Even interdepartmental.
**14.** Which must therefore be made impervious to any intrusion.
**15.** The term "information" has a very broad meaning here: information, orders, transmission of working documents, etc.

between the strategic, operational and tactical levels, both "top-down" and "bottom-up". The multi-domain approach leads us to reflect on how to adapt current command relationships. The synergy of the effects obtained in (or thanks to) one or more of the seven confrontation domains raises the question of the exercise of command at the level of the armed forces. Relationships between environmental commands, on the one hand, and with the joint level, on the other, undoubtedly deserve to be adapted and the environmental culture also needs to be better shared. Tomorrow's decision-maker will be imbued with the characteristics and capabilities of the different environments. They will therefore need to have followed a path that enables them to master the multi-domain spectrum.

At the same time, the complexity of the action of the armed forces in all areas of confrontation will lead, according to needs, to more subordination to the lower echelons, in particular tactical. Some operational concepts and decision-making will be shifted closer to the battlefield, contributing to a more horizontal chain of command. The digitization of the battlefield, the connectivity of tactical units regardless of the service to which they belong, the implementation of informational clouds and the robustness of transmissions will promote the global understanding of tactical units, a better awareness of the multi-domain operational environment. Thus, from a pyramid architecture, the chain of command and control of operations will evolve towards an architecture with a very broad and meshed base, similar to a spider's web.

Airmen believe that the development of greater subsidiarity is a doctrinal opportunity to be more effective in decision-making by giving the tactical effector the means to make decisions that structure the course of operations-decisions traditionally made by higher echelons. The principles that have until now set the pace for the functioning of an Air Command structure are the centralization of command (a single leader, regardless of the origin of the air assets deployed[16], and centralized design) and control[17] (monitoring the execution of orders and evaluating results). The execution of orders by combat units remains decentralized at their level. This mode of operation has proven its worth in guaranteeing concentration, selectivity of effort and economy of means.

However, it can be cumbersome, and the issues described above – specifically the permanent updating of the multi-domain operational situation – militate in favor of making it evolve towards greater subsidiarity. There are two essential conditions for achieving this distribution. The first is the train-

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**16.** As was the case, for example, during the first Gulf War.
**17.** Not to be understood in the sense of air traffic control performed by controllers in control towers.

ing of decision-makers at the tactical level. Today, they are far removed from central-level thinking, focused on considerations of tactical expertise, and rarely have a detailed understanding of general air maneuvers. In order to broaden their contribution to the air campaign, they should be familiarized as soon as possible with the functioning of a multi-domain air operations command structure and with the methodology mentioned above, which, as we recall, still must be adapted. This theoretical approach will allow them to consider the mission in which they are going to be engaged with a more complete viewpoint than they have today: not only through the technical-tactical prism, but with the awareness that their decisions could have a structuring impact on the operation in progress, whereby they would become, as it were, "strategic lieutenant colonels". To ensure the relevance of their decisions, the theoretical approach must be made concrete throughout the operation itself, through close exchanges amongst the staff, grouped around the head of the multi-domain C2 Air Command, and these tactical-level decision-makers. They must be constantly informed of the component commander's intention so that their decisions are naturally in line with their leader's vision.

The second condition is technological. It is necessary for the tactical decision-maker to have access to useful top-down information at the best moment to make a decision. At the tactical level, information management is decisive, given the direct contact with the adversary and the very short decision times in the cockpit of an aircraft. Only useful elements must therefore reach him, in an orderly and timely way. Connectivity between the different actors (fixed, in-flight, manned or unmanned), artificial intelligence developed as a decision aid and data management as imagined for FCAS must enable the transfer of responsibility. The connectivity between all the air vectors in the first circle (i.e. in contact with the adversary), those in support (second circle) and the air command chain on the ground, makes this very significant change in current command principles technologically possible.

The problem of information management also arises in the upward direction, from the effectors to the component commander. We have seen that the ability to have a permanent multi-domain situation assessment gives a real operational advantage. In order to give the commander of an operation the ability to make decisions, this assessment must be complemented by an evaluation of the effectiveness of the operations in progress. The evaluation function is generally the weak link in command structures. It is difficult, subjective, and yet essential to allow the military leader to orient the operation and make any necessary corrections. The multi-domain nature of the problem makes it even more complex: while there are effects that are fairly simple to measure (the production capacity of a power plant, whether or not adversary radio transmissions are being pursued), there are others for which measures of effectiveness or performance are more difficult. This is generally

the case for actions having effects on perceptions and intangible fields and more particularly for cyber actions or actions in the information sphere.

The problem of evaluation also arises within a C2 environment. For an air force, there are currently three levels of reporting: the first during the action, transmitted by radio by the crews; the second just after the action, transmitted to the ground, generally by intelligence officers; and the last, the most exhaustive, by the staff services. It is with this evaluation that the head of the air component will be able to make decisions for the continuation of operations[18]. Just as was mentioned for subsidiarity in decision-making, the same principles - training of "strategic lieutenant-colonels", technological innovation - make it possible to envisage enriching the initial reports of combat units. Part of the analysis work that was previously done by the component staff must be taken on by the first tactical echelons in order to save time.

The joint collaborative approach mentioned, the review of command relationships outside and within the air component, raise the question of information sharing and "decompartmentalization". Whether it is used in the long term, for planning purposes for example, or in the very short term, intelligence remains the fuel for operations. Without quality fuel, the best engine cannot deliver the expected power. The enrichment of raw information by all the actors in the intelligence sphere according to a timeframe adapted to the needs of operations (medium term, long term, or instantaneous), and the dissemination of the intelligence thus obtained to decision-makers and effectors, are decisive capabilities for a multi-domain chain of command. The tools that enable the efficient processing of a large mass of information are being developed with the help of artificial intelligence and are already proving their worth. The speed of analysis, attribution and transmission remains a challenge. This last point is also related to the security of the transmission. Operational security in the transmission of intelligence or orders is essential to maintain the advantage. It is also a technological challenge in which the control of the electromagnetic spectrum is essential; the developments in progress and the progress made by laser communication, which allows the transfer of large masses of data very quickly (of the order of 2 gigabits per second) while being extremely difficult to jam, are likely to reinforce the protection of our data.

Finally, mastering time in all its dimensions is one of the challenges of multi-domain C2 Air. It must take the long term view in monitoring, planning and evaluating effects in the field of perception. On the other hand, the ability to react quickly to seize any opportunity will depend on the ability to master the instantaneous or the very short term. This is only possible if the assessment of the multi-domain situation is ongoing, requiring constant

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**18.** This is the orientation phase of the OODA (Observation, Orientation, Decision, Action) loop.

monitoring. Time management is also expressed by C2 Air's ability to reproduce work processes systematically and rigorously, an ability that is inseparable from operational efficiency. Finally, time management is expressed through the circulation of information and elements useful for carrying out missions at all levels of responsibility at a frequency and tempo adapted to the individual needs.

The French Air and Space Force is fully aware of the geostrategic, doctrinal and technological challenges that will characterize the next twenty years. The conceptual work carried out for the evolution of its operations command structure and the progress of FCAS project enable it to identify future requirements. In an innovative approach, it envisages a C2 Air Force capable of mastering all the dimensions of time with renewed command principles. While the centralization of design is maintained to guarantee the overall coherence of air action, structuring decisions can be envisaged and distributed at the tactical level. Technological advances allow for improved evaluation of air maneuvers and the circulation of data (information, intelligence, situation assessment) is favored by the use of an information cloud connected to that of other armies and the joint level. The design of disruptive modes of action in all areas of confrontation and the connected collaborative approach will confront the adversary with an operational complexity that will deny him any initiative.