Decentralisation of command and control (C2) of air operations

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For several years now, in parallel with technological developments to come, many air power stakeholders have emphasised the need, or even the inevitability, of "distributed control" of air operations. This question of distribution or decentralisation therefore represents a challenge for the design of our future system of systems as represented by FCAS and, more generally, for future air operations, whatever the platform. However, the current literature, particularly in French, contains very little detailed analysis of what decentralisation involves. This note thus proposes to contribute to the exploration of this question, mainly from a doctrinal point of view.

1. The need and opportunity to increase decisional agility

Operations, especially air operations, are experiencing a two-fold trend:

- The first is of a technical nature, with the development of **new technologies and practices to exploit information** (new networking technologies, development of combat clouds to exploit the coming tsunami of operational big data);
- The second relates to the need to manage an increasingly strategic problem: **the mass of French forces and of those of their allies has become subcritical at a time when "postures are hardening" and zones of conflictuality are expanding.** Therefore, there is an increasing risk of conventional conflict and a growing need to make deterrent mechanisms credible, whether to confront major competitors (Russia and China) for engagements under American leadership or to oppose regional adversaries — state or non-state — in unstructured spaces. The latter players also benefit from the dissemination of deep precision strike, air defence and ground attack capabilities, even rudimentary ones. Our forces must therefore become more effective and resilient. **One of the major conditions to achieve this effectiveness is to make the decision-making process more agile and to strongly reinforce synergies between elements of the process.**

The two trends combine to advance further in implementing the principles of **Network-Centric Warfare (NCW)** as set forth 20 years ago, seeking to develop a system of sensors / C2 (command and control) / effectors to achieve victory by accelerating the decision cycle.

In the United States, following the *Air Sea Battle* developed ten years ago, **the current major concept driving this progress is that of *Multi-Domain Operations* (MDO),** known since last year as *Joint All Domain Operations* (JADO). The general idea is to further develop the "Operational Agility" (the central tenet of the Air Force concept) of the force system in order to destabilise and ultimately dislocate an enemy force capable of denial operations in a given domain, according to the traditional logic of combined arms manoeuvres. Concretely, the American concept, which continues to set the tone for the capability developments of most conventional forces, is to create "kill webs" by multiplying the possibilities for combining sensors, C2 nodes and effectors, and to better integrate the space-based and cyber dimensions as well as the use of the electromagnetic spectrum. Collaborative combat is typically a part of this process.

These strategic and operational requirements, this vision of operations, as well as the technological developments currently underway, mean that future systems will rely on a greater dispersion of their elements, **a "physical disaggregation"** of their operational functions, whether this is multi-domain or, more often, specific to each domain. This is, for example, the logic behind DARPA's vast *Mosaic Warfare* project aimed at developing the technologies that will allow for the dynamic creation, during the campaign, of the kill webs mentioned above[1]. One of the essential challenges then lies in the ability to maintain coherent employment of these systems. **The Gordian knot of this trend thus lies in the C2 function**, in the way operations are planned, conducted and assessed. This has become the focus of recent US Air Force work with the concept of *Multidomain C2* (MDC2), which has been extended since last year to the US joint force level with the *Joint All Domain C2* (JADC2) concept.

It is true that the technical aspects of this undertaking represent a huge challenge. However, the main problems are most likely related to doctrine and the competences to implement this type of combat. This note will focus more particularly on the question of doctrine.

[1] Dr. Tim Grayson, Director, DARPA/STO, *Mosaic Warfare*, presentation, 27th July 2018.

2. The main principles of air operations C2

It is appropriate at this stage to explain the main principles of C2 during operations, particularly air operations.

First of all, one must refer to **the joint doctrine for the command and control of overseas contingency operations** that the *Centre interarmées de concepts, de doctrines et d'expérimentations* (CICDE) updated in 2019[2]. Generally speaking, a distinction must be made between command, which consists of defining and assigning missions or tasks to subordinate assets, and control, which consists of evaluating and adjusting the employment of these assets. These two concepts are combined at the strategic, operational, and tactical levels as follows:

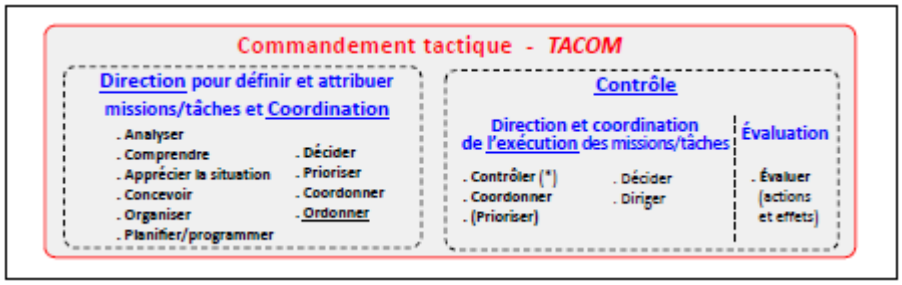
- In French doctrine, the Chief of Defence Staff (*Chef d'état-major des Armées*, CEMA) remains the permanent depositary of operational command (OPCOM) over any French service member, whether deployed or not. He defines the framework of engagement and the types of missions that can be attributed to French forces and ensures their deployment in-theatre.

- The CEMA delegates operational control (OPCON) of forces under his authority to a subordinate joint force commander (COMANFOR for a French operation) or transfers it to a coalition force commander. For the command concerned, this OPCON consists in deploying the forces under its authority within the theatre and providing overall direction for the employment of those forces: definition of the types of activities, tasks and missions, the space and time framework and the modalities of employment, all of course in accordance with the directives set by the operational commander. In general, COMANFOR delegates this OPCON to component commanders to carry out operations in their domain (land, air, sea, special operations, etc.). Among these is the *Joint Force Air Component Command* (JFACC), which must guarantee the unity of command and effort of air operations and, more generally, coordinate actions in the air regardless of the component implementing them, which distinguishes it from surface component commands.

- Next comes Tactical Command (TACOM), the authority directing in detail the employment of assets. This comprises first of all the direction and coordination of operations at the tactical level: as part of the planning process, after assessing the situation, this means defining and assigning, this time precisely, the missions and tasks to be carried out, prioritising the employment of assets and, *in fine*, issuing orders. TACOM consists, secondly, in controlling the employment of assets: this is tactical control (TACON), i.e. "*the detailed direction, normally limited to the local level, of the movements or manoeuvres necessary to carry out the missions or tasks assigned*" and the assessment of the results of actions performed. As noted by researchers Dave Alberts and Richard Hayes of the Pentagon's Command and Control Research Program, the function of control "*is*

[2] CICDE, *Commandement des engagements opérationnels hors du territoire national*, Doctrine interarmées DIA-3.0_CEO_L1_HTN (2019), n° 127/ARM/CICDE/NP, 17th July 2019.

to determine whether current and/or planned efforts are on track. If adjustments are required, the function of control is to make these adjustments if they are within the guidelines established by command. The essence of control is to keep the values of specific elements of the operating environment within the bounds established by command, primarily in the form of intent"[3]. TACOM goes hand in hand with the OPCON that COMANFOR delegates to its component commanders. Component commanders may in turn delegate TACOM to their subordinate echelons, but this is generally not the case for air assets, which remain under direct command of the JFACC.



Source: "Articulation du TACOM" in CICDE, *Commandement des engagements opérationnels hors du territoire national,* Doctrine interarmées, DIA-3.0_CEO_L1_HTN (2019), N° 127/ARM/CICDE/NP du 17 juillet 2019, p. 66

Second is the doctrine of tactical C2 for air operations. The "Gold Standard," as explained in USAF doctrine, is the principle of *Centralized Control/Decentralized Execution* (CC/DE) that was first integrated into Air Force doctrine, AFM 1-1, in 1975[4]. While TACON consists of directing and coordinating the execution of missions, the actual implementation of this execution occurs at a different level. In theory[5]:

- **TACOM (in its broadest sense, including TACON)** comprises first of all, prior to engagement, the planning processes for air operations (culminating in an air directive) and targeting (determining and prioritising effects and enemy targets to be affected). During the conduct of operations, it is then embodied in the *Joint Air Tasking Cycle* (JATC), which integrates and updates these elements of strategy, precisely determines the actions to be carried out and correlates them with the assets available in the proportions set by the air directive, allocates assets to the different missions, culminating in a *Master Air Operation Plan*. The next step in the JATC is to programme the air missions integrating the elements of this plan, resulting in the *Air Tasking Order* (ATO). The cycle continues with the execution of this ATO (*see below*) and finally with the assessment of the operations undertaken, especially their effects. Organisationally, **this cycle is centralised within the JFACC.** It is important to note that within NATO and the

[3] David Alberts, Richard Hayes, *Understanding Command and Control*, CCRP, 2006, p. 59.

[4] Michael W. Kometer, Lt Col, USAF, *Command in Air War: Centralized vs. Decentralized Control of Combat Airpower*, Air University Press, Maxwell Air Force Base, Alabama, June 2007, p. 23.

[5] See mainly NATO Standard AJP-3.3, *Allied Joint Doctrine for Air and Space Operations*, Edition B Version 1, April 2016.

French Air Force, and unlike the USAF[6], there are today few mentions of the *Combined Air Operations Center* (CAOC) as it used to be understood. It is retained by NATO in the form of deployable elements. Its functions did correspond in programming and executing air operations, contrasting with strategy development and planning performed in the other part of the JFACC. However, it will be used here for the sake of simplicity;

- **The execution,** i.e. the implementation of the ATO, is therefore a prerogative of the "CAOC", but **can be decentralised** towards the tactical nodes that will manage the actions of ISR, combat, tanker aircraft, etc. These nodes include AWACS-type early warning aircraft, the E-3 or the Navy's E-2 Hawkeye, battlefield surveillance aircraft (such as the U.S. JSTARS), ground-based control and reporting centres and warships, which integrate data from sensors, mainly surveillance radars, and can assume air defence command functions for a given sector. The Americans also have the *Air Support Operations Center* (ASOC), a dedicated centre to manage air support for ground forces, and the *Tactical Air Control Party*, including the *Joint Terminal Attack Controller* (JTAC), which supports land forces in the decentralised execution of close air support (CAS) missions[7]. A large part of this execution is also designated BMC2 (*Battle Management C2*). As a typical illustration of this decentralised execution, in the field of air defence, NATO recognises a dozen *Tactical Battle Management Functions* (TBMF) that can be delegated to these nodes: authority to identify, interrogate, act, engage, choice of weapon systems, deployment and positioning of air defence systems, control of electromagnetic emissions, management of tankers, etc.[8]

This CC/DE principle is inseparably linked to the history of air power and its institutions, but also to the characteristics of the air environment. The principle of centralised control must guarantee the unified management of a scarce resource intended to operate in a homogeneous environment. It also reflects the age-old institutional struggle of air forces to avoid dispersing the use of their resources under the authority of other components, thus destroying the continuity of air operations. The totally fragmented use of French Air Force assets in May 1940, the 80th anniversary of which is being celebrated this year, is typical of what aviators were unhappy about. Decentralised execution remains necessary, however, for reasons of flexibility: manoeuvres will be better decided by the tactical operators present on the battlefield.

For decades, the unified nature of air operations – even when achieved, based on strategic considerations – adapted perfectly to strong decentralisation at the tactical level. The latter was necessary *de facto* given the absence of modern means of communication. The past thirty years, however, roughly speaking from the end of the Cold War and then *Desert Storm*, have been marked by the difficult edification of the JFACC and its CAOC, which has

[6] In the United States, the Air Operations Center, which is managed like a real weapon system (AN/USQ-163 Falconer for the AOC regional operational commanders), clearly constitutes the technical and infrastructural substrate for the entire JFACC.

[7] USAF Doctrine, "Appendix D: The Theater Air Control System" in Annex 3-30 – Command and Control, 7th January 2020.

[8] Joint Doctrine and Concepts, JWP 3-63 Joint Air Defence (2nd Edition), July 2003.

gradually assumed the role of central controller. Lieutenant Colonel Kometer explains that it has become the "centre of calculation" theorised by French sociologist Bruno Latour, presiding at the heart of the network of air power players.

However, as mentioned in the introduction, many military and industrial players involved, on both sides of the Atlantic, in the development of future air capabilities, are calling for a change in principle, seen as inexorable by some. For them, **C2 needs to be more flexible**. Lieutenant Colonel Hinote, in a study written in 2009, in the light of lessons learned in Iraq and Afghanistan, considered that there was no single solution to the organisation of C2 and called for a major increase in decentralisation according to circumstances[9].

The *Air Force Operating Concept* of September 2015 neatly sums up the desired changes. It describes U.S. air operations in the 2035 timeframe based on the general principle of operational agility. One of the pillars of this agility is "dynamic C2": "*By 2035, enhanced battlespace awareness, improved planning and assessment, and organizational flexibility will better enable elements to self-synchronize and adapt to fulfil commander's intent. Commanders, planners and operators will have the requisite authorities, at the appropriate levels, to integrate effects. Cognitively and physically, dynamic command and control will permit fluid transitions between supported or supporting roles and between centralized control and distributed coordination. Operationally agile forces will defeat future enemy threats by fighting in a highly coordinated manner under the principle of mission command"*[10].

The French Air Force's recent exploratory concept on connected collaborative air combat also refers to a "*progressive transformation of C2 towards adaptable command structures capable of distributing responsibilities more dynamically, if necessary as close as possible to the action to ensure continuity of decision-making and guarantee the best possible adaptation to a given context*"[11].

It is widely believed that this decision-making agility should lead to **a distribution of TACON**. Among others, General Hostage, then commander of U.S. Air Combat Command, called for the implementation of this **"Distributed Control"** concept[12] in 2014. The Northrop Grumman vision of *5th Generation C2*, to accompany the arrival of 5th generation aircraft such as the F-35, points exactly in this direction, and recommends a modification of the ATO cycle (*see diagram below*)[13].

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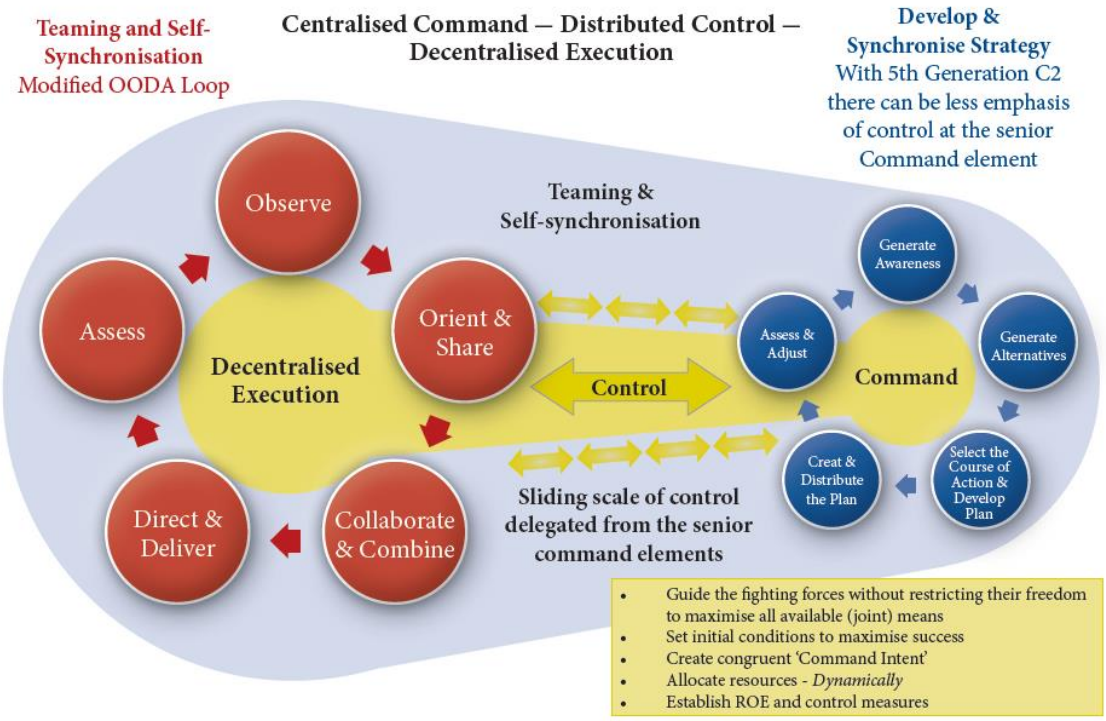
[9] Clint Hinote, *Centralized Control and Decentralized Execution: A Catchphrase in Crisis?*, Air Force Research Institute Paper, March 2009.

[10] Deborah Lee Jones, General Mark A. Welch, *Air Force Operating Concept*, September 2015, pp. 9-10.

[11] EMAA / B.PLANS, *Concept exploratoire, « Combat collaboratif aérien connecté »*, April 2020, N°00501068/ARM/ EMAA/SCPA/BPLANS/NP, p. 3.

[12] See for example Gilmary Michael Hostage III, Larry R. Broadwell Jr., "Resilient Command and Control. The Need for Distributed Control", *Joint Force Quarterly*, JFQ 74, 3rd Quarter 2014.

[13] "Integrating 5th Generation Systems Requires 5th Generation C2", Northrop Grumman, NIDV-magazine NR.3, November 2015, cited in Lieutenant Colonel Bart A. Hoeben, Royal Netherlands Air Force, *5th Generation Air C2 and ISR*, Australian Air Power Development Centre, 2017, pp. 38-39.



Source: "Integrating 5th Generation Systems Requires 5th Generation C2", Northrop Grumman, NIDV-magazine NR.3, November 2015, cited in Lieutenant Colonel Bart A. Hoeben, Royal Netherlands Air Force, *5th Generation Air C2 and ISR*, Australian Air Power Development Centre, 2017, p. 39

Some other USAF officers are even reportedly considering "*Disaggregated C2*", a much wider distribution of control involving a complete reworking of decision cycles. For its promoters, this vision would possibly lead to the disappearance of the CAOC, as it exists in the United States, or the AWACS[14].

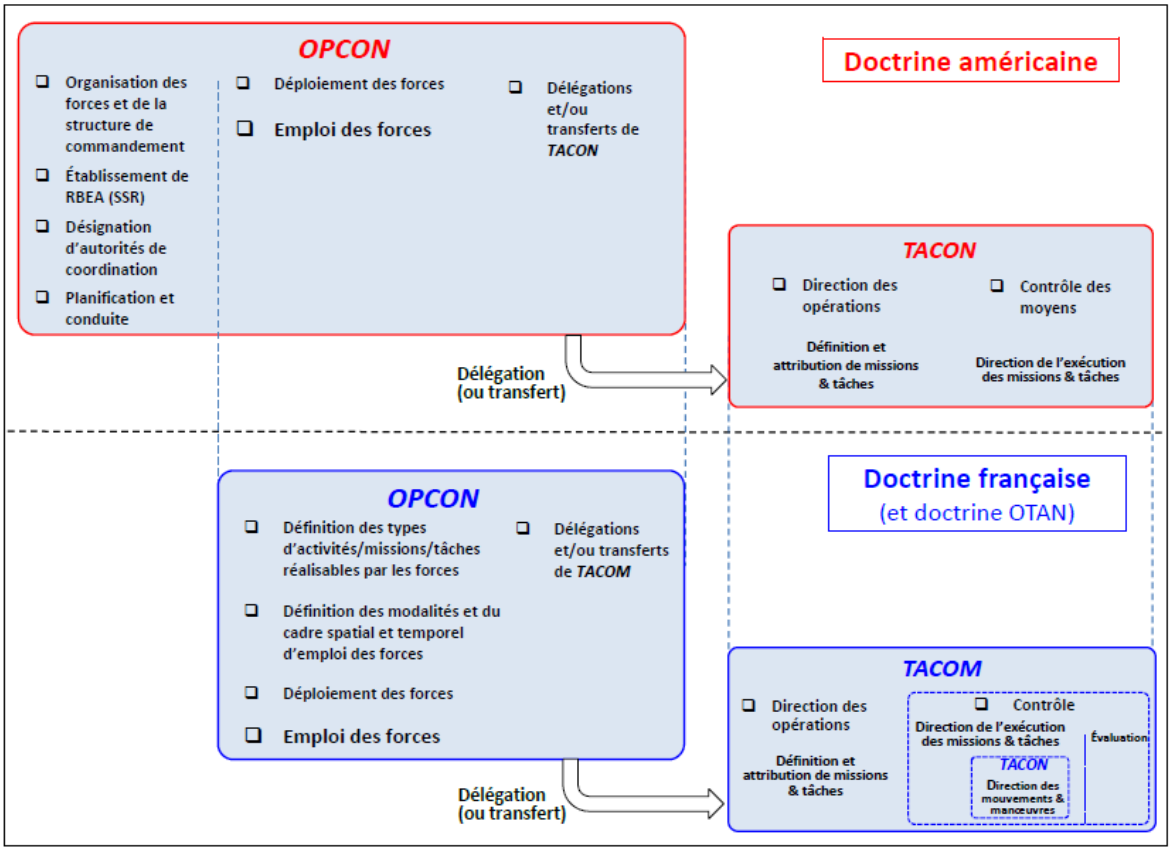
In practice, however, **even the current demarcation between CC and DE is much less clear than it seems,** according to studies carried out by officers involved in these operations, such as Lieutenant Colonels Kometer and Hinote, previously cited. Hinote has proposed clarifying the notion with the expression "*centralized command and control at the strategic and operational levels of war, decentralized execution at the tactical level*"[15]. This lack of clarity increases *a fortiori* when one considers decentralised control. Several sets of questions then arise: what does this decentralisation mean? Why decentralise? Decentralise what, to whom and in what context? Decentralise how?

[14] George I. Seffers, "Air Force Seeks Disaggregated Command and Control", *Signal*, 1st February 2019.

[15] Clint Hinote, *op. cit.*, p. 57.

3. Defining "decentralised control"

First of all, what exactly does tactical control mean? **The differences in doctrine between the dominant air power, the U.S., and its NATO counterparts, including France,** do not facilitate a precise understanding of the term. As we have seen, the French doctrine makes a distinction between TACOM and TACON, which has a smaller scope. In the French (and Alliance) sense, "*the tactical controller can neither modify the missions/tasks assigned to the assets concerned by their tactical commander, nor intervene in the execution of the missions/tasks assigned to the assets concerned, nor assign other missions/tasks to them*"[16].



Source : « C2 : Comparatif doctrine française/doctrine américaine » *in* CICDE, *Commandement des engagements opérationnels hors du territoire national,* Doctrine interarmées, DIA-3.0_CEO_L1_HTN (2019), N° 127/ARM/ CICDE/NP du 17 juillet 2019, p. 125

The American concept does not recognise the notion of TACOM, all of whose authorities are in fact part of a TACON with a much broader scope. Thus, in the debate on "decentralised control" with regard to air power, largely inspired by the actors of U.S. air power, reference is often made to the decentralisation of tasks that are in fact covered by TACOM in our doctrine.

A second factor contributing to the confusion is **the increasing overlap between the activities involved in directing the execution of operations and the execution itself.** Over

[16] CICDE, *op. cit.*, p. 70.

the past twenty years, the use of tactical data links, especially link-16 (L16), has enabled dynamic decision cycles faster than the ATO cycle[17]. This is the case for RESCO missions in the case of a downed pilot and of course strikes against fleeting targets of opportunity: *Time Sensitive Targeting* against strategically important targets, *Dynamic Targeting* against more tactical targets, undertaken in cycles of a few tens of minutes, and even *Dynamic Deliberate Targeting* introduced in Libya in 2011 against infrastructure targets determined in a few hours. Integration of the *Fix, Find, Track, Target, Engage, Assess* (F2T2EA) cycle that technically characterises these fast targeting loops mechanically implies increased centralisation of execution activities at the CAOC level. Conversely, with increasing information management and connection capabilities, those in charge of *Battle Management C2* (BMC2) tactical nodes such as AWACS sometimes already have the capability to perform tasks such as "fluid tactical control" and even "target development" for the benefit of the joint force targeting cycle, as part of the identification and surveillance functions (etc.)[18].

Clearly, this note has no intention of settling this particularly complicated doctrinal debate. However, in order to move forward in our reflections, it is necessary to arbitrarily establish a working definition that is both more granular and more global. We propose to consider that decentralisation, during a campaign, can potentially relate to:

- Mission Risk Assessment (regarding the threat and the environment), the reference in the decision-making cycle of the missions considered;
- Definition and prioritisation of tactical missions (objectives and tasks) to be carried out by the assets under control, obviously in the framework of the authority granted to the C2 node within the established space-time;
- Definition and prioritisation of the targets to be assigned and the direct tactical effects to be achieved;
- Allocation to these missions of the assets under control of the C2 node;
- Determination of the tasks to be carried out by these assets under control;
- The order given to these assets;
- Direction of the execution of the missions and tasks;
- Assessment of the execution of these missions and tasks.

We will thus refer to the tactical element(s) affected by this decentralisation as C2 nodes and not control nodes in the literal sense.

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[17] U.S. doctrine on C2 for air operations (JP 3-30) still indicates the reference duration of the JATC at 72-96 hours, which implies a duration of 24h for execution of the ATO. In practice, the duration depends on the number of sorties involved and the type of mission to be performed. These doctrines are based on major operations with several hundred sorties and including complex missions. In reality, cycles can be much shorter, e.g. in the case of an air superiority mission. They have also been shortened by the increasing use of mission planning systems in units. These can be interconnected to manage operational data more rapidly.

[18] Lieutenant Colonel Joshua W. Conine, USA AF, NAEW&C Force Command, "Future Considerations of BMC2 Must be both Horizontally and Vertically Integrated to Maximize Information Exchange and Fusion", *JPACC Journal*, Edition 19, Autumn / Winter 2014, pp. 36-41.

4. Why decentralise?

The rationale behind decentralisation is often addressed through the availability of new technologies that allow it. According to this approach based on seizing a technological opportunity, we should decentralise... because we can! If the new technologies do indeed allow new possibilities, such reasoning would be the reverse of a logical operational analysis. It is therefore necessary to go back to the strategic and operational factors underlying this need.

Decentralisation is generally part of **the need to apply,** as far as possible and to varying degrees (as we shall see), **the principle of subsidiarity,** the vaunted Mission Command, or command by intent, which already guides decentralised execution. This is a principle that has long been recommended, inherited from the *Auftragstaktik* developed in Prussia during the Napoleonic era. As the French doctrine states, subsidiarity "*aims to grant each level of command the freedom of action indispensable to the proper execution of missions received, by delegating to it the appropriate C2 responsibilities and the most suitable functions [...], to seek the optimal effectiveness of [its] action, by making the best use of their capacities for initiative*"[19]. It is all a question of degree, however.

Beyond this general requirement of subsidiarity, an initial reason, regularly put forward to justify decentralisation, is **the resilience of the C2 function in the face of enemy attack.** First of all, the extension of the range of fires and, even more so, the increasing cyber-attack capabilities available to the major powers are said to increase the vulnerability of the CAOCs. Maintaining these centres as the sole air operations control nodal point would therefore make them critical vulnerabilities of the Joint Force. However, this argument should be put into perspective. First of all, given their critical nature, one supposes that their cybersecurity is particularly elaborate. Second, CAOCs are well-protected infrastructures, located far from putative theatres. Tactical C2 nodes operating over the theatre are much more vulnerable to kinetic threats. In contrast, cyber-electronic warfare capabilities (combining cyber-attack and electronic warfare, such as electronic intrusion), for example by attacking communications satellites and other airborne relay platforms beyond the line of sight, are much more problematic threats that could cut off the CAOC and/or other tactical C2 nodes, resulting in the functional decapitation of air operations C2 as currently designed. The degraded mode of operation required to mitigate this threat necessarily implies C2 decentralisation measures.

The second major reason is linked to the **limitations of the current, highly centralised system**. It is true that networking has enabled the CAOC to achieve an unprecedented level of feedback and fusion of threat and environment information, embodied in its *Recognized Air Picture* and the broader *Common Operating Picture*. However, this fusion does not always allow for the exploitation of opportunities and the proper assessment of risks. In a recent operation, a tactical operator was about to be engaged by an enemy system. At the same time, a friendly aircraft was transiting the effect zone of his weapons. Given the operational situation generated by L16 and displayed on his screens, the CAOC director refused to allow the tactical operator to open fire. The latter, noting that in reality the

[19] CICDE, *op. cit.*, p. 27.

friendly aircraft had in fact exited the collateral damage envelope of his weaponry, nevertheless disobeyed, neutralising an immediate threat[20]. In this case, the operator had a better perception of the threat and the risks of collateral/friendly damage from his weapons than the CAOC. It would have been judicious to leave the decision to engage to him. This example, along with many others, shows that perhaps NCW's greatest challenge over the past twenty years has not so much been the availability of sensors and information as the ability to use them wisely and in a timely manner. However, the availability of C2 analysts and experts, which is always limited, risks being even more strained in large-scale engagements, which are likely to entail the "hardening of postures" mentioned earlier and where situations of this type are likely to multiply simultaneously.

Decentralisation is therefore based on two ideas: the imperative need for an operating process in degraded mode if the CAOC is cut off from the deployed elements, or the initiative to optimise the operation of the system.

Finally, decentralisation is regularly considered vertically, in the form of delegation of authority to one or more subordinate tactical nodes of the air component. However, it may prove just as necessary from **a horizontal angle, in the context of air-surface integration (ASI)[21].** It would then result in **the transfer of authority to other components or, conversely,** from the other components to the air component. In this sense, it would go hand in hand with the full implementation of the concepts of multi-domain operations (MDO). Currently, there are in reality several MDO bubbles in each domain: each service aims to better integrate space-based support and the exploitation of the cyber and electromagnetic domains into its operations. The desired end state, as it were, of the MDO concept goes beyond this and consists of being able to integrate air, naval and land (and of course space and cyber) operations, where such integration is necessary insofar as some areas of combat retain specificities that do not require it. MDOs, by extension of the precepts of combined arms manoeuvres, consist in making effects converge, creating "windows of superiority" in one domain to disrupt the enemy's battle plan, and manoeuvring in other domains to ultimately destroy it. This search for synergies is an even greater effectiveness imperative for French forces – and those of their European allies – than for their American counterparts, following the cutbacks over the past decade.

The French doctrines already provide for C2 options to organise this synergy, such as the designation by the operational commander of a joint mission leader or entrusting the direction of a joint manoeuvre to a component command. The supported/supporting relationship with the other components, a cardinal principle of these doctrines, is then organised, whether or not in a centralised manner. In this case, the rules of these relationships are set at the operational level. Within this framework, the relationships are then implemented between components during the campaign, with the operational level intervening only to settle conflicts, if necessary. The doctrine specifies, however, that direct

[20] Real example given by an officer during an interview, presented here as a generic case.

[21] The CICDE's eponymous doctrine defines air-surface integration as "*all of the processes employed by several components, during planning and conduct of operations, to combine the operational activities of air, land and/or naval assets to fully exploit the complementarities between components and to cumulate and conjugate the effects produced by each component in order to improve the effectiveness of manoeuvres at the tactical level and the global efficiency of the joint force*" (CICDE, *Intégration Air-Surface, Air-Surface Integration (ASI)*, Doctrine interarmées DIA-3.0.3_ASI (2017), N°134/ARM/CICDE/NP, 7th July 2017, p. 8).

support does not constitute a delegation of C2. The problem is that the support provided may compete with other missions in the allocation of assets by the component providing them. However, the flexibility of this C2 is probably also one of the necessary conditions for guaranteeing our capacity to generate effects. It means considering, for example, within a predetermined framework, of course, that a naval command could receive C2 of air assets for a surface battle, or that a land-based command post could have C2 for an integrated air-land manoeuvre, or that the CAOC or a tactical air node could be given C2 for deep fires or light aviation of the land component.

Decentralised control, a key element in the evolution of Israeli air-surface integration

The example of Israeli air-surface integration over the last decade speaks for itself: the 2006 war against Hezbollah revealed a flagrant lack of interoperability between air and ground forces and insufficient close air support (CAS) training. Concerning attack helicopters, which are organic assets of the air force (IAF), the general commanding the AOC retained tactical control throughout the engagement, despite the doctrine in force and in disagreement with the Palmachim unit's commander. The fact was that the IAF AOC attached greater priority to deep interdiction missions than to support for elements on the ground. The result was a recurring lack of reactivity to requests from Army tactical commanders.

By time of Cast Lead against Hamas in 2009, practices had been thoroughly overhauled. The Army brigade commanders involved were given control over all the air support assets allocated to them by the IAF (not only helicopters but also some fighters and drones). Each commander was advised by a TACP made up of experts in the various assets and a senior officer, all seconded to him by the IAF for the duration of the operation, making the brigade command post a veritable local hub for air-surface integration. The reorganisation was accompanied by major convergence efforts in terms of procedures and terminology. Feedback was very positive[22]. It is true, however, that during this operation, the IAF was less stretched by competing operational tasks and was able to devote an essential part of its sensors and effectors to support for ground forces.

5. Decentralisation: which criteria and which missions?

Following on from the remarks above, several criteria, largely interwoven in practice, should logically indicate the degree of decentralisation. Lieutenant Colonel Hinote proposes the following: the nature of the operation, the missions for which flexibility must be preserved, the volume of assets available, the geographical range of effects, the person with the best situational awareness[23].

We will start with the latter. The optimal level of situational awareness is essential and represents one of the explanatory pillars of command by intent. Control of the actions to be

[22] Benjamin S. Lambeth, *Air Operations in Israel's War against Hezbollah: Learning from Lebanon and Getting it Right in Gaza*, RAND Corporation, 2011, pp. 190-198; 228; 264-267.

[23] Clint Hinote, *op. cit.*, pp. 59-64.

executed must logically reside at the level of the operator with the best awareness of the risks for the mission, the risks of collateral damage and the operational opportunities.

Then comes the **volume of operations**. The more they involve managing a large number of tactical actions simultaneously, the more decentralisation may be appropriate. Conversely, it is less necessary if tactical actions follow a simpler sequence, even if the number of operators involved is high.

In the same vein, the more operations are based on **relatively well-established parameters** (environment, threats, etc.), which can be planned in time (such as Deliberate Targeting, of course), the less decentralisation appears necessary. The ATO will be able to specify all the elements and decentralise only the execution of the mission by the operators. Conversely, if the situation does not allow these parameters to be precisely determined beforehand and/or if it involves managing multiple opportunity decision cycles in parallel according to unplanned contingencies, such as TST, the more decentralisation will be necessary.

Another parameter formulated by Kometer, closely associated with the previous one, is the **degree of "coupling" between operators.** Kometer thus adapts the work of the American sociologist Charles Perrow on risks in complex technological systems. Perrow has shown that linear systems whose elements are strongly "coupled", in other words closely interdependent, are better managed centrally. Complex systems (with non-linear relationships) are generally weakly coupled: they allow local innovations insofar as they do not have a major impact on the whole, or even require them to adapt to situations and limit incidents. Kometer shows that the elements of a complex system such as an air component or a joint force are in practice coupled to a greater or lesser degree depending on the situation and that this degree of coupling actually determines the need to decentralise. In conclusion of his thesis, he explains that, at the planning stage, both the JFC and the JFACC must assess whether effects and actions can be determined in advance and whether the plans require a high degree of coupling of components and tactical actors, respectively. "*When the mission can be planned in advance and requires little coupling, the details of the mission can be controlled by the AOC*"[24]. This is the case, for example, with deliberate targeting. Conversely, decentralisation appears to be the most relevant approach when the mission is uncertain or involves a high degree of coupling between tactical operators, especially with operators from other components. One obvious example is support for ground manoeuvres short of the *Fire Support Coordination Line* (FSCL, the line up to which air and surface fires must be closely coordinated).

The degree of decentralisation will therefore also depend on what might be called **"the degree of fragmentation of the space-time frame"** imposed or permitted by the operational context and type of mission under consideration. Admittedly, the air domain differs from surface domains in its homogeneity, the extreme speed of the actions that take place there, and the relative ubiquity of the players operating there. At the scale of a theatre, however, there are intermediate levels in the organisation of this space. Let us consider the counter-example of the missile defence mission: it takes place within a space frame of several hundred kilometres and a time frame of a few minutes. It requires instantaneous integration of the tasks of a number of remote actors (detection chain, C2, effectors).

[24] Michael W. Kometer, *op. cit.*, p. 283.

These parameters suggest that, conversely, **close air support (CAS) and certain types of interdiction missions would be particularly conducive to decentralisation** depending on the circumstances. In CAS, for example, most of the engagement phase is managed between tactical players: the tactical air controller (in the French forces), the JTAC, the combined arms commander, the effector and even the ISR sensor. As far as interdiction is concerned, the extension of decentralisation to the multiple authorities mentioned makes particular sense for Dynamic Targeting (including *Time-Sensitive Targeting*) and Strike Coordination and Reconnaissance (SCAR) missions, when an aircraft is dedicated to target detection and coordination of interdiction missions in a given area[25]. Control of counter-air missions, which is already decentralised through the TBMFs mentioned above, could also follow this logic depending on the threat level.

6. Capability requirements

In order to decentralise C2, it is necessary to possess the capability to do so. It requires **sufficient "depth in the command relationships"**, i.e. a significant number of C2 nodes, as Kometer explains, making this the central idea of his argument. This depth flows naturally from the ability of operators to receive, process, exploit and transmit in a timely manner the information needed to assume the authority invested in them.

This is where **technological opportunity** comes in. Writing in 2005, Kometer explains that these information exchange capabilities are not yet accessible. For the future, "*If the technology were available, the next step would be to move mini-TCT [Time-Critical Targeting] Cells (or miniteams) to airborne platforms, each of which has responsibility for missions with specific ground or special operations units or in specific areas*"[26]. This was, moreover, the idea that prevailed in the USAF with the defunct E-10 programme intended to replace the E-3/E-8/RC-135 triad. As we have already written, with their modern sensors, recent combat aircraft have already become both effectors and ISR assets. Current and future platforms such as FCAS will incrementally be equipped with more sophisticated technologies to create combat clouds, such as high-speed directional connections, on-board computing capabilities, semi-automated processing of the masses of available data and analysis tools using artificial intelligence. In theory, they should provide the pilot with the situational awareness and automated management tools necessary for these new assignments. The use of the American F-35 and F-22 as "digital quarterbacks" for 4th generation aircraft would prefigure this trend (despite the current limitations of interoperability with other aircraft).

This question of AI is therefore a decisive factor in the degree of authority of C2 that can be invested in future aircraft such as the FCAS Next Generation Fighter (NGF). For example, these on-board tools should enable operators to perform positive target identification; calculate the current tactical capabilities of the adversary and the sequence of his course of action in the zone, with predictive analysis if necessary; to merge and automatically integrate the status of the sensors and effectors under their authority, along with the

[25] These are the two interdiction missions likewise identified by the CICDE as coming under ASI.

[26] Michael W. Kometer, *op. cit.*, p. 285.

various operational constraints insofar as they are quantifiable and already well identified (e.g. restrictions on opening fire, airspace coordination measures, etc.); and to coordinate tasks between operators. Thus, probably, these tools will gradually be able to provide valuable decision support in simple, or, more accurately, univocal tactical situations. On the other hand, the person embodying the role of commander or tactical controller will need advisers for a long time to come to manage the most intellectually demanding stages of this authority. Legal Advisors, of course, come to mind first of all, to assess the legal framework and implications of the action, but other advisers will be needed, too. For example, if the decision requires a detailed understanding of the enemy system, with its multidimensional causes and effects, and an estimation of the intentions underlying the adversary's course of action in progress or the domino effects of the planned action on a systemic scale (e.g. in the political, economic and societal domains), direct links with intelligence analysts will continue to be necessary. These situations would indeed require so-called "strong" artificial intelligence, which remains a hypothetical perspective in the very long term. This condition does not necessarily mean maintaining the centralisation of C2. It may be a question of organising the decentralisation of this human expertise as close as possible to the C2 node under consideration.

Besides, it should be noted that the decentralisation of C2 makes it necessary to retain manned platforms. Exclusive recourse to unmanned systems would result in a transfer of situation assessment and would therefore contribute nothing compared to the present situation.

Finally, alongside the development and management of C2 decentralisation methods, the CAOC will in any case have to continue to express its intent as clearly as possible in the ATO.

Capability requirements go much further with regard to possible transfers of control between components. These would require a **much higher level of joint interoperability than currently exists.** The problem is not confined to the technical realm of IT and communication systems. It concerns perhaps even more the "cognitive" realm – the institutional cultures of services whose officers still have great difficulty understanding each other – and, in the resulting normative operational realm, that of tactics, techniques and procedures. Let us take the example of CAS, a multi-domain mission if ever there was one. It has been one of the most widely practiced combat missions for the past fifteen years, and the armed forces have a common joint (and allied) doctrine. However, work on the development of the tools for digitally-aided CAS mission has highlighted different perceptions by the French air force and army on the details of supported/supporting relationships, e.g. on situational awareness requirements during the mission, and on the way to achieve convergence between their information architectures. Extending this operational integration to other intelligence or fire support missions would therefore be particularly complicated.

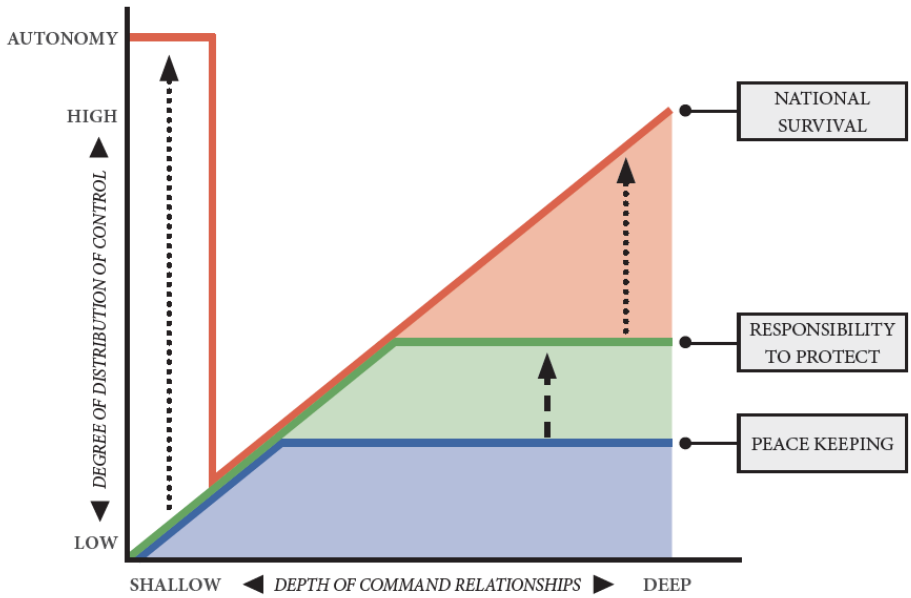
Even if these measures do indeed see the light of day, it will be of critical importance to **develop and maintain the skills of personnel to take on these decentralised C2 authorities.** Delegation would already be a major challenge if we consider the air component alone. Maintaining the "depth in command relationships" in practice will make it possible to develop the learning curve for these prerogatives. The question of transfer between components is even more acute given the already glaring lack of joint exercises.

Finally, not only training but also data management architectures and strategies must take into account **the case of imposed decentralisation**. In particular, this will mean prioritising the programming of C2 nodes at the planning stage with the maximum amount of information (e.g. intelligence, "historical" data, threat patterns, etc.) and limiting the flow of critical information from the CAOC for these different C2 authorities during the conduct of operations. In other words, resilience should logically build on a strong informational autonomy of decentralised C2 elements.

7. Limits of decentralisation

The requirements that we have just mentioned contain in themselves a whole series of limitations or conditions for the exercise of decentralisation. But there are others.

The first lies in the political and strategic control of the operation, which is reflected in particular in the **degree of constraint of the rules of engagement and the risk assessment mission**. Lieutenant Colonel Hoeben of the Royal Netherlands Air Force even makes this an essential criterion. Thus, in peace operations or even Responsibility to Protect operations that are characterised by very restrictive ROE, decentralisation of a good number of authorities – starting, of course, with that of clearance to strike a target – will be less common. On the other hand, decentralisation will be all the more admissible, even necessary, when the achievement of strategic objectives presupposes allowing the force system to operate at the full extent of its military capabilities, for example in a high-intensity engagement[27].



Source: Lieutenant Colonel Bart A. Hoeben, Royal Netherlands Air Force, *5th Generation Air C2 and ISR,* Australian Air Power Development Centre, 2017, p. 52

[27] Lieutenant Colonel Bart A. Hoeben, *op. cit.*, p. 52.

Political and strategic constraints may affect decentralisation in another way. The discussion so far has generally been implicitly based on a force with well-integrated, relatively homogeneous elements, demonstrating a good level of interoperability. However, in practice, the reluctance of our Western political authorities to commit their land forces has led to a range of operations characterised by heterogeneous arrangements in which Western air power and even ground fire support local manoeuvre forces, as in the case of Operation *Inherent Resolve* (OIR) in Iraq and Syria. These situations considerably complicate the degree of coupling with these tactical actors and are likely to reinforce the CAS mission control centralisation[28].

Another constraint arises from the **information disclosure rules** governing access to intelligence and relevant operational information. On the one hand, these info-sharing limits represent a glass ceiling for multinational interoperability, and on the other, they also constrain exchanges between units covered by different security domains (Secret level for air operations *vs.* Restricted level at the tactical edge of land operations). This is an ongoing challenge for CAS players, for example. It is clear that the transfer of C2 to an element of another component could be all the more disrupted in view of the information flows corresponding to this authority. That said, the general trend towards standardising security levels (between France and its partners, between air and land combat domains, with the latter evolving towards the Secret level) and the development of "multi-domain" technical solutions (this time in the sense of security domains, such as software gateways) could no doubt help to break down some barriers. Finally, a central echelon also appears necessary both to **manage decentralisation** (we will return to this below) and to coordinate the authorities, as well as to **determine the allocation of High Demand / Low Density Assets** constituted by ISR support platforms or refuelling tankers.

8. The need for a dynamic direction of decentralisation

The various parameters mentioned above **do not imply that one should consider the idea of permanent decentralisation of C2, but rather that one should develop decision-making agility,** i.e. providing for a function of dynamic change in decision-making levels according to lines of operations, missions and the operational environment and situation.

There are two distinct cases:

- Assignment by the JFACC, according to the delegation principle, of decision-making authority to the most appropriate C2 node(s) for the mission in question, of which it has OPCON;
- Transfer of C2 to nodes of other components if the existing arrangements (Joint Head of Mission, supported/supporting relationships, etc.) are not sufficient. Like the latter, the types of transfers would be determined at the operational level.

[28] During OIR, forward observers of the Iraqi and Peshmerga forces passed on their requests to Western JTACs… deployed in the Erbil and Baghdad command centres and had little direct contact with pilots. Only Special Forces deployed on the ground had direct control of their support (Daniel Wasserbly, "USAF: Use of F-22s Target Dependent, JTACs Crucial for Air Support", *Jane's Defence Weekly*, 30 September 2014; a situation confirmed by an air force pilot).

This direction function would take place at two levels: in a deliberate timeframe at the level of the force commander, and in a more "dynamic" timeframe within and between the different components.

In any case, for the assets for which C2 is delegated or transferred, the ATO, whatever its nature, would establish the intent and above all, as already mentioned, would have to continuously organise the provision of support resources via the various plans (ISR, in-flight refuelling, etc.), which becomes more complicated with the development of space-based support. On the other hand, the JFACC would decentralise, insofar as the C2 nodes have adequate capacities, the determination of direct effects on the targets identified as part of the mission and tasks to be carried out, the allocation of the assets provided and the direct assessment of damage.

Such dynamic management of the assignment of authority to C2 tactical nodes determines, and will be limited by, the information flows between the ISR / C2 / effector functions. One solution would be to develop *Joint Mission Threads* (JMT). The JMT is already a well-understood tool for listing the sequence of information exchanges between mission actors for the purposes of capabilities development or developing C2 architecture in operations (Mission Threads have been used for at least fifteen years, for example by U.S. joint force structures to develop their interoperability standards, or by NATO to develop the *Afghan Mission Network* and *Federated Mission Networking*)[29]. Traditionally, in the context of these applications, it is based on a doctrine and actors that have been clearly identified beforehand. In this case, it would be developed at the planning stage, using modelling and simulation tools, to dynamically determine information exchange needs in relation to decentralisation requirements in order to identify the most appropriate tactical nodes according to available C2 resources and the different conditions associated with the threats, the operational environment and restrictions of all kinds. This work would be a prerequisite to the development of C2 and communication architectures, as part of the plan or order of operations.

9. Conclusions for capabilities development strategy

It is therefore reasonable to argue that the increased demand for resilience and effectiveness of air power in the future will require a C2 function that implements decentralisation as necessary and in a dynamic manner. Several capability requirements result from this: first of all, **deeper operational integration,** in the short or medium term, implies supplementing or amending the existing doctrinal corpus (rather than rewriting it, since it already includes many of the necessary generic "building blocks") and, above all, integrating this notion of decentralisation into curricula, exercises and training.

At the same time, **this notion of dynamic decentralisation must be fully incorporated into the incremental development of "systems of systems",** starting with Connect@aéro and

[29] See for example Mark Fiebrandt (Senior Operations Research Analyst), *Measuring System Contributions to System of Systems through Joint Mission Threads*, Joint Test & Evaluation Methodology Transition (JTEM-T), 2010; or US Joint Staff, *Mission Partner Environment (MPE) and NATO Federated Mission Networking (FMN) Overview*, BOLD ALLIGATOR CAOPT, 25 June 2015.

then FCAS for air power. It must also support a true joint multi-domain way of warfare, which implies convergence with developments by French Army (SIC-S and the Titan programmes), as well as with the French Navy's approach (Axon@V / collaborative naval surveillance / collaborative naval combat). Analysis of these decentralisation requirements and the resulting information flows should therefore constitute an essential element in defining the specifications for navigation and attack systems (and their surface equivalents), network architectures and data management strategies that will be at the heart of future combat clouds.

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