

# French Air and Space Force

# Aerospace Power & High Intensity Warfare

Paris Air Show 2023

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### **Preface**

s the doors open onto the 54th edition of the Paris Air Show, this special issue of *Revue Défense Nationale* focuses on the interests of the French Air and Space Force in the current international context.

The complexity of this unsettled geopolitical environment, together with increasingly tense balances of power between states, is creating new challenges for aerospace power, which are discussed in the first part of this review.

It is essential for France to have guaranteed freedom of action in the third dimension and in space.

However, with apologies to Plato, if you seek the end, you have to want the means.

Material resources, human resources, activities and organisations need to be permanently examined, adapted and adjusted.

Moreover, the air arm and technological progress are so intimately linked that the innovations of our Defence Industrial and Technological Base (DITB) are of strategic importance to our forces.

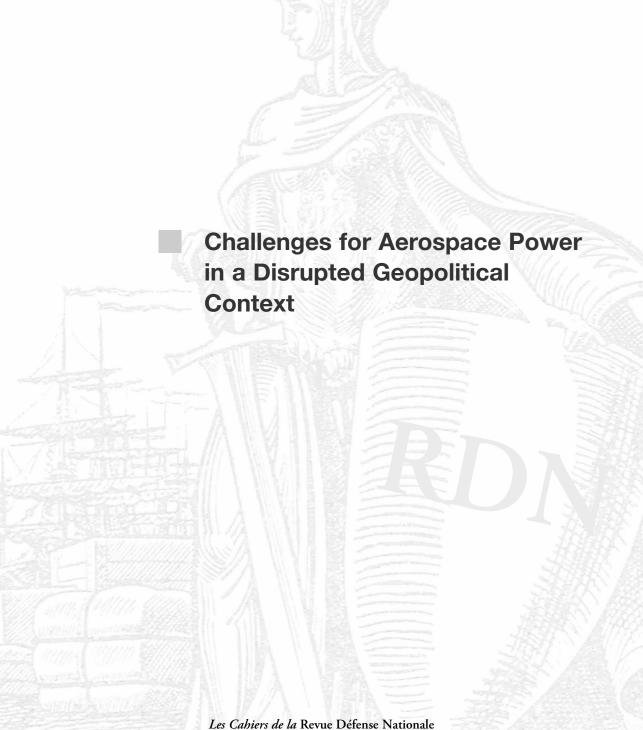
All consideration of the defence economy must allow us to breathe new life into them.

With that in mind, this edition of RDN is almost a reflection of how air strategy is conceived: starting with the objectives to be sought, it proposes a number of ways to achieve them, and offers some outlines for the future to enable us to maintain an advantage in the concert of nations.

I would like to thank those who have contributed to this edition of *RDN* for their effort in highlighting French military aeronautical and space expertise.

I wish you a good read and a pleasant visit to the Paris Air Show!

General Stéphane MILLE Chief of Staff of the Air and Space Force



#### Louis PENA

Inspector of the Air and Space Force.

Preliminary note: Général de corps aérien (NATO OF-8), from July to November 2013 the author was air advisor to Comanfor (Force commander) of Operation Serval and at the same time commander of the air detachment at Bamako. From May to November 2015, he was Chief of Staff of the Joint theatre command post for Operation Barkhane. Then from June 2018 to September 2019, as General in charge of Operations of the Air defence and air operations command (Commandement de la défense aérienne et des opérations aériennes—CDAOA), he commanded the JFAC (Joint Force Air Component) in Central and West Africa.

n 15 August 2022, at the desert operational platform (*Plateforme opération-nelle désert*—PFOD) at Gao in Mali, two soldiers hauled down the French colours for the last time. A few hours later a helmeted French soldier symbolically closed the gates of the PFOD. During the night, these and their fellow soldiers were the last to leave Mali for redeployment in Niger following the President of the Republic's decision announced on 17 February 2022.

During Operations *Serval* and *Barkhane*, French armed forces halted armed terrorist groups, besieged the sanctuary of the *Adrar des Ifoghas*, created conditions for a return to democratic life and extended the fight to five countries in the Sahel-Sahara Strip, from Mauritania to the borders of Libya. The French Air and Space Force (*Armée de l'Air et de l'Espace*—AAE) was present even before the start of operations on 11 January 2013 as a key player alongside special forces in the blocking movement against armed terrorist groups attempting to swoop down on Bamako, and contributed to this activity in the skies over Africa and on the ground.

What follows is not exhaustive but retraces the activity of the AAE throughout those nine years. It covers the contribution of all airwomen and men, operations in Central and West Africa and highlights a number of salient points.

#### A Military Intervention: Envisaged, Though not the Preferred Choice

The anticipatory work done by the Joint Forces Staff (*État-major des armées*—EMA) led to a 2009 draft strategic plan for the Sahel, and thereafter to some operational planning.

This work called upon elements regularly updated from several sources, including those of the French Air Force which at the time had not yet added *and Space* to its name. During 2011 and 2012 missions were programmed to start from mainland France, to be triggered in agreement with the Centre for planning and conduct of

operations (*Centre de planification et de conduite des opérations*—CPCO), and planned, programmed and conducted by the Air defence and air operations command (*Commandement de la défense aérienne et des opérations aériennes*—CDAOA). In addition, the regular transport aircraft activity in the western part of Africa improved our knowledge of aerodromes in the region, their condition and their capacity. The air activity of the *Mirage F1* during Operation *Épervier* in Chad, from 1986 to 2014, afforded good knowledge of the eastern area of the Sahel and other possible areas of interest.

During 2012, Mali plunged into a darkness that directly threatened regional balance and indirectly, European security. Faced with this situation, France was diplomatically very active towards its European partners in order to create the European Union Training Mission, and also with the UN. UN Resolution 2085 was adopted on 20 December 2012: it provided for a one-year deployment of the African-led International Support Mission to Mali (AFISMA).

Whilst not the preferred political option, a possible military intervention was examined. It was decided to deploy one of the Air Force's four *Harfang* drones to the base at Niamey from the beginning of 2012. In N'Djamena, three *Mirage 2000D* (conventional attack version) were added to the two *Mirage F1CR* (reconnaissance), *C-160 Transall* (transport) and eight *Puma* support helicopters usually deployed. Two Naval *Atlantique 2* (surveillance) were sent to Dakar. Naturally the alert elements of the French forces, the so-called *Rapace Cell* of the Air Force, were ready to reinforce these measures if needed. The forces had a good idea of the missions they were to be tasked with (the *Mirage 2000D* had already had several training sessions on stopping and neutralising columns of trucks), and had good knowledge of the theatre in which the missions would be conducted. They also knew that they would have very short notice of pre-positioned special and conventional forces.

Finally, on 11 January when asked by Dioncounda Traoré, the President of Mali, who sought immediate airborne intervention, and having received a blank cheque from the UN Security Council emergency meeting of the previous evening, France decided to intervene militarily to halt the terrorist incursion. The forces, and in particular the Air Force were not caught off guard since the combat aircraft deployed in Chad had been on alert since 9 January. There were six Mirage 2000D, rather than the planned three, because the rotation planned for 9 January had been put off in order to keep aircraft and crews in Chad.

#### Air Force Strikes in a Few Hours, even from the French Mainland

On 11 January, helicopters of Special Operations Command rapidly intervened in mid-afternoon in the Konna region and were able to stop the jihadists but at the cost of losing one of their own men.

The aircrews who had been standing by their armed aircraft since the morning, took off at 8.15 pm, and more followed them an hour later. After two essential inflight refuellings, given the distances to cover, the first wave destroyed the HQ of Ansar Dine in Konna just before midnight. The second wave continued the effort and

erased a number of jihadi logistic centres from the map. In addition to this physical strike was the psychological effect on the rear: it was completely undetectable at night until the firing started.

The same Friday, and at the same moment as those *Mirage 2000D* crews were walking out to their aircraft, crews of Air Base 113 at Saint Dizier received the order to stand by. They had to fly to Chad on a mission which would overfly Mali. Four *Rafale* took off at dawn on Sunday 14 for a 10-hour air raid, routed to the west of Algeria. They destroyed some twenty targets<sup>(1)</sup> before landing at the base at N'Djamena. The mission involved the air bases at Saint-Dizier, Mont-de-Marsan and Istres, which almost instantaneously transferred from a peacetime to a war footing. Once again, the model of the air base as an element of combat proved its relevance.

From the following day and for two nights, Special Operations Command helicopters and Air Force aircraft operated together to neutralise a second jihadist column near Diabaly. The terrorist offensive was crushed and the initiative passed to regular Malian forces supported by French aircraft and special forces troops.

Combat aircraft intervened again in the north of Mali at the beginning of February in support of French ground forces coming from Chad, Côte d'Ivoire and mainland France, accompanied by Malian and Chadian soldiers. They cleared the jihadist sanctuary of the *Adrar des Ifoghas*. After some very intense combat, the coordination of fires between aviation and artillery and the determination and professionalism of the ground troops put paid to this terrorist bastion.

The effectiveness of combat aircraft was proven throughout operations in the Sahel. *Rafale* and *M2000* aircraft ensured on-alert and planned support to forces in the Sahel—African and French, special and conventional—and also on the periphery, in support of our troops and those of our allies as required.

#### Military Air Transport in All its Dimensions

Whilst French forces were not caught napping, it is no less true that the in-theatre assets immediately available were insufficient to carry out the mission required by the political level. Plans were for the deployment of more than 4,000 men and 20,000 tonnes of freight to Bamako in just a few weeks. (2) Sixty per cent of this logistic effort was performed by military and chartered air transport. Air Force transport aircraft carried almost half of the required freight. (3)

During operations in the Ifoghas, eleven tactical transport aircraft were used every day, two of them for water alone.<sup>(4)</sup>

<sup>(1)</sup> Ammunition and logistic depots.

<sup>(2) 10,000</sup> tonnes were transported in 3 weeks, the equivalent of what was withdrawn from Afghanistan in a year.

<sup>(3) 53</sup> per cent of freight was transported by our partners.

<sup>(4)</sup> Of which, 47 per cent supplied by our allies.

Throughout operations in the Sahel-Sahara Strip, airborne logistics played a central role in the support of our strongpoints, scattered islands in an ocean of sand. Aircraft remained the indispensable solution in the face of the challenges posed by overstretch, the difficulties of the rainy season, the poor road infrastructure and the terrorist threat. For all of those, the A400M *Atlas* opened up new perspectives for transport inter- and intra-theatre. In the same way, the multi-role aspects of our aircraft meant the Multi Role Tanker Transport (MRTT) *Phénix* was able to carry out refuelling and strategic transport tasks during the same flight, if needed. These aircraft were particularly in demand during the final redeployment, when French forces left Mali. Just over 300 flight rotations were needed (some 12 per cent of the total effort, the remainder being transported overland) of which two-thirds were performed by the AAE.

Nevertheless, during the first few days the transport aircraft were also used on very demanding joint missions.

On 25 January, a combined operation of combat aircraft, helicopters, transport aircraft, and special and conventional forces took Gao airport. After members of No.10 Air Parachute Commando (CPA10) had assessed the state of the runway and identified a section suitable for aircraft to land, two waves of aircraft performing assault landings and take-offs landed special forces to seize the airport, followed by men of the 1st Parachute Regiment (*Régiment de chasseurs parachutistes*—RCP).

Then, on 28 January, a combined air group consisting of an AWACS, a *Harfang* drone, combat aircraft, a C-135 refuelling aircraft and an *Atlantique 2* deployed over Mali. They were supporting a night-time air-drop operation of nearly 250 soldiers who were to be parachuted without any ground markers from five C-160 *Transall* and C-130 *Hercules* transports out of Abidjan. Their action, and that of the ground troops who had seized the airport several minutes before the parachute jump, led to the liberation of Timbuktu the following day.

Airborne operations were used throughout operations in the Sahel. An A400M departing from France performed an air drop to the north of Niger in March 2019, then performed two more over Kidal and Tessalit in May 2020. Night parachute drops from the A400M were performed close to Niger, on the border with Algeria, and from the French homeland. These operations benefited from area clearance<sup>(5)</sup> performed by an Air Force drone.

These airborne operations—real missions—enabled us to refine a particular capability that France is one of the rare nations to master: the night parachute drop without ground references.

Throughout operations in the Sahel, the use of military transport helicopters and aircraft meant our troops and those of partner nations could count on MEDEVAC facilities to the closest medical posts as well as back to France.

<sup>(5)</sup> To ensure there are no threats or civil population nearby.

#### **Fully Mature Drones**

At the time operations started, the Air Force had acquired fifteen years' experience in operational use of drones. It knew just how much they could be decisive in that type of asymmetric engagement. On 17 January the *Harfang* outfit deployed in Niamey<sup>(6)</sup> launched its first flight. In addition to Intelligence, Surveillance and Reconnaissance (ISR) missions, on 29 January it made the first operational laser target illumination, guiding a *GBU12* (*Paveway*) launched from an *Atlantique 2*. Use of the *Harfang* allowed us to develop our doctrine, for example by putting a Joint Terminal Attack Controller (JTAC) together with the operators, with similar prerogatives to those of an Airborne Forward Air Controller (AFAC). Relying on the expertise and credibility of its personnel the *Harfang* outfit clocked 7,000 flying hours up to July 2016.

The MQ-9 Reaper took over from it in Niamey in the summer of 2016. The Air Force took the step of arming drones in mid-December 2019. Able to commit both to targets of opportunity and planned targets, they complement combat aircraft. Now essential to action in and from the air, Reaper crews are shifting doctrinal boundaries by assuming tactical command of committed assets when required.

#### Intelligence

The Air Force was also deeply involved in intelligence from IMINT, ELINT and even HUMINT sources in a similar way to No.20 Air Parachute Commando (CPA20), which conducted patrols around the Bamako Aerial Port of Debarkation (APOD). Air assets proved indispensable both for understanding the situation and for gathering intelligence prior to action. Drones are like gold dust for this task: their sensors, discretion and endurance make them highly appropriate for ISR in such a permissive environment. In a similar way, the light surveillance and reconnaissance aircraft<sup>(7)</sup> were of great value, largely owing to the on-board operators. The AAE put its own aircraft to work towards the end of the campaign.

In addition to these vehicles, the Air Force regularly deployed the C-160G  $Gabriel.^{(8)}$  Used initially to survey the theatre with its broad-field sensors, it was also highly successfully used for intelligence gathering for the purposes of action. Rafale was deployed from time to time with a  $Reco\ NG$  pod.

Alongside this specialised materiel, the AAE showed great imagination in intelligence gathering. The crews of the tactical transports which criss-crossed the theatre of operations were fitted with high-performance sensors in order to be able, as opportunities were presented, to photograph sites, concentrations and movements of interest. This initiative produced very beneficial results at very low cost.

<sup>(6)</sup> As stated above, the decision had been taken at the beginning of January 2012.

<sup>(7)</sup> Editor's note: specially modified Beechcraft King Air 350 turboprop aircraft.

<sup>(8)</sup> Editor's note: the 2 transport aircraft specially modified for EW and intelligence were withdrawn from service in 2022.

#### Innovative and High-Performance C2 Air Born of Operational Necessity

Since the autumn of 2012, in Lyon, where the permanent JFAC C2 organisation is sited, and in Paris, at the operational staff HQ, the CDAOA has taken part in the anticipation work mentioned above. In Chad, at the end of the same year, the Air Force created a structure aimed at coordinating future air transport activity, before the CPCO approved the creation of an ad hoc C2 Air structure called JFAC AFCO (Central and West Africa) responsible to *Comanfor Épervier* (Force commander; an Air Force colonel). Thereafter, the permanent *JFAC* and *JFAC* AFCO worked together, under CPCO's authority until the operation was taken over by the Joint theatre command post (*Poste de commandement interarmées de théâtre*—PCIAT) in February.

During this initial period, this C2 Air planned and conducted the inter- and intra-theatre transport activity of national and chartered aircraft as well as those of partner armed forces. The Air Force was thus responsible for over 70 aircraft. The C2 Air also planned the activity of combat aircraft deployed in the theatre, initially in Chad then in Bamako, as well as the mission that lasted nearly 10 hours and the airborne operations already mentioned.

Until the spring of 2014 the Air Force's command structure relied on two centres, one in Chad and the other in Lyon. The latter was in the underground National air operations centre (*Centre national des opérations aériennes*—CNOA), from where the Permanent air security posture (*Posture permanente de sûreté Air*—PPSA) is also commanded. The Chad structure moved to Lyon in 2014 and they were amalgamated in a dedicated site in 2017 before joining the European and worldwide command organisations in January 2022 on creation of the Centre for planning and conduct of air operations (*Centre air de planification et de conduite des opérations*—CAPCO).

The Air Force's C2 permitted the General Officer Commanding to take on the operational responsibilities for airspace management over combat zones and also for air defence. For airspace management, the JFAC had responsibility for air traffic in the north of Mali and had to coordinate both French and allied (US included) traffic, plus that of the United Nations Multidimensional Integrated Stabilization Mission in Mali (MINUSMA). The Air Force had the additional responsibility of optimising use of airspace over combat zones, which permitted efficient concurrent use of the space by artillery and by civil and military aircraft. Regarding air defence, the special arrangement for air security (*Dispositif particulier de sûreté aérienne*—DPSA), set in place over Bamako during the September 2013 election in cooperation with Malian forces, was coordinated by the air advisor to the Force Commander.

The knowledge acquired by Air Force personnel went beyond that of the infrastructure and information and communications systems essential to the C2 function, to include planning which, aided by experience of the permanent command structure, meant they could propose relevant ground force support operations to the Force Commander as well as effective Air Force-led operations.

#### An Air Force on the ground as well

I could not end this overview of the AAE's action in the Sahel without mentioning its sometimes ignored activity on the ground.

The Air Force ensured the operation (air traffic controllers and responsibility for air transit) and security (airborne commandos) of forward air bases, platforms essential to the activity of all French forces. As such it was in charge of the management and security of the APOD in Bamako airport throughout Operation Serval. The head of the air detachment thus became Commander of the site (Comsite), and CPA20 personnel ensured protection outside the site during their external patrols. Air parachute commandos were also deployed to remote sites such as Tessalit, and patrolled in the north of Mali or maintained permanent presence on isolated sites where the conditions were such that transport aircraft could land.

Airmen were present in special and conventional force command structures, deployed on the ground alongside their comrades to ensure best use of the air arm.

They were also heavily involved in the operational military partnership, for example, training Malian soldiers in the rudiments of advanced combat aircraft direction, and in the functioning of a C2 structure.



The nine years of operations *Serval* and *Barkhane* undeniably contributed to developing the operational performance of the AAE. Its equipment and personnel, like all deployed in the Sahel, suffered extreme conditions to which they stood up perfectly. Recent, proven material replaced older equipment and doctrines were adapted.

The most spectacular development was probably the capability of the AAE to plan, programme and conduct its operations from mainland France, a considerable contribution to the operational aspect of operations. It should be borne in mind that operations in the Sahel were conducted alongside those in the Levant, in the Central African Republic, in Europe over the Baltic States, and over the homeland during the Covid-19 crisis. That is not to forget activity relating to sending strategic messages and airborne diplomacy such as P'egase and Heifara-Wakea. (9)  $\bullet$ 

<sup>(9)</sup> Editor's note: *Pégase 2022* was the deployment of French air assets (combat, refuelling and transport) in under 72 hours to New Caledonia, then returning in the following days via Australia, Indonesia, Singapore and the UAE. *Heifara-Wakea* took place a year earlier on the same principle but to French Polynesia, then Hawaii.

#### Pascal Delerce

Général de corps aérien (NATO OF-8).

ith the Russian invasion of Ukraine on 24 February 2022, crisis returned to Europe. NATO's posture for ensuring the collective defence of Europe has been considerably strengthened as a consequence. It is unfortunate that it is often necessary to be confronted by realities on the ground in order to move the lines of battle, and this conflict is allowing us to validate a number of concepts and arguments long upheld by many national and NATO military authorities. Among them, the characteristics particular to the air environment are showing their relevance and are now more appropriate than ever.

Calling on my experience as second in command of the NATO Air Component over the past three years, I want to show how NATO, and in particular its air element, had initiated the strategic and operational moves well before the fateful date of 24 February. This major development will serve to explain how the air component responded to political expectations and was capable of ensuring the protection of the Eastern European population from the very first hours of the conflict. This crisis nevertheless demonstrates clearly the need to develop our capabilities for facing a high-intensity conflict and for ensuring our resilience.



The American General Tod D. Wolters, Supreme Allied Commander in Europe (SACEUR) from 2019 to 2022, and previously COMAIRCOM (Commander Allied Air Command), was the driving power behind the dynamic development of a new NATO military strategy and a new set of domain and region-related strategic plans. This development meant that high-intensity, hybrid and multi-domain issues could be properly taken into account, as could the permanent state of competition that exists even in peacetime.

NATO had not revised or updated its strategic plans for nearly 60 years. The framework documents of the military alliance proved largely unsuited to the current international context and the resurgence of potential crisis in Europe. Overall, the plans allowed no flexibility and could not be applied to the hybrid and high-intensity situations found today. The Military Committee's development in 2019 of a new NATO Military Strategy led to the drafting of two reference documents which took

into account the now hybrid nature of crises and conflicts, together with the need to adopt a multi-domain approach:

- first, the concept for deterrence<sup>(1)</sup> and defence in SACEUR's area of responsibility, the Deter and Defend Concept,<sup>(2)</sup> which outlines the need to conduct military activity in time of peace to make an all-round show of our presence, and to operate simultaneously in multiple theatres, and
- second, the concept for development of NATO's military organisation, the NATO
  Warfighting Capstone Concept,<sup>(3)</sup> which identifies the need for adapting the
  organisation for the next twenty years in order to keep it aligned with the threats.

This major revolution in Alliance strategy brought with it a general revision in the operational command of the set of plans which now offer SACEUR the flexibility he needs to ensure overall deterrence and prevent our competitors and enemies as early as possible from imposing their will on us.

SACEUR's aim was to make the command and control (C2) structures more agile and more flexible. It introduced the Supported/Supporting Interrelationship between the different commands as a function of the effects desired, and is defined in the Joint C2 CONOPS<sup>(4)</sup> issued in the summer of 2019. The command in the best position to synchronise and coordinate effects in time and space is the supported command, with all others supporting it. This notion allows us to break away from the rationale regarding ownership of assets, which creates much frustration and misunderstanding: it means we can focus on the expertise of each domain in the knowledge that the integration of effects is being handled by the command having best visibility. At the AIRCOM level this meant a complete overhaul of the Air C2 CONOPS. The principal aspects to be considered were agility and flexibility, reactivity and permanence, and resilience.

General Jeffrey L. Harrigian (COMAIRCOM from 2019 to 2022) wished to build a C2 structure, adaptable from time of peace through crisis and conflict situations. The principle of centralised command but decentralised execution remained the keystone of the new concept. Centralisation of decision-making at his level allows him, as commander of the air forces component, to optimise the use of critical assets by distancing himself from the areas of responsibility and allowing the transfer of certain assets from one area to another, subject to SACEUR's agreement. Delegation of responsibility and authority to lower levels is provided for in order to strengthen the reactivity and resilience of the structure. Since coordination and synchronisation with the JFC and JTF<sup>(5)</sup> will always be crucial, a Deputy Commander Air, and a team appropriate to the situation in hand, is appointed to each Joint Commander's staff.

<sup>(1)</sup> When used within NATO, deterrence does not necessarily refer to nuclear deterrence.

<sup>(2)</sup> The Concept for Deterrence and Defence of the Euro-Atlantic Area. See: https://shape.nato.int/dda

<sup>(3)</sup> Known also as NATO's North Star. See: https://www.act.nato.int/nwcc

<sup>(4)</sup> Joint Command and Control (= C2) CONcept of OPerationS.

<sup>(5)</sup> Joint Force Command and Joint Task Force: the first is a permanent structure, the second an ad hoc structure, created according to circumstances.

Work also had to be done on reactivity, the main failing identified during the build-up during 2019. The NATO Joint Force Air Component (JFAC) command structure required several days to achieve operational capacity following a decision by the North Atlantic Council (NAC) to activate it, a delay incompatible with the objectives of the NATO Response Force (NRF), the tempo of contemporary action and, above all, with the new set of strategic plans. AIRCOM therefore created a Core Air C2 capability, manned solely by personnel at Ramstein, in Germany, whose principal function is to initiate the cycle of the Air Tasking Order (ATO) while awaiting the arrival of reinforcements and setting up the JFAC.

Regarding structure, the latest joint exercises conducted in 2019 and 2021 showed that to face up to an adversary who possesses robust air defence and who is conducting hybrid action, there is a need to synchronise the effects produced by the different domains (air, land, sea, cyber, space and information), in particular by integrating non-kinetic effects into kinetic operations. With this objective, AIRCOM has developed an effects synchronisation team, and a division for non-kinetic operations whose representatives are integrated within each division of the JFAC command structure (strategy, combat plans and combat ops). This cross-domain way of operation leads to better integration of effects throughout the ATO cycle, hence optimal effectiveness of the various actions. Though still at the development stage, these structures have been activated in order to face the potential consequences of the war in Ukraine.

Extensive work on the Handover-Takeover process has been done with AIRCOM and the US Air Forces in Europe, especially to facilitate the transition between a national or coalition structure to the NATO structure or vice-versa. The concept had its first test during Exercise *Ramstein Ambition 2020*. Work continues to finalise the standardisation of operational processes and documents.



The gradual adaptation of plans and associated command structures since 2019 allowed the NATO air component to be in a position on 24 February 2022 to defend the airspace for which it was responsible. Before that date, the build-up was aided by a number of exercises and events:

- The Core Air C2 was activated on two occasions: the first, to manage the rotations of transport aircraft during the evacuation of Afghan nationals, and the second, after November 2021 to enable the prudent planning of the NATO posture in case of a Russian attack on Ukraine. These two operations highlighted the value of this organisation, through its permanence, expertise and reactivity.
- The Deputy Commander Air model was tested during several exercises and proved very effective during the first weeks of the war in Ukraine, when AIRCOM general officers were deployed to the JFCs in Naples, in Italy, and Brunssum, in the

<sup>(6)</sup> Editor's note: AIRCOM is based in Ramstein, and SACEUR at SHAPE, in Mons, Belgium.

Netherlands. Their presence aided the complex understanding of operations, drafting of orders and planning of defence phases.

Several months before Russia's invasion of Ukraine, in close collaboration with NATO air forces and in addition to the air assets then available, AIRCOM had prepared an alerting system for air assets to protect NATO's Eastern front. In accordance with political expectations, this step was purely defensive and non-escalatory but demonstrated our determination to protect the territory of NATO's Member Countries. In just a few hours following the Russian attack on Ukraine the entire Eastern front, from the Baltic Countries to Bulgaria, was protected by combat air patrols supported by intelligence-gathering and in-flight refuelling tanker aircraft, as well as others on ground alert.

Several key factors explain this result:

- The very close relationship between the Chiefs of air staff of the NATO countries and COMAIRCOM. It stemmed from the high level of confidence reigning over the regular meetings in Ramstein.
- Sharing of essential intelligence in order to adapt the organisation to the real situation.
- Highly detailed planning for use of airspace, which always comes under national control. In peace time it is vital to coordinate military and civil activity. Action by Eastern countries was remarkable in the search for the best compromise.
- Proven principles of air action, which include reactivity (the ability to respond to a political decision in just a few hours), reach (some patrols took off from national soil to conduct the mission), concentration of effort (NATO's entire Eastern front was covered), reversibility in order to adapt the arrangements to the situation (amend patrols as a function of the actual threat), and immediate interoperability between allies (the result of frequent common training).

The air action also showed very strong cohesion within the Alliance through the participation of the majority of Member Countries in a position to react at very short notice.



Whilst the air component was able to react speedily, and be the first to respond to the political objectives, there is still some way to go before achieving sustainability, ensuring satisfactory resilience and protecting Europe effectively. Effort still needs to be expended, particularly in the following areas:

• Integrated Air and Missile Defence (IAMD): The aim is to have visibility across the entire range of missions for protecting Europe and to be capable of handling all types of threat, from ballistic missiles to cruise missiles to combat aircraft and drones. Nevertheless, the evolution of the IAMD chain of command and the recent adaptation of posture to the security situation will not overcome the desperate shortage of assets (sensors and effectors) among NATO nations, the fewer opportunities for

combined training or the lack of prioritisation of points to defend. Recognition of this situation needs to be made at the political level if there is to be any hope that IAMD becomes a priority in armament programmes. The major points that need to be taken into account:

- capability, with priority given to improving sensors.
- an adapted C2 structure.
- architecture which allows connection between all actors.
- a posture that ensures reactivity.
- Space: Technological advances and the militarisation of space by some countries have compelled NATO to reconsider space as a new field of battle on the same level as the cyber domain. In December 2019 the Alliance declared space the 5<sup>th</sup> operational domain. A road map for 2020-2025 has been drawn up which specifies both the missions and the resources (such as HR, infrastructure and budget) necessary to implement the initial space plan. NATO's space structure will be based on a Theatre Space Component and a NATO Space Centre commanded by COMAIRCOM. The NATO Space Centre is currently sited within AIRCOM and manned by personnel from the Command and other experts specifically put in place by Member Countries. The build-up of the Centre of Excellence in Toulouse should also contribute significantly to developing the space dimension within NATO.

Even though the NATO Space Centre has yet to declare its operational capability, it is already permanently committed to exercises and real action. It is called upon by all military components and by Member Countries as an organisation unequalled with regard to the collection and sharing of space information. Even though the Alliance has no plan to acquire its own space assets, the NATO Space Centre will be a wonderful hub for information on our competitors' knowledge and understanding via its many links with national space centres.

• Synchronisation of fires and targeting: The complexity of theatres of operations, together with the capabilities of our competitors now requires a combination of multi-domain action if we are to avoid being driven by adversaries' intentions. AIRCOM has established within the JFAC command structure an effects synchronisation cell and a division for non-kinetic operations, intended to provide overall coordination of action in order to achieve the sought-after effects. These structures were set in place during recent exercises and fully demonstrated their value throughout different phases of the campaign.

Whether in a peacetime environment, or when conducting military operations becomes a challenge (airspace management), or in a situation when a crisis has been declared, non-kinetic operations play a crucial role: in particular in the information war which, despite considerable progress, continues to demand greater effort to reach the level of our competitors.

Right from the deterrent phase, the joint effects synchronisation team enables planning of desired effects as early as possible in the C2 Air process. It integrates both

kinetic and non-kinetic effects and ensures close, interlinked coordination with the various components. In view of the rapidity of operations today, these two divisions have proven beneficial during the latest exercises. Now, with the war in Ukraine, they are fully committed on a daily basis within the NATO JFAC command structure.

Regarding synchronisation of fires, there has been much discussion on targeting procedures, which are far from perfect in the Alliance as a result of the number of actors in the decisional process, along with often unclear roles and responsibilities of the different HQ staffs involved. The aim is to define the process of prioritisation of targets, on one hand using the principles of the new C2 concept, and on the other optimising the decisional cycle.

The air component advocates a theatre-level approach to arrive at a matrix and authority for synchronisation of individual effects which is coherent with the flexibility sought by SACEUR as a function of the phases of the operation. The phase of dealing with the adversary's Anti Access/Area Denial (A2/AD) capabilities is an excellent example of where the air component can be better placed to achieve synchronisation of effects.

- Capability development: The complex and changing character of the contemporary security situation has compelled the Alliance to speed up its decision-making processes and acquire better knowledge and understanding of its potential adversaries to determine the best-adapted posture. The new strategic plans and the new C2 concepts clearly help the acceleration of decision cycles and reactivity of the posture. Despite all of this, the fact remains that the available assets are not all compatible with the modern world. In both European and NATO contexts, several sectors merit considerable further effort:
- We need to develop our capability for managing and exploiting data and sharing it more easily. Data management is one of the key points clearly identified by the current Supreme Allied Commander Transformation (SACT, in Norfolk, Va). It will define our ability to keep the advantage in future conflicts.
- Connectivity is determinant in synchronising effects in an ever-shorter timescale. It would seem that the most appropriate solution is to try to develop equipment and arrangements that are designed from the outset to be interoperable, at the same time ensuring the interoperability of existing assets, particularly between  $4^{th}$  and  $5^{th}$  generation aircraft (among which, *Rafale* and *F-35*). The networks that link the headquarters with each other and with the units on the ground need particular attention.
- Innovation must be the inspiration that feeds our adaptation, and focus on a DevSecOps (development, security, and operations) approach. The development and adaptation of systems must be done in an agile manner; software coders should discuss directly with operators. The approach of the US Air Force, and the creation of its Kessel Run laboratory is an example to follow.

— Quantity: as the French Chief of the Air and Space Staff's strategic vision<sup>(7)</sup> clearly states, sustainability is a key capability, in particular in the fields of war economy and Maintenance in operational condition (*Maintien en condition opération-nelle*—MCO). In the Western world, for the moment only the United States is able to ensure continuity in high-intensity effort. In the current climate, we cannot make any assumption about the capabilities that the United States might bring to Europe, especially if operations are underway in several theatres. It is therefore vital that Europe make a major effort to overcome this shortfall in areas such as the number of aircraft and the ability to arm and equip them (with weapons and self-protection systems, for example), ground-to-air systems and means for intelligence gathering in contested environments, to name but a few.



The conflict in Ukraine has made us conscious that Europe is no longer sheltered from a major crisis or war on its soil. Even though NATO, and in particular its air component, has begun to put itself in battle order to face a high-intensity conflict, it is essential that Alliance Member Countries, and in particular the European ones, grasp the measure of the organisational and capability developments that are necessary to provide effective protection for their populations. •

<sup>(7)</sup> MILLE Stéphane, Vision stratégique de l'armée de l'Air et de l'Espace 2022 – Décourager-Défendre-Défaire – Vaincre par la 3D [Strategic vision of the Air and Space Force 2022-deter, defend, dismantle-conquer through the third dimension], April 2022 (https://www.defense.gouv.fr/).

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he war in Ukraine has been waging for over a year, overshadowed by the nuclear threat. The various nuclear dimensions to this conflict have been examined and identified. (1) The propensity of Russian officials to have manipulated this threat very early in the conflict and to remind everyone regularly of the destructive capability of Russian forces has given rise to considerations and debates forgotten since the darkest moments of the Cold War. For example, Western mainstream media have again been talking of the effects of nuclear weapons and the consequences of a detonation over their territory. Military experts have been looking at the tactical strike options that might be envisaged by Russian forces and Moscow's strategy of nuclear deterrence, coercion and, if necessary, intimidation has been examined at length.

It is also instructive to look into the way in which the war in Ukraine has altered the nuclear grammar of the other powers, particularly of the three Western nuclear weapons states (United States, France and United Kingdom). There states initially had to decide how they wished to respond to the aggressive Russian rhetoric, both individually and in coordination, especially within the framework of NATO. The conflict has certainly influenced the various bilateral and multilateral nuclear discussions, making it more difficult to limit strategic competition and proportionally increasing the risk of escalation towards a nuclear exchange.

#### **Aggressive Russian Language**

Just as it did during the invasion of Crimea in 2014, Russia employed aggressive nuclear language in parallel with its brutal invasion of Ukraine. On 24 February 2022, Vladimir Putin declared, "No matter who tries to stand in our way or all the more so create threats for our country and our people, they must know that Russia will respond immediately, and the consequences will be such as you have never seen in your entire history. No matter how the events unfold, we are ready". (2) These words were widely

<sup>(1)</sup> TERTRAIS Bruno, Les armes nucléaires et la guerre en Ukraine: bilan provisoire et conséquences possibles [Nuclear weapons and the war in Ukraine: provisional assessment and possible consequences], Note of the FRS, No 28/2022, 21 July 2022, 10 pages (https://www.frstrategie.org/).

<sup>(2)</sup> PUTIN Vladimir, Address by the President of the Russian Federation, Moscow, 24 February 2022 (http://en.kremlin.ru/events/president/news/67843).

interpreted as an implicit nuclear threat, underlined again by the Russian President a few weeks later, "Let me emphasise once again: if anyone intends to intervene from the outside and create a strategic threat to Russia that is unacceptable to us, they should know that our retaliatory strikes will be lightning-fast. We have the tools we need for this, the likes of which no one else can claim at this point. We will not just brag; we will use them if necessary. And I want everyone to know this; we have made all the decisions on this matter".<sup>(3)</sup>

Since the beginning of the conflict, Russia has been playing the nuclear threat tune in different keys: reminders at the highest level of its status as a nuclear weapons state, aggressive and alarmist declarations by commentators and parliamentarians, yet also more reassuring words, from the foreign minister in particular, who dismissed as unlikely the possibility of the conflict becoming nuclear in the short term. The intention behind this language has been closely studied. The declarations have been compared with the actual activity of the strategic forces, the tests, deployment of units and their alert states, and deployment on the ground of dual-capable missiles, able to carry conventional or nuclear payloads. From the point of view of official doctrine and the alert level of forces, this analysis has shown that there have been no changes up to now to give any impression that Russia might be preparing for a nuclear attack.

Nevertheless, Russian officials' extensive reference to their nuclear capability is clearly in line with a policy which is probably to seek to intimidate Western audiences, limit Euro-American support for Ukraine, and raise the stakes in Russia to rally the population to its government. It has also been noted that the regular reference to the power of Russian nuclear forces could be designed to mask the relative weakness of conventional forces. <sup>(5)</sup> It was also a way—especially at the start of the conflict, and perhaps since the annexation of the new republics to the Russian Federation—of making sanctuaries of the land conquered through aggression, by dissuading any Western operation in support of Ukraine's recapture of its lost territories. <sup>(6)</sup>

Although this Russian nuclear language varied in intensity during the first year of conflict, the commonplace aggressive statements and frequent nuclear threats have been rejected by a large part of the international community as irresponsible behaviour which carries the seeds of risk of escalation of the conflict. In this context, the Western partners, and in particular NATO member states, have had to face up to the challenge of responding to this Russian language in order to make clear their refusal to yield to nuclear blackmail without increasing the risk of nuclear conflict.

<sup>(3)</sup> PUTIN Vladimir, Meeting with Council of Lawmakers, Saint Petersburg, 27 April 2022 (http://en.kremlin.ru/events/president/news/68297).

<sup>(4)</sup> See especially Facon Isabelle, Guerre en Ukraine: le sens du signalement nucléaire russe [War in Ukraine: meaning of Russian nuclear language], Note of the FRS n° 30/2022, 27 July 2022, 11 pages (https://www.frstrategie.org/).
(5) Ibidem.

<sup>(6)</sup> FACON Isabelle, Septembre 2022 et le regain d'agitation nucléaire Russe, (September 2022 and the revival of Russian nuclear agitation) Bulletin n° 102, Observatoire de la dissuasion, October 2022, pp.5-8 (https://www.frstrategie.org/).

#### Respond Without Imitating: the Challenge of Western Powers

Although they share the same aim of condemning Moscow's agitation and rejecting all nuclear coercion but at the same time not wishing to imitate Russian rhetoric, NATO's three nuclear weapon states did not adopt similar strategies at the start of the conflict. For the United States, President Biden immediately decided that moderation was the order of the day by delaying the launch of an ICBM planned for March 2022, noting the need to avoid any risk of false interpretation of that sort of activity.

Conversely, France decided to go ahead with a qualification test on 23 March 2022 of the new improved medium-range air to surface missile (air-sol moyenne portée-amélioré—ASMPA). A few days beforehand, the Minister of foreign affairs had publicly stated that NATO is also a nuclear alliance. Moreover, the press had evoked the possibility of sending three of the four French SSBNs (Sous-marins nucléaires lanceurs d'engins—SNLE) out on operational patrol, a situation quite unheard of since the end of the Cold War. (7)

During the second wave of Russian nuclear gesticulation, in September and October 2022, the roles were somewhat reversed. The French President Emmanuel Macron clearly stated during a TV interview that France would not respond with a nuclear strike to Russian use of nuclear weapons in Ukraine *or in the region.* [8] Joe Biden declared that "…no one can be sure what would happen [following such a strike] and [it] could end in Armageddon". [9] Through their differing approaches, the two heads of state have sought to fulfil potentially divergent aims: first, to deter the Kremlin from using any nuclear weapon in the conflict whilst reassuring their own populations and avoiding any trivialisation of the idea of the use of nuclear weapons. Emmanuel Macron considered that we should not speak too much of a possible Russian nuclear attack, probably wishing not to give the impression that this scenario was conceivable from a military point of view, thereby limiting the risk of a self-fulfilling prophesy. [10]

These examples show that two close NATO allies were able to make marginally different statements at different times whilst sharing fundamentally similar strategies. First, it is a matter of emphasising the strength of their own deterrent forces and ensuring the relevance of their doctrine. Whether one looks at France, the United Kingdom, the United States or NATO as a whole, the past year has been marked by reminders of the investments undertaken to modernise nuclear capabilities and by high-level political declarations which recall the central position of deterrence in the defence of the country and the Alliance. In the same spirit, the publication in October

<sup>(7)</sup> JÉZÉQUEL Stéphane, 'Why has France sailed 3 nuclear submarines from Ile Longue [the SSBN base]?' Article in the newspaper *Le Télégramme*, 21 March 2022 (in French).

<sup>(8)</sup> ROUX Caroline, Interview of Emmanuel Macron, guest on L'Événement, a political programme on TV channel France 2, 13 October 2022 (https://www.francetvinfo.fr/).

<sup>(9)</sup> COLLINSON Stephen, Biden sends a Careful but Chilling New Nuclear Message to Putin in CNN Interview, CNN Politics, 12 October 2022 (https://edition.cnn.com/).

<sup>(10)</sup> MAITRE Emmanuelle, *Répondre à la menace nucléaire* [Responding to the nuclear threat], *Bulletin* No 102, Observatoire de la dissuasion, October 2022, p.8-11 (https://www.frstrategie.org/).

2022 of the US Nuclear Posture Review<sup>(11)</sup> is worthy of note, as is the June 2022 update of NATO's Strategic Concept.<sup>(12)</sup> Second, the Western nuclear powers have sought to distance themselves from Moscow and contrast their responsible and wholly defensive stance in nuclear matters to the Russian attitude, based on nuclear blackmail, taking civilian society hostage and use of the weapons to support an aggressive posture.<sup>(13)</sup>

#### **Evolution of Russian-American Strategic Dialogue**

Beyond the postures adopted by states individually, the nuclear dialogue between the major powers has evolved since the beginning of the war. It is notable that one of the first US declarations on the subject was the announcement of the suspension of the dialogue with Russia on strategic stability, which had been relaunched in 2021. The aim of this bilateral dialogue was not only to discuss the outlines of future agreements between the two countries on arms control, but also to adopt measures aimed at limiting strategic risks and reducing the risk of escalation between them. The US President has on occasion opened the door to discussions aimed principally at negotiating an agreement that could follow on from the New START treaty, which limits the strategic arsenals of the two countries and will expire in 2026. His Administration has nevertheless made mention of the difficulties in discussing these subjects with Moscow so long as Russia pursues its aggression in Ukraine. In addition, Vladimir Putin himself has shown little interest in the topic. In fact, for several months he refused to restart the inspections on the ground, provided for under the New START treaty, which had been interrupted by the Covid epidemic, and finally announced unilateral Russian suspension of the treaty on 21 February 2023.

The fallout from the war in Ukraine has been gradual erosion of the means of control and limitation of the nuclear competition between Moscow and Washington, first with the suspension of the strategic dialogue, then the interruption of the New START treaty inspection programme. In particular, communication between the two powers has been adversely affected even if certain confidence measures and channels of communication still survive. The effect of the strategic environment on the inclination to agree on establishing minimal measures of restraint and transparency to limit the risk of nuclear conflict can be seen at the bilateral level and also in wider forums. Meetings of the P5, the group of nuclear weapons states recognised by the Non-Proliferation Treaty (NPT), have been less frequent since February 2022, and on the multilateral level, Russia has adopted a posture of continual challenge to the international nuclear order, which prevents any support of regulatory measures.

<sup>(11)</sup> US DEPARTMENT OF DEFENSE, DoD Releases its 2022 Strategic Reviews – National Defense Strategy, Nuclear Posture Review, and Missile Defense Review, 27 October 2022 (https://www.defense.gov/).
(12) NATO, Strategic Concept 2022, 29 June 2022 (https://www.nato.int/).

<sup>(13)</sup> This aim appeared on publication of a trilateral document in the margins of a conference examining the NPT in 2022: NPT - Ministerial statement of France, the United Kingdom and the United States of America, 01 August 2022 (https://www.diplomatie.gouv.fr/).

#### The Role of the Small European Nuclear Powers

On the European level, limiting nuclear competition above all depends on dialogue between Moscow and Washington. In a similar vein, NATO member states broadly consider that their security is primarily ensured by a stable deterrence relationship between the United States and Russia, and are particularly concerned that the broader American deterrent should be credible from both capability and political points of view. Despite that, the two other nuclear powers in the Alliance defend their differences and claim a role in the nuclear debate that has been imposed on the continent since the start of the conflict.

First, as we have seen, the fact that whilst keeping a common broad view countries might choose a slightly different strategic language as they seek as much to show their restraint as to affirm their determination, is often put forward as an element that serves the Alliance deterrent posture by complicating the adversary's decision process.<sup>(14)</sup>

Moreover, European nuclear allies play an important role in the denunciation of irresponsible and dangerous Russian behaviour, and in promotion of a global nuclear order based on respect for international agreements, the UN Charter being at the top of the list.

These states, and France in particular by virtue of its status within the European Union, play a special role in the developing debate on the security of the continent, their desire being to bring greater weight to bear, not in replacing, but in complementing NATO's mission at that level. Paris has made widely known its desire for broader discussion with European allies on the role of its national deterrent, and the war being waged on the borders of the EU has given impetus to the will to examine together both the threat and those assets best suited to protect the security of the continent.

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<sup>(14)</sup> This is the interpretation that appears in the latest (2022) NATO Strategic Concept.

# The War in Ukraine and Space Theatre

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n 3 October 2022, the head of the non-proliferation and arms control department of the Ministry of Foreign Affairs of the Russian Federation, Konstantin Vorontsov, declared before the First Committee of the United Nations General Assembly: We would like to specifically stress an extremely dangerous trend that goes beyond the harmless use of outer space technologies and has become apparent during the latest developments in Ukraine. Namely, the use by the United States and its allies of civilian, including commercial, infrastructure elements in outer space for military purposes. [This] infrastructure may become a legitimate target for retaliation. Over the days that followed, his declaration made the front pages of the main Western newspapers, along with stories about potential Russian targeting of commercial satellites. It was a first in the sense that, since the start of the conflict, and even before, it has not been the usual practice for a state to envisage officially the destruction of adversaries' space assets, even military ones. The possibility is mentioned in doctrinal texts and in manoeuvres in space which demonstrate the ability to do it, but such an act of war has never been performed. Commercial constellations seem so far to have been excluded from targeting by orbital strikes because at first sight they had no relation to military matters. A few months later, on 16 February 2023, Mr Vorontsov used similar terms when speaking to the Council of the Russian Federation. (1)

Though the conflict in Ukraine is not the first space war, it is seeing the integration of exo-atmospheric space into operations in a new and managed way. There are advantages in terms of intelligence, of course, but there is also activity by private companies within a military framework—jamming and contest in orbit, for example. What does the conflict in Ukraine show that is new regarding the place of exo-atmospheric space in a high-intensity conflict?

Even before the Ukrainian conflict, space was offering considerable advantages in the military field by virtue of the material and the activity possible in that environment, which encouraged different powers to invest in it. In the weeks following 24 February 2022, space was not excluded from the battlefield and two space coalitions gradually

<sup>(1)</sup> US Civilian Space Facilities in Ukraine May come Under Retaliatory Attack—Russian MFA, TASS, 16 February 2023 (https://tass.com/defense/1577235).

began to confront each other. The conflict therefore invites analysis of current and future forms of combat in space, from a contested environment to a potential theatre of confrontation.

#### Before Ukraine, Increased Military Interest in Space

#### Disarray of the geopolitical context of space

Exo-atmospheric space did not have to wait for the Ukrainian conflict to become part of the battlefield: most researchers and military analysts agree that the first 'space conflict' was the Gulf War, in which space-based assets (essentially, satellites) were fully integrated into operational requirements, especially in terms of intelligence gathering and targeting. Their use has expanded, and the war in Ukraine has not escaped the trend: each of the belligerents needs space assets in order to fight better.

For several years, exo-atmospheric space has been gradually occupying an important position as a completely separate theatre. The armed forces of a number of countries are shifting effort onto space matters, but the investment demands a very substantial budget and is not the priority of all. Some tend to count on being able to call upon their allies' capabilities or, increasingly, those of private companies. The exponential increase in investment over the past ten years has shaken up the sector with the deployment of private constellations of satellites such as *Starlink*, developed by SpaceX. National programmes cannot alone fulfil the growing demand for access to these new technologies.

For countries that do not have space assets, private companies offer the possibility of support in case of need, as was the case of Ukraine at the start of the conflict.

#### Increased contest in orbit

Space assets are being used more and more in the framework of military operations, so they need to be protected from both natural risks and malevolent acts. Whilst the destruction in October 2021 of an unserviceable Russian satellite by a *Nudol* missile was seen by Western space powers as a provocation, other threats exist in the environment. Even isolated actions in orbit can result in damage. Among them are the approaches of spy satellites to adversaries' military satellites, the direct projection into orbit of other objects, attempts to approach or to eavesdrop, interception of signals and jamming.

Russia possesses most of these offensive capabilities in space and tests them regularly. Its activity allows it to demonstrate its power to other space actors even at a time when its space programme is in difficulty.

#### A limited spatial shock at the start of the conflict

The war in Ukraine did not begin with some gigantic anti-satellite operation in space, spectacular destruction of enemy satellites or wide-scale jamming of

Ukrainian and NATO assets in the area. However, it would be an error to exclude the space environment from the early stages of the conflict, since the war in Ukraine most certainly began in space with a cyber attack on 24 February on the Viasat network of satellites and KA-SAT terminals. Ukraine had no national space assets and Russia, not wishing to directly upset NATO at the beginning of the conflict, saw no value in creating a great shock in the space environment. This position was consistent with Russian rhetoric which insisted that it was not a war but an operation. Russian authorities have changed their line since then because Moscow increasingly speaks of direct confrontations with the United States or NATO in the Ukrainian theatre. This change gives greater credence to the possibility of Russian aggression in space.

#### Two Space Forces Integrated into the Ukrainian Conflict

At the beginning of the conflict each of the belligerents sought to acquire spatial assets, thereby creating a kind of proportionality of assets in the domain through the creation of two coalitions.

#### A weak Russian space component

The integration of military space assets into operations dates back to the 1990s, led by the United States in the first Gulf War and Kosovo in particular. Russia was going through its difficult recovery following the fall of the Soviet Union and had to adapt to dimensions other than nuclear, which had been its raison d'être throughout the Cold War. During the 1990s and 2000s there was not really any feedback on Russian capability for integrating space assets into operations, unlike in other fields such as electronic warfare and cyber. We had to wait almost until the intervention in Syria in 2015 for military chiefs to start talking of using satellites in the planning and conduct of operations.

Russia currently possesses an operational range of satellites of almost all types, and yet it has little capability for radar observation through cloud<sup>(2)</sup>—something that could nevertheless prove useful in Eastern Europe in winter. The military Neitron satellite, launched at the beginning of February 2022, might have such a capability that Russian forces could have used when the offensive began. In a similar vein, Scandinavian media<sup>(3)</sup> reported the use of *Chayka* hyperbolic aerials before the operation instead of the usual Glonass: equipment that is less accurate but also less open to intercept and jamming, though easier to destroy.

Satellites are now used by armed forces for multiple purposes including targeting. And yet the inaccuracy of Russian strikes appears due to problems with stocks of guided munitions or their quality. The lack of coordination and the inherent logistical issues among Russian forces on the ground hinder the integration of all space assets.

<sup>(2)</sup> However, on May 26, 2023, Russia placed the Kondor-FKA satellite into geosynchronous orbit from the Vostochny

cosmodrome, which has radar observation capability. It should be up and running soon.

(3) Reuters-Helsinki, *Finland reports GPS disturbances in aircraft flying over Russia's Kaliningrad, The Guardian*, 9 March 2022 (https://www.theguardian.com/world/2022/mar/09/finland-gps-disturbances-aircrafts-russia).

To resolve these difficulties the space component needs to be supplemented and restructured. The recent destruction of some critical Ukrainian infrastructure would seem to indicate improvement in the methods or materiel the Russian armed forces use for targeting. The destruction of a bridge in the Odessa region on 10 February 2023 is an example of this. (4)

### The contribution of international private industry to the creation of a Ukrainian space coalition

On the first day of the conflict the Russian space component nevertheless faced forces that had no satellite structure available to them. This situation compelled the Ukrainian forces to seek foreign assistance by creating a dual-use spatial coalition. From the start of the conflict the Ukrainian government and private agencies, such as EOS Data Analytics, launched appeals to foreign governments and companies, asking that they make their satellite assets available.

For imagery, companies such as Maxar Technologies and Planet responded to the call in March 2022. In terms of communication, the rapidly deployable Starlink satellites and relay aerials give connectivity to the Ukrainian units closest to the fighting, though this carries considerable risks should the front line move, in terms of security and protection of infrastructure (mobile elements included), which must not be left behind on territory captured by Russian forces. Ukrainian forces have brought this commercial equipment into the very heart of their operations: they use it ingeniously, at the tactical level in particular such as in the fitting of Starlink antennas to minidrones, which caused American companies to react. At first claiming that the materiel was made available for civilian use, the companies later acknowledged that their aerials could have a limited military use. On 12 February, Elon Musk, CEO of SpaceX, published on Twitter, Starlink is the communication backbone of Ukraine, especially at the front lines, where almost all other internet connectivity has been destroyed. But we will not enable escalation of conflict that may lead to WW3. Using commercial equipment is therefore not always easy since, in contrast to sovereign equipment, it relies on the goodwill of the company that hires out its property. Ukraine is dependent on foreign space-related intelligence assets. Nevertheless, the operational revelation of the advantage offered by this commercial space asset was a considerable shock for Russia, since until then the country had delayed any opening-up to the private sector.

#### The Russian wake-up call and the race for dual use

One of the objectives of the economic and industrial sanctions, some of which had been in place since the annexation of Crimea in 2014, was to block Russian acquisition of component parts. Dmitri Rogozine, the media relations specialist at the head of the state space activities company, *Roscosmos*, was pushed aside in July 2022 and replaced by Yuri Borisov, a former deputy prime minister for defence industry. He is

<sup>(4)</sup> FEERTCHAK Alexis, Guerre en Ukraine : les Russes auraient utilisé un drone naval contre un pont stratégique [War in Ukraine: Russians may have used a naval drone against a strategic bridge], Le Figaro, 13 February 2023.

a technician of military background, specialised in radio electronic components. Since February 2022 the Kremlin has wanted its armed forces to have access to a wider range of dual-use equipment and commercial satellite constellations. New projects were started to provide Russian satellites with nationally produced micro-electronic modules instead of imported chips. This change to national products is gradually expanding to probes, satellites and motors, among others. Additionally, for their communications since the end of *Globalstar*, Russian companies are mainly using *Glonets* satellites.

In October 2022, Yury Borisov lamented the fact that Russian commercial space activity was dragging its feet, and announced an increase in the rate of production of the *Sfera* constellation, <sup>(5)</sup> which should eventually bring internet connection to Russia, along with low-orbit communications: but increasing production from one satellite in more than a year to one per day seems more than somewhat optimistic! In this field of activity, China exerts considerable influence on Russia despite its ambiguous diplomatic position. Industrial and commercial cooperation between the two is intensifying for the replacement of Western products. <sup>(6)</sup> This creates a dependence which gives Beijing a significant means of exerting pressure on Moscow: in September 2022, 51 per cent of Chinese exports to Russia were of mechanical devices, electrical machines and electronic equipment. <sup>(7)</sup>

Russia is seeking to inject new dynamism into its space programme whilst remaining autonomous, though it is too soon to see the result of this effort. In order that its shortcomings do not allow it to become ousted by other space powers, and to continue to contest the use of space assets for Ukrainian military purposes, Russia continues to occupy space and show its presence there.

#### War in Space? From Contest in Space to Conflict

#### Integrating challenge in space into a high-intensity conflict

Regarding the cyber domain, on 24 February 2022 the *KA-SAT* satellite network used for internet cover for Ukrainian police and armed forces was attacked by Russia, necessitating the replacement of 30,000 modems. On 3 March 2022, the Russian military control systems of the Roscosmos space vehicles were attacked, after which Dimitri Rogozin [then director general of Roscosmos] spoke of a *casus belli*. In March and April of the same year, *Starlink* denounced cyber attacks against its terminals.

In the field of electronic warfare, at the start of the conflict the Russian armed forces jammed GPS and *Galileo* signals of NATO forces operating in Eastern Europe, operations which have since continued. It remains uncertain whether *Peresvet*<sup>(8)</sup> will be

<sup>(5)</sup> Roscosmos is to actively develop commercial industry, said Borisov [in Russian], Ria Novosti, 20 October 2022 (https://ria.ru/20221020/sputnik-1825349209.html).

<sup>(6)</sup> Manned cooperation in space has not stopped, as it did not during the Cold War. Anna Kikina, a Russian cosmonaut, made a flight with SpaceX in February 2023.

<sup>(7)</sup> TKATCHEV Ivan, Russian trade with China ahead of programme establishes a new annual record [in Russian], RBC.ru, 7 November 2022 (https://www.rbc.ru/economics/07/11/2022/6368c0209a7947cd28bf0605).

<sup>(8)</sup> A laser officially in service since 2019, which could jam orbiting satellites from Earth.

deployed for the Ukrainian theatre, even though it has been the subject of official announcements and supposed testimonials such as in October 2022, when various pro-Russian activists claimed it had been brought into use in the jamming of *Starlink* satellites. American experts estimate that the *EO MKA* satellites that fell out of orbit after a few weeks,<sup>(9)</sup> could have been sent into orbit over the past two years for operational testing of the laser.

These contest activities are often exploited for the purposes of war communications. Nevertheless, the war in Ukraine is witnessing the generalised use of assets for contest in exo-atmospheric space. Indeed, in March 2022, the Russian Colonel Yuri Krinitsky of the Military Academy of Air and Space Defence in Tver claimed that the priority of gaining superiority in the aerospace environment will be achieved by dazzling, by wiping out, by defeating air defences and infrastructure installations on the ground and in the air, and through similar effects on space vehicles and the enemy's orbital systems. (10) The quest for space superiority has a double aim: to contest enemy assets on the ground and in orbit.

### Recurrence in space contest activity

In 2022 there was a considerable number of Russian military launches— 14 satellites. In August 2022, Russia launched a military satellite, Kosmos-2558, into low orbit very close to that of the American intelligence satellite, USA-326. It was a Nivelir inspector satellite, of the same design as 2519 and 2542, launched in 2017 and 2019, which have a capability for projection in orbit that 2558 might also have, according to Bart Hendrickx, an expert on Russian space matters. Any act of that sort close to the American intelligence satellite USA-346 could have major strategic and diplomatic consequences. In a different domain, on 4 January 2023, 2499, a mysterious military inspector satellite launched in 2014 and suspected from the outset of having an anti-satellite capability, 'disintegrated' in orbit, to borrow the term used by the 18th Space Defense Squadron of the US Space Force. It created a mass of debris and some in the media speculated half-heartedly that it might have been a demonstration of a kamikaze capability. A military electromagnetic intelligence and communication satellite Luch-Olymp, was launched 12 March 2023 into a more distant orbit: it is the little brother of the one which, in 2018, performed eavesdropping operations against the Franco-Italian geostationary military communications satellite Athena-Fidus. The majority of Russian contest activity in space takes place in low orbit, but Russia is already looking towards higher, more distant orbits.

<sup>(9)</sup> NB Kosmos 2568 was launched on 29 March 2023 from Plesetsk. It might be an EMKA observation satellite, even though there are various theories surrounding the fact that it seems to have the same characteristics as the previous EO MKA—2551, 2555 and 2560.

<sup>(10)</sup> KRINITSKY Yuri (Colonel), Considerations for the development of ways and methods of action for aerospace defence forces [in Russian], Voennaya Mysl [Review of military theory], No 3, March 2022 (https://ym.ric.mil.ru/Stati/item/388551/).

### The Russian position in global anti-satellite capabilities

The Russian offensive action in space foreshadows wider-ranging offensives to allow Russia to gain some time for training to occupy space, if only partially, without having full superiority, given that it is not the only country to have these capabilities—the United States and China also have dedicated programmes. (11)

Russian aerospace forces have greater capacity than resources and, unwilling to wage open warfare in space, conduct manoeuvres there from time to time, a sort of guerrilla tactic to train themselves, to destabilise adverse space powers and occasionally to prevent the use of certain equipment. Theirs is an asymmetric, covert military response.

An article co-authored by three Russian armed forces research officers in March 2023 claims: The theatre of space warfare is the area of exo-atmospheric space within which orbiting constellations of space systems for different uses are based, operate permanently and are rapidly deployed and used as a function of prevailing conditions, to effect support and combat tasks. (...) It is therefore becoming clear that the deployment of space and anti-space combat systems in space or on Earth will be the start of the next revolution in military affairs. (12) Space currently has two battlefronts: the first is the essential support that is now integrated into the field of battle, although its operational use requires a degree of agility, one that Ukraine has been able to acquire through the help of its allies and one that Russia is also putting into effect, albeit with difficulty. The second front, of combat, opened well before 24 February 2022. This combination takes into account a new military dimension of space, one which includes a dual-use arsenal. •

<sup>(11)</sup> At the start of 2022, China launched two *Shiyan* experimental 'technological development' satellites into geostationary orbit close to that of the American *USA-270* intelligence satellite. Since then, it has been a game of cat and mouse between the three countries.

<sup>(12)</sup> KOVALEV A.P., SOTNIK S.A. and SOTNIK D.S., Space as a new sphere of armed struggle [in Russian], Voennaya Mysl, No 3, March 2023, p.35-52 (https://vm.ric.mil.ru/upload/site178/ICmCpEOiWw.pdf).

## Influence and Coerce: the Diplomacy of Air Power

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In Raymond Aron's rational analysis of international relations, *Paix et guerre entre les nations*, the diplomat and the soldier symbolise relations between states which, in their very essence, offer the alternatives of war or peace. (1) The power of a state at the international level therefore comes from its ability to impose its will, be it by arms or by diplomatic negotiation.

Nevertheless, these alternatives would not appear to be completely independent, and Raymond Aron admits a degree of porosity in stating that if, by definition, strategy and conduct of military operations play no part when there are no operations, then military weight is an integral part of the diplomats' instruments. This was the case in June 2002, for example, when the United States deployed USS *George Washington* in the Persian Gulf to put pressure on Iraq, whom it accused of producing weapons of mass destruction and supporting terrorism. Admiral Michael G. Mullen, commander of the naval-air group, told the press that he considered the deployment as the backbone of contemporary diplomatic effort. That role was also acknowledged by the international relations historian Jean-Baptiste Duroselle who, in his foreword to *Diplomatie et outil militaire* by Jean Doise and Maurice Vaïsse, writes: so, it is, in the vast machine which turns the wheels of foreign policy of a great country, that the power of the military plays a specific and essential role, but not an absolute one. (3)

This use of the military by international actors, be they state or inter-state organisations such as the UN or NATO, might be referred to as *military diplomacy*. Raymond Aron uses the term to describe relations between NATO member countries, as he uses *economic diplomacy* to describe collaboration between states within GATT, the forerunner of the World Trade Organisation. (4) Air diplomacy could be defined as a form of military diplomacy, but in the context of a country's foreign policy, in

<sup>(1)</sup> ARON Raymond, *Paix et guerre entre les nations* [1962], Calmann-Lévy, 1984, p.18. See also, *Peace and War*, original English translation, Doubleday, 1966. New imprint by Routledge, 2003.

<sup>(2)</sup> *Ibidem*, p.37 (French edition).

<sup>(3)</sup> DOISE Jean et VAÏSSE Maurice, *Diplomatie et outil militaire* [Diplomacy and the military tool], Imprimerie nationale, 1987, p.10.

<sup>(4)</sup> ARON Raymond, De l'analyse des constellations diplomatiques [On the study of diplomatic galaxies], Revue française de science politique, Vol. 4, No 2, 1954, p.239.

addition to military aviation we should also include civil aviation, aeronautical industry, air bases and—lest they be forgotten—the aviators themselves. Given that, how can the export of Dassault *Rafale* aircraft not be included in the broader field of French air diplomacy, just as foreign sales of the Lockheed Martin *F-35 Lightning II* are part of US air diplomacy? In these five areas we find the constituents of air power analogous to those of sea power as defined by the American Admiral Alfred Mahan in the nineteenth century. Perhaps the most appropriate formula to speak of the contribution of air power to a country's foreign policy would be *air power diplomacy*. This article intends first to offer a definition of air diplomacy, and to classify its various modes of action, before looking at its recent applications.

### The Concept of Air Diplomacy

What exactly is meant by *air diplomacy*? It can be cooperative in form, like diplomacy in general, or coercive. These two facets were mentioned in 2014, for example, when, during a colloquium on military diplomacy by Philippe Errera, then Director of strategic affairs in the French Ministry of Defence, he said on the subject of air power that its use beyond national territory carries a de facto political dimension. Accession to this 'diplomacy through air power' offers a form of coercive diplomacy and at the same time a diplomacy of influence. Across the spectrum of international relations, which stretches from peace to war, air diplomacy can play a part in sending messages in peace time as well as in the grey period that lies between peace and war.

The main methodological difficulty lies in distinguishing between what relates to coercive air diplomacy and what concerns war. In a significant part of that spectrum, diplomacy and war are closely entangled, such that the military tool might be used during an essentially diplomatic process or that diplomacy might intervene in a principally military context. Yet how can we differentiate one from the other when states no longer legally declare war? Military force is applied differently in a diplomatic situation from when it is one of war. We merely have to remember the example of the French restrictions imposed in 1999 on the choice of targets for NATO's *Allied Force* air campaign, by the refusal to destroy bridges across the Danube in Belgrade.

This distinction between war and coercive diplomacy can be made thanks to General Beaufre, who unites diplomacy and war in what he calls *indirect* strategy, as distinct from *direct* strategy. In *An Introduction to Strategy*, he defines indirect strategy as inspiring all forms of conflict that do not directly seek a solution through confrontation of military forces, but by the least direct methods of a political or economic, or even of a military order (a revolutionary war), and proceeding by a series of actions independently of negotiations (Hitler's strategy from 1936 to 1939). (6) If we draw on Beaufre's definition of indirect strategy, we can sustain the argument that air

<sup>(5)</sup> Translator's note: from this point on, the simpler term *air diplomacy* is used, to avoid repetition of the rather clumsy, albeit correct, *air power diplomacy* or *the diplomacy of air power.* 

<sup>(6)</sup> Général BEAUFRE, *Introduction à la stratégie* (1963), Hachette, 1998, p.63. Published in English as *An Introduction to Strategy*, Faber and Faber, 1965.

diplomacy links the cooperative use of air assets in relations between states with their coercive use whenever the solution is not sought through confrontation of military might but through negotiation of a diplomatic solution.

### The Taxonomy of Air Diplomacy

Limited like that, air diplomacy would nevertheless appear to have tremendous scope. An initial method of analysing it would be to draw inspiration from the studies of the American international relations theoretician, Arnold Wolfers, on the aims of foreign policy in which he classifies different foreign policies as a function of the objectives that states set for themselves. <sup>(7)</sup> In *Paix et guerre entre les nations*, Raymond Aron also uses a taxonomy based on the nature of the real or abstract objectives that states seek to gain. Other studies have devised different classifications, including those of James Cable on naval diplomacy, which lists over 200 naval operations from 1919 to 1979, Barry M. Blechman and Stephen S. Kaplan, with 215 US operations from 1946 to 1975 and Hervé Coutau-Bégarie, who considers some 170 naval operations from 1969 to 2009. <sup>(8)</sup> Inspiration from these works on naval power, in particular those of Hervé Coutau-Bégarie, allows us to discern seven categories of air diplomacy, divided into two major families, influence and coercion:

- Symbolic, for example, demonstrations by teams like *Patrouille de France* (e.g., when the *Patrouille de France* flew over the Great Wall of China in October 2004, during the 'Year of France' in China).
- Humanitarian, whose aim is to come to the aid of populations that are victim of natural disasters or armed conflicts (e.g., the intervention of 4 *C-160* in Peru in June 1970 following a violent earthquake).
- Cooperative, with the aim of promoting bilateral or multilateral relations between states by encouraging cooperation on aerospace matters or by promoting sales of civil and military aerospace materiel (e.g., the French participation since 1981 in the US Exercise *Red Flag* at Nellis Air Force Base, Nevada).
- Preventative, whose aim is to warn of the possible outbreak or spread of a conflict (e.g., the stabilising effect of pre-positioned air forces).
- Protective, with the aim of evacuating nationals threatened by a conflict (e.g., Operation *Requin* in Gabon in May 1990 with 2 *DC-8*, 1 *Falcon 900*, 2 *C-130* and 11 *C-160* which permitted the evacuation of over 2,000 French and foreign nationals).

<sup>(7)</sup> WOLFERS Arnold, Discord and Collaboration: Essays on International Politics, Baltimore, John Hopkins Press, 1962, p. 67-80

<sup>(8)</sup> CABLE James, Gunboat Diplomacy 1919-1979, Political Applications of Limited Naval Force, New York, Saint Martin's Press, 1981; BLECHMAN Barry M. et KAPLAN Stephen S., Force without War: US Armed Forces as a Political Instrument, Washington, Brookings Institution Press, 1978; COUTAU-BÉGARIE Hervé, Le meilleur des ambassadeurs - Théorie et pratique de la diplomatie navale [The Best of Ambassadors—the Theory and Practice of Naval Diplomacy], Économica, 2010.

- Deterrent, by demonstrating air capability to prevent a conflict from breaking out or spreading (e.g., Operation *Chevesne* in January 1984, in which 4 *Jaguar* flew on a raid to Beirut from their base in France).
- Coercive, to limit the use of air power to cause another state to change its attitude (e.g., Operation *Hamilton* against Syria in April 2018 following the use of chemical weapons in Douma by Bashar al-Assad's regime).

Air diplomacy, like space diplomacy, albeit in a different environment, gives added value to the third dimension as a diplomatic field of manoeuvre whilst allowing the AAE to retain its essence as a political and strategic tool of force and power projection.

### The Air and Space Force in the Field of International Relations

The political and strategic objectives of air diplomacy are, on one hand, to underline the vital position of the air environment in the stakes of sovereignty and power, and on the other, to guarantee freedom of access to it, freedom of navigation and respect for international law within it.

Air diplomacy is closely linked to French political and strategic intentions, and provides permanent cover to military and operational objectives. The AAE's exercises therefore primarily focus on developing and maintaining skills within a framework of national or coalition operations, including interoperability, training and support. In this way, air and space diplomacy is inseparable from the overseas relations activity of the AAE, which is principally operational and committed to strategic partnerships. It is fully in line with production of effects for the six strategic functions as defined in the 2022 National Strategic Review. This diplomacy aims in particular at conducting activity which, by sending strategic signals, uses the advantages of air power to deter our competitors from challenging us, and prepares for potential confrontations. Furthermore, air and space diplomacy also carries economic aims linked to French industrial policy through the support of exports and public promotion of French knowhow and industrial excellence.

### Airways of Power and Strategic Signalling

In addition to its capability to operate and project from home territory, air and space diplomacy relies on a number of strategic air hubs—bases in overseas territories or in foreign countries and other points which serve as support or unloading stages or platforms for operating A330 Multi Role Tanker Transport (MRTT), Rafale or A400M—which form a worldwide map of the AAE's Airways of Power that summarises the security challenges, the potential value of these places and the construction of a network of allied air forces in support of our air diplomacy.

<sup>(9)</sup> SECRÉTARIAT GÉNÉRAL DE LA DÉFENSE ET DE LA SÉCURITÉ NATIONALE (SGDSN), Revue nationale stratégique, 2022—RNS [National Strategic Review, 2022], p.21 (https://www.sgdsn.gouv.fr/publications/revue-nationale-strategique-2022).

Air diplomacy opens up a field of initiatives within these Airways of Power ranging from cooperation to strategic signalling. Included in this are organising bilateral or multilateral AAE exercises, symposiums and congresses in which the AAE participates, preparation or support for operations and organisation of stagings in liaison with embassies. Air diplomacy is the integral, soft power version of Air Power Advocacy, embodying a form of force and power projection.

Maintaining a capability for forward air projection in key regions of the world strengthens our links with allies and enables us to contribute to deterring acts of aggression whilst offering the capability to react to crises by sending strategic signals. In the regions where this strategic posture has been adopted it affords the AAE the essential strategic access needed to respond to the defence of national interests.<sup>(10)</sup>

## An Example of Air Diplomacy Serving French Strategy: Pégase 2022, Projection in the Indo-Pacific region

The Indo-Pacific region stretches from the coast of East Africa to the coast of South America. It is by nature extremely mixed and vital to the world economy, accounting for 30 per cent of world trade and 60 per cent of the worldwide population. It is an area of tensions, between powers including India, China and the United States, and is affected by problems of piracy and illegal fishing, trans-national organised crime, illegal immigration, Jihadist terrorism and climate change. Hence the Indo-Pacific is a region that attracts great attention and is the subject of a specific strategy<sup>(11)</sup> presented by the President of the Republic, founded upon four pillars—security, economy, multilateralism and environmental diplomacy. As a balancing power (see the 2022 National Strategic Review), France is fully committed to the region by virtue of the concentration of its interests there, including trading partners, two million French nationals and three-quarters of France's entire exclusive economic zone (EEZ). France ensures and defends the integrity of its sovereignty in the region, and the protection of its citizens, its territories and its EEZ. In addition, it contributes to the security of spaces in the region through promoting military and security cooperation, and with its partners in preserving access to common spaces in a climate of strategic competition and hardening of military environments.

The Air and Space Force participates fully in national policy through its contribution to air diplomacy. This includes regular power projection operations in the Indo-Pacific region. In 2022, the AAE conducted a large-scale deployment departing from France to the Indo-Pacific region. Called *H. Brown-Pégase*, the mission followed the earlier deployments in 2021 (*Heifara*) and 2018 (*Pegase*). It was a positive demonstration of operational military strategy in the Asia-Pacific region and of the Indo-Pacific

<sup>(10)</sup> Cf. SAND Ivan, Géopolitique de la projection aérienne [Geopolitics of air projection], La Documentation française, 2022.

<sup>(11)</sup> MINISTÈRE DE L'EUROPE ET DES AFFAIRES ÉTRANGÈRES (MEAE), La Stratégie de la France dans l'Indopacifique [French strategy in the Indo-Pacific], February 2022, 77 pages (https://www.diplomatie.gouv.fr/).

element of the European Union's *Strategic Compass*,<sup>(12)</sup> published during the French presidency of the EU. The deployment in three phases involved 170 airmen who travelled over 18,000 km from mainland France and reinforced our strategic facilities in the region. The first phase, *Henri Brown*,<sup>(13)</sup> concerned the deployment to New Caledonia of 3 *Rafale*, 2 *A330* and 2 *A400M Atlas* in under 72 hours. The second phase, *Pitch Black*, was designed to train AAE crews and their partners, Australia in particular, in a complex, high-intensity environment involving over 100 aircraft and 2,500 personnel from 17 Nations. Finally, the third phase, *Pégase*, had two enhanced stages in Indonesia and Singapore, and a final stage in the air base in the United Arab Emirates. These exercises were an ideal showcase for the performance of the aircraft used: several countries in the region, including India, Australia, Indonesia, Singapore and Malaysia have procured some of the aircraft. This is proof that air diplomacy clearly has an economic dimension. On a political level, these operations boost our credibility in the region, in particular for South Pacific nations which have limited means and whose relations with China are often delicate.

The cooperative and protective air diplomacy exercised by the AAE above all affirms French sovereignty, even in this region furthest from mainland France. It also demonstrates that France is a reliable, credible and reactive ally for regional security. Furthermore, it shows a commitment to freedom of navigation in the air and at sea, and to acting in accordance with international laws and conventions. This is essential for ensuring the protection of sea lanes using aerial surveillance operations or by sending strategic signals to competitors or mafia-like organisations.



The exercises, organised meetings, enhanced visits and training periods are the immediate, visible applications of air diplomacy. On this principle, operations like *Pégase 2022* also have a symbolic function in the strong strategic message they send to Indo-Pacific countries by the deployment of 170 personnel, *Rafale* and considerable logistic support. It also has a humanitarian element that is both preventative and protective it demonstrates the availability, readiness, equipment and skills that the AAE can mobilise in case of a major environmental crisis and in support of forces in place as part of the policy of securing our overseas territories. •

<sup>(12)</sup> COUNCIL OF THE EUROPEAN UNION, A Strategic Compass for a stronger EU security and defence in the next decade, 21 March 2022, (https://www.consilium.europa.eu/)

 $<sup>^{(13)}</sup>$  Editor's note: from the name of a Kanak (inhabitant of New Caledonia) who lived from 1924-1989 and was engaged in the Free French Air Forces, and served with the  $2^{nd}$  RCP,  $4^{th}$  SAS during the Second World War.

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he Indo-Pacific is a vast geopolitical region which encompasses the two eponymous oceans and which extends from Eastern Africa to the American continent. It is first and foremost a semantic contrivance developed by several governments with the aim of limiting the growing presence of the People's Republic of China (PRC) in the region. Thought of even in the 1930s by the German geopolitician Karl Haushofer,<sup>(1)</sup> the notion reappeared in the writings of the former Japanese Prime Minister Shinzo Abe in 2007.

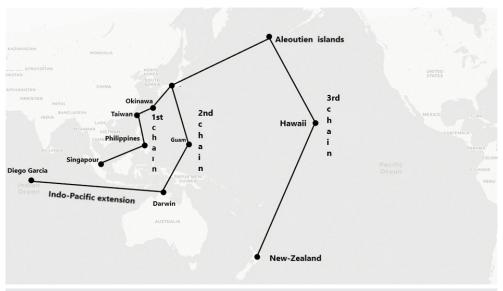
The term soon came into general use in various chancelleries, those of Australia (2013), the United States (2017), and India and France (2018) in particular. Whilst each interprets and characterises the region according to his own interests, the extent of the China-centric concept is well understood. The PRC's main partners—Russia, Pakistan, Iran and North Korea—do not use this terminology directly despite their considerable influence in the region. On the other hand, the United States and its historical allies were the first to make use of it. The appearance of the description Indo-Pacific as a geopolitical space of reference underlines a new Sino-American duopoly in international relations.

In general, when one thinks of the Indo-Pacific the maritime aspect comes first to mind since the region encompasses 60 per cent of the world's oceans, some 233 million square kilometres, (2) and yet the airspace above it is a further fundamental component of the multi-dimensional aspect of US power in the area. Through its Indo-Pacific strategy, Washington seeks to develop key sectors, including its power projection capability, permanent bases in allied countries, access to military installations, international cooperation between air forces and civil and military export markets.

The United States still has a systemic air advantage over China in the region, though the hybrid action conducted by Chinese air forces is gradually redefining the balance of power.

<sup>(1)</sup> Li Hangsong, The "Indo-Pacific": Intellectual Origins and International Visions in Global Contexts, Modern Intellectual History, Vol. 19, No 3, September 2022, pp.807-833 (https://doi.org/10.1017/S1479244321000214).

<sup>(2)</sup> PERON-DOISE Marianne, *Indo-Pacific, le maritime*, (The Maritime Indo-Pacific) *Les Grands Dossiers de Diplomatie* n° 53, October-November 2019, published again in *Asie Pacifique News*, 12 January 2020 (https://asiepacifique.fr/).



© Paco Milhiet, 2023. Source: Kulshrestha S. (RADM Retd.), Cupping the Pacific—China's Rising Influence, Unbiased Jottings on Global Maritime Issues, 27 March 2018 (https://skulshrestha.net/).

#### The United States of America—an Indo-Pacific Power

The United States has long been a power in the Indo-Pacific region. From the 19th century, the federal government developed a high-seas capability and extended its influence to the whole of the Pacific Basin—to Japan in 1853, Midway in1867 and the Philippines, Hawaii and Micronesia in 1898. Even before the United States entered the Second World War in 1941, the US Navy was a blue-water force, capable of being projected anywhere on the high seas. During the Cold War, the Secretary of State John Foster Dulles envisaged the containment of communist forces by a system of three arcs of circles—the island chain strategy—off the coastline of Eastern Asia. Washington still has sovereignty over eleven US territories in the Pacific Ocean<sup>(3)</sup> and through the Compact of Free Association has links with the Republic of Palau, the Federated States of Micronesia and the Republic of the Marshall Islands.

In the Indian Ocean, the military base of Diego Garcia, which became part of the British Indian Ocean Territory in 1965, has been let to US forces since 1971. It is an important logistic and operational base, notably used by B-2 Spirit bombers as a departure point for raids on Iraq in 1991 and 2003, and Afghanistan in 2001.

<sup>&</sup>lt;sup>(3)</sup> Guam, Northern Mariana Islands, Johnston Atoll, American Samoa, Baker Island, Howland Island, Jarvis Island, Kingman Reef, Midway Atoll, Wake Island and Palmyra Atoll.

### The Emergence of a US Indo-Pacific Strategy

As a consequence of Barack Obama's 'rebalance to Asia' strategy of 2011, the US Administration progressively adopted the terminology. Even in 2010, in a speech to representatives of the Association of South-East Asian Nations (ASEAN)<sup>(4)</sup> Hillary Clinton, then Secretary of State, highlighted the importance of the Indo-Pacific Basin. Think tanks and major analysts also gradually accepted the vocabulary<sup>(5)</sup> and later President Donald Trump made the strategy his own in a speech during a meeting of the Asia-Pacific Economic Cooperation (APEC) in Vietnam in November 2017.<sup>(6)</sup> Since then the various ministries and authorities concerned have consistently referred to the Indo-Pacific in statements on geopolitical matters concerning Asia and the Indian and Pacific Oceans. The transformation in 2018 of the US Pacific Command (PACOM) into Indo-Pacific Command (INDOPACOM) was official recognition by the military authorities of this evolution in vocabulary. The change of Administration on the election of Joe Biden in 2021 has not altered the broad principles of US foreign policy, particularly regarding the Indo-Pacific region. Notwithstanding the divisions within US society, it would seem that in terms of foreign policy and more specifically in the face of Chinese development, there is geopolitical continuity in the White House.

### Extension of the Indo-Pacific into Other Strategic Schemes

To keep the initiative on the strategic narrative US diplomacy has devised complementary forums even more overtly directed against Chinese expansion in the region, such as the Quadrilateral Security Dialogue (QUAD), a multimodal partnership of the United States, Australia, India and Japan, and AUKUS, the new tripartite military alliance of the United States, Australia and the United Kingdom.

The increased number of divisive strategic schemes coincides with intensified US criticism of the Chinese regime, (7) something on which Republicans and Democrats agree. Should a crisis situation arise between the two superpowers, the principal manoeuvres will probably be conducted from the air.

### Airspace, a Space of Confrontation in the Indo-Pacific

The United States has dominated international relationships since 1945 through the strength of its foreign trade and military power. Over the same period, the phenomenal growth in aviation has transformed international relations by playing a dominant role in contemporary conflicts, at the same time contributing to the globalisation of trade and movement of people.

<sup>(4)</sup> CLINTON Hillary, Secretary's speech–America's Engagement in the Asia-Pacific, Honolulu, 28 October 2010 (https://2009-2017.state.gov/secretary/20092013clinton/rm/2010/10/150141.htm).

<sup>(5)</sup> For example, KAPLAN Robert in America's Pacific Logic, Stratfor Analysis, 2012, http://www.stratfor.com/.

<sup>(6)</sup> TRUMP Donald, Remarks by President at APEC CEO Summit, Da Nang (Vietnam), 10 November 2017 (https://trumpwhitehouse.archives.gov/).

<sup>(7)</sup> Of note, the Congress convened a Select Committee on the CCP (Chinese Communist party) to achieve bi-partisan consensus on the threat posed by the PRC and to develop an action plan to defend the American people.

The US Air Force and other elements of the US armed forces are the guarantors of US domination through the use of their air assets in support of Washington's foreign policy. The advent of Chinese competition, especially its capability in the air, is a sign of a new duopoly developing in the Indo-Pacific region, and in particular around the island of Taiwan, for long the main stumbling block there.

### US Air Diplomacy in the Indo-Pacific

US air diplomacy is an extremely wide-ranging subject and insofar as it involves the use of air assets in support of foreign policy<sup>(8)</sup> it is applied in various ways in the Indo-Pacific.

First, in terms of military might, the USAF has nearly 330,000 personnel on active service<sup>(9)</sup>, and over 5,200 military aircraft, which make it the biggest air force in the world<sup>(10)</sup>. Aircraft of the US Army (4,409), US Navy (2,464) and US Marine Corps (1,157) add to that figure to give a total of 13,247 aircraft, which is more than the next 5 air fleets in the world put together (all of which border the Indo-Pacific).

In the Indo-Pacific region INDOPACOM has 375,000 military personnel (of which 46,000 are USAF) and 2,500 aircraft operating from US Pacific bases in Hawaii, Alaska, California, Guam, Micronesia and Diego Garcia. US forces can also rely on a network of forward bases in foreign countries (in Japan, 45,000 personnel on the bases of Misawa, Kadena and Yokota, another 22,000 on the South Korean bases

Number of militar	v aircraft in the arm	ed forces by Cour	try (Source:	Flight International)

	Air	Army	Navy	Marine troops	Total
United States	5,217	4,409	2,464	1,157	13,247
Russia	3,863	nc	310	/	4,173
China	1,991	857	437	/	3,285
India	1,715	232	239	/	2,186
South Korea	898	611	69	17	1,595
Japan	746	392	311	/	1,449
Pakistan	810	544	32	/	1,386
Egypt	1,053	nc	nc	/	1,062
Turkey	612	398	47	/	1,057
France	570	306	179	/	1,055

NB: the figures in this table given by Flight International include for each country, combat, transport and refuelling, intelligence, surveillance and command and control aircraft. It also includes combat and transport helicopters and training helicopters and aircraft.

<sup>(8)</sup> LESPINOIS (DE) Jérôme, Qu'est-ce que la diplomatie aérienne? [What is air diplomacy?], ASPF Afrique et Francophonie,  $4^{th}$  Quarter 2012 (https://www.airuniversity.af.edu/).

<sup>(9)</sup> DEPARTMENT OF DEFENSE, 2021 Demographics, Profile of the military community (https://download.militaryonesource.mil/12038/MOS/Reports/2021-demographics-report.pdf).

<sup>(10)</sup> FLIGHT INTERNATIONAL, 2022 World Air Forces, (https://www.flightglobal.com/download?ac=83735).

of Osan and Kunsan and 2,500 personnel in Darwin, Australia). They also have access to certain military installations in the Philippines and in Singapore. Furthermore, the USAF organises a number of bilateral exercises with Asian air forces and participates in major multilateral exercises in the area to boost interoperability and develop politico-military relations.<sup>(11)</sup>

Arms sales are a further basic element of US air diplomacy. The United States is the biggest arms exporter in the world. These sales are not devoid of politico-strategic interest and moreover they help standardise training and doctrine of use. Where technology transfer becomes involved, the agreements go beyond simple sales of equipment and take on a geopolitical element regarding long-term protection and the spread of operational culture and technological seasoning. (12)

Armed forces in the Indo-Pacific region remain largely dependent on weapon systems imported from foreign suppliers; indeed, the biggest arms importers in the world are to be found there.<sup>(13)</sup>

Country	Millions of dollars spent from 2016 to 2022	% of Imports from USA	
India	21,122	9.5	
Saudi Arabia	20,129	75	
Qatar	10,386	45.5	
Egypt	10,169	72	
Australia	9,135	71	
China	8,741	unknown	
South Korea	7,114	66	
Pakistan	6,750	1	
Japan	5,666	96	
United Arab Emirates (UAE)	5,412	65	
Vietnam	2,820	4	
Singapore	2,767	40.7	
Indonesia	2,721	24	
Thailand	1,984	10.5	
Bangladesh	1,964	0,5	
Philippines	1,731	16	
Myanmar	1,556	unknown	
Taiwan	1,114	99	
Malaysia	890	4.6	

<sup>(11)</sup> For example, Garuda Shield (Indonesia), Cope Tiger (Thailand), Keris Strike (Malaysia) and Cope India.

<sup>(12)</sup> ZAJEC Olivier, Les industries d'armement et le commerce des armes, (Arms industries and the arms trade) Questions internationales No 73, 2015, pp.70-74 (https://medias.vie-publique.fr/).

<sup>(13)</sup> BERAUD-SUDREAU Lucie, LIANG Xiao, WEZEMAN Siemon T. and SUN Ming, Arms-production Capabilities in the Indo-Pacific Region: Measuring Self-reliance, Stockholm International Peace Research Institute (SIPRI), October 2022 (https://doi.org/10.55163/XGRE7769).

Clearly, the Indo-Pacific is a favoured export market for the US DITB. The main purchasers of US arms are also their main political partners, though the reverse is also true—the countries with which the United States does not maintain good relations do not buy its arms. For example, the F-16, the most-sold combat aircraft in the world, <sup>(14)</sup> has been bought by over 20 countries, notably South Korea (171, produced locally under licence), Indonesia (36), Singapore (60), Thailand (68) and Taiwan (142). More recently the fifth-generation combat aircraft, the F-35 developed by Lockheed Martin and in service in the US forces since 2015, has been sold to Australia (72 on order), Japan (145), Singapore (4) and South Korea(40).

The United States still has a significant air power advantage over its main opponent in the Indo-Pacific: China. Nevertheless the People's Liberation Army Air Force (PLAAF) is developing hybrid strategies which could in time pose a threat to some US allies in the area and overcome US military and technological superiority.

### Chinese Air Force deployments around Taiwan

The airspace around China is subject to growing geopolitical challenges. In addition to the territorial conflicts in the China Seas the island of Taiwan, claimed by Beijing but supported politically by the United States, crystallises regional tensions. Since 1979 Washington has ceased to guarantee military intervention in case of Chinese invasion of Taiwan, instead maintaining a deliberate strategic ambiguity<sup>(15)</sup> on what American reaction to Chinese aggression might be in order to prevent unilateral annexation of the island. The trilateral relationship between China, Taiwan and the United States is therefore both complex and sensitive: the least politico-diplomatic incident threatens to upset the status quo.

The most recent crisis was on 3 August 2022, when Nancy Pelosi, third in the order of US protocol, arrived in Taipei on board Air Force One. Her visit was seen in Beijing as an intolerable provocation, and provoked the launch of eleven DF-21 ballistic missiles into the area around the island, of which 5 overflew Taiwanese territory. In the same period, a hundred combat aircraft and ten warships crossed the median line in the Strait of Taiwan, an unofficial border tacitly accepted since 1955. These manoeuvres of a hitherto unseen magnitude are now classified as the 4th Taiwan Strait Crisis. (16) (17) Since that date the PLAAF has increased its incursions beyond the median line.

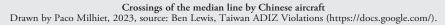
The PLAAF now operates in a grey area, operations hovering between peace and war which fog the distinction between a permanent air security posture and overtly aggressive action in order to destabilise the Taipei regime. Given that the

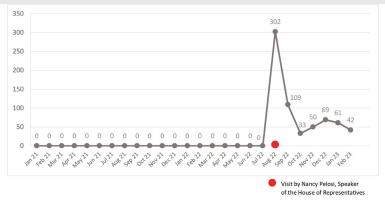
<sup>(14)</sup> FLIGHT INTERNATIONAL, op. cit.

<sup>(15)</sup> Kuo Raymond, 'Strategic Ambiguity' Has the U.S. and Taiwan Trapped, Foreign Policy, 18 January 2023.

<sup>(16)</sup> The first three crises in the Strait were in 1954, during the armed conflict over the Dachen Islands, in 1958 with the shelling of the islands of Kinmen and Matsu, and in 1996 when the United States deployed two naval-air groups in the Strait in response to Chinese missile firings.

<sup>(17)</sup> DANJOU François, La 4º crise de Taiwan. Quels risques d'escalade? [The 4th Taiwan crisis. What are the risks of escalation?], Question Chine, 6 August 2022 (https://www.questionchine.net/la-4ieme-crise-de-taiwan-quels-risques-d-escalade).



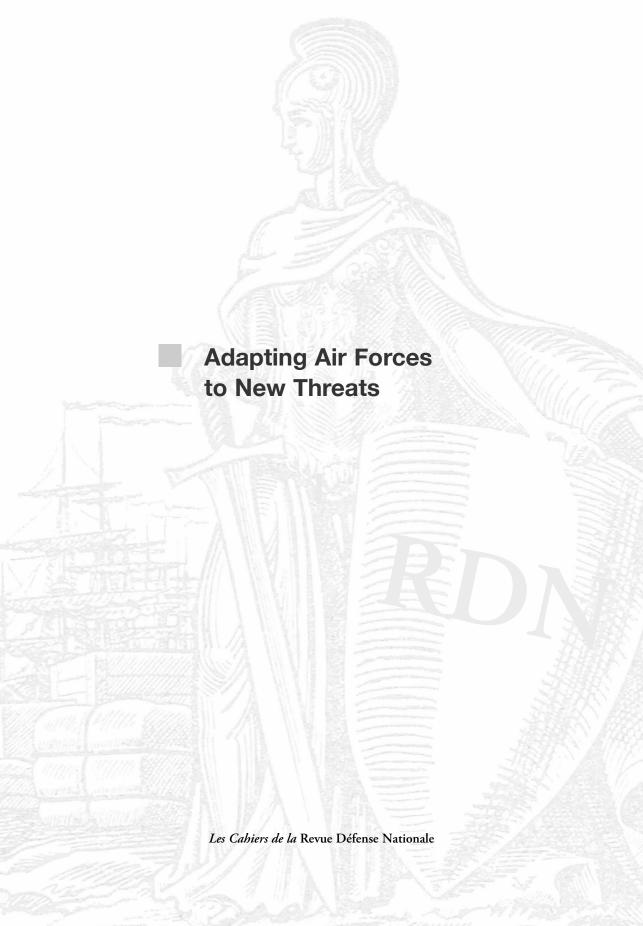


virtual border of the median line is now defunct, the next crisis is likely to see a greater intensity of Chinese provocation.

### Conclusion

The United States still enjoys overall air superiority in the Indo-Pacific region. Were there to be any military escalation involving the two great powers, the Chinese Air Force would probably not venture beyond its immediate neighbourhood.

Nevertheless, by way of the repeated incursions of the PLAAF close to Taiwan, the Chinese authorities are sending a clear message: the time when US forces had an asymmetrical advantage in the Strait of Formosa is past. The People's Republic of China is now able to bring many assets to bear, air assets in particular, in launching an overall offensive on Taiwan. Any foreign involvement in defending the island will be at a high material and human cost. •



Frédéric Parisot

Général de corps aérien (NATO OF-8), Vice Chief of the French Air and Space Force.

Inding the right format for combat aviation is an esoteric exercise: many arguments compete in the search of a subtle balance between political ambitions regarding defence and security, operational credibility, support for exports and budgetary sustainability.

Although combat aviation can have many objectives (including defence, attack and intelligence), one of the major operational functions demanded of it is the achievement of air superiority, even if locally and temporary, in order to deliver effects in various domains and environments for its own account or that of other components. Air superiority nevertheless faces danger from two sources:

- Externally, from new threats which employ A2/AD (Anti-Access/Area Denial) strategies and from new-generation aircraft that challenge its freedom of action.
- Internally, from periodic challenges, questioning its real value in terms of power, its format and even its very existence, in favour of remotely-controlled aircraft.

In a remarkable visionary analysis in 2021 the French Institute of International Relations (*Institut français des relations internationales*—Ifri) drew attention to the risks of an unrelenting attrition of the mass of our high-tech military effectors, were they to be involved in a hypothetical high-intensity engagement, starting with combat aviation. (1) That was in June of 2021, eight months before the return of war to the marches of Europe. Hollowed out by decades of cuts despite an increased number of operations over the past 30 years, the Air and Space Force's (*Armée de l'Air et de l'Espace*—AAE) target for multi-role combat aircraft was cut by 25 per cent between 2008 and 2017 alone, a significant reduction in its organic and operational depth. This weakness is still

<sup>(1)</sup> BRIANT Raphaël, FLORANT Jean-Baptiste and PESQUEUR Michel, *La masse dans les armées françaises : un défi pour la haute intensité* [Mass in the French armed forces: a stake in high intensity], *Focus stratégique*, No 105, Ifri, June 2021, 80 pages (https://www.ifri.org/sites/default/files/atoms/files/briant\_florant\_pesqueur\_masse\_2021.pdf).

with us, and the Ukrainian conflict is a reminder of the serious consequences it could have.

It is worth remembering that combat aviation is most often the initial intervention means of choice for political leaders; it is vital that it is reactive to ever more rapidly evolving threats, and yet deciding its appropriate format is far more complex than a simple analysis of the number of its effectors.

### The Place of Combat Aviation in the Supreme Commander's Options

Combat aviation is, and will remain, the backbone of air power, a strategic tool in the hands of the statesmen. Let us be quite clear about this: air power is used for the primary intervention in any large-scale military operation. The reactivity and intensity of air power brought to bear by its combat aircraft makes possible the achievement of decisive air superiority anywhere, even on the other side of the world, whilst retaining the unique degree of reversibility of such value to the political level. This value has been underlined time and time again over the past thirty years: the 1991 Gulf War (*Desert Storm*), Kosovo in 1999 (*Operation Allied Force*), Afghanistan from 2001, Libya in 2011 (*Harmattan*), Mali in 2013 (*Serval*, then *Barkhane*), operations against *Daesh* from 2014 (*Inherent Resolve*) and the retaliation raid in 2018 against Syrian chemical arms programme sites (*Hamilton*)<sup>(2)</sup> to speak only of French activity.

The choice of combat aviation as a military weapon with a strong political dimension was further endorsed by the Chief of the Armed Forces during his speech to the forces on 20 January 2023 at the air base at Mont-de-Marsan. The President of the Republic expressed his desire to ensure that France should be able to build and command a first-rate coalition. (3) Moreover, the President specifically wished to favour coherence in mass and reactivity without sacrificing endurance. (4) Two lessons of significance can be drawn from these two precepts. On one hand, although it is not the only factor involved, the coherence and weight of combat aviation is determinant in a country's military credibility within a coalition of Western air forces, especially when coalition leadership is assigned. The most recent coalitions, *Desert Storm* and *Inherent Resolve* are clear demonstrations of this. On the other hand, they highlight the difficulty and demands of defining a credible format.

The war in Ukraine is also a stark reminder of the vital role played by French combat aviation in strategic dialogue. We have seen the return of high-intensity warfare and of nuclear posturing—two areas in which combat aviation offers a response to the political decision maker. Initial analysis of a balance of power shows that without sufficient quality and coordination, quantity alone cannot guarantee air superiority.

<sup>(2)</sup> MOYAL Éric, Operation Hamilton...Strategic Demonstration and Air Power, RDN special edition for the 2019 Paris Air Show, Air and Space—Challenges for French Sovereignty and Freedom of Action, in English at pp.47-52 (https://www.defnat.com/e-RDN/vue-article-cahier.php?carticle=115&cidcahier=1183).

 <sup>(3)</sup> MACRON Emmanuel, Discours du président de la République aux Armées [The President's speech to the armed forces],
 20 January 2023 (https://www.elysee.fr/front/pdf/elysee-module-20711-fr.pdf).
 (4) Ibidem.

Proof is in the nine-to-one ratio in favour of the Russians, who also had a significant technological advantage.

### Format vis-à-vis a New Strategic Dialogue and a Continually Evolving Threat

In his 2021 strategic plan,<sup>(5)</sup> the Armed Forces Chief of Staff outlined the changed patterns of today's world. The change from the traditional pattern of escalation, peace-crisis-war, to the current competition—contest—confrontation, is compelling us to adapt our strategic vision of these new forms of conflict.

To make this transition, the AAE has established a number of principles which are set out in General Mille's 2022 strategic vision: (6) reactivity, agility, multi-tasking and credibility, related to the maxim of conquer through the third dimension: deter, defend and dismantle. Combat aviation is playing its part in these three pillars. Deterrence remains the military effect initially sought. The principal asset for achieving this is the Airborne nuclear component (Composante nucléaire aéroportée—CNA), maintained unfailingly since 1964 by the Strategic air forces (Forces aériennes stratégiques— FAS). The CNA must remain strong, credible and permanent, whatever the circumstances. The second pillar is *defence*. Combat aviation participates in the permanent air security posture (Posture permanente de sûreté aérienne—PPS-A) through its mission of operational permanence. Our aircraft are constantly ready to take off to offer assistance and protect our citizens. Finally, for dismantling [an opposing force] it is essential to have a robust, reliable and coherent combat organisation. Combat aircraft are the keystone of our institution and need to be equipped and ready for combat at all times and in all places. The latest demonstration of this was *Pégase*, a large-scale power projection manoeuvre in the Pacific in the summer of 2022. It once again<sup>(7)</sup> demonstrated our capability to project front-line air forces to New Caledonia in under 72 hours, as well as our interoperability with our principal allies.

This strategic transformation has been made in line with current and future threats. The characteristic of ground-based air defence systems, in particular those based on Europe's Eastern flank, is not so much in their modernity as their mobility in order to optimise their lethality and survivability. What is more, these systems have significant fields of fire which compel combat aircraft to use weapons of greater range. For the current air-to-air threat, dangers from fifth-generation stealth aircraft are gradually becoming the priority. By 2035, Integrated Air Defence Systems (IADS)<sup>(8)</sup> and Low Observable/Very Low Observable (LO/VLO) aircraft will have proliferated and become the main threat. They will progressively be accompanied by *Remote Carrier*, *Loyal Wingman* or other unmanned combat air vehicles (UCAV), whose aim is to

<sup>(5)</sup> BURKHARD Thierry, *Vision stratégique du chef d'état-major des Armées* [The strategic vision of the Armed Forces Chief of Staff], October 2021 (https://www.defense.gouv.fr/).

<sup>(6)</sup> MILLE Stéphane, Vision stratégique de l'AAE [The strategic vision of the Air and Space Force] 2022

<sup>(</sup>https://www.defense.gouv.fr/sites/default/files/air/vision\_strategique\_armee\_air\_espace.pdf).

<sup>(7)</sup> Editor's note: Heifara-Wakea was held a year earlier on the same principle but to French Polynesia, then Hawaii.

<sup>(8)</sup> Combination of captors and effectors (ground-air and/or air-air systems) networked together in order to protect an area from the air threat.

saturate the enemy and confront manned aircraft with a capability for detection and lethality.

To face these threats we are developing new capabilities for our combat aviation. A new standard of *Rafale* (*F5*) is being prepared for 2030 and beyond, which will have improved capability for detection of new stealth threats, together with a complete SEAD (Suppression of Enemy Air Defences) capability for combating modern IADS. In the future we will also see increased cooperation and the Future Air Combat System (*Système de combat aérien du futur*—SCAF) programme.

Despite the strategic, operational and capability changes to our combat aviation to bring it into line with new strategic conditions and threats, its format has never been so slim<sup>(9)</sup>—quite the contrary of our competitors' aircraft fleets.

### Slim Format and Few Personnel: Training is the Key

The format is too often approached from the point of view of the number of aircraft alone. Balancing aircraft, crews and training is a complex equation, and each of these factors merits study to reach an objective solution.

The main dilemma to resolve in studying combat aviation is the balance between technology and overall mass (*masse brute*). The resultant of increasing costs of development, production and maintenance in operational condition of our materiel would appear to follow Norman R. Augustine's law. Proof is in General Philippe Steininger's analysis, where he reminds us that the average unit cost of a combat aircraft has in real terms increased five-fold in fifty years. At the same time, technology has allowed the effective and rapid achievement of military effects in modern conflict with drastically reduced collateral damage and numbers of aircraft needed. It has redefined the concept of concentration and mass through the use, for example, of precision-guided munitions. For a given effect the necessary mass is reduced: it is a measure of effectiveness.

The use of technology is a basic element of deterrence. As already mentioned, deterrence is the fundamental pillar of our forces and is tailored to our need. (13) The airborne nuclear component requires state-of-the-art aircraft and armament to remain credible, offsetting just the right number of effectors needed for the mission.

<sup>(9) 1960, 700</sup> combat aircraft; 1990, 450 aircraft; 2020, 185 aircraft. STEININGER Philippe, *Les fondamentaux de la puis-sance aérienne moderne* [The fundamentals of modern air power], L'Harmattan, 2020.

<sup>(10)</sup> Overall mass (*Masse brute*): represents the permanent capabilities of a system of forces, which in particular allow the generation and support of one or more operational masses. Operational mass (*Masse opérationnelle*): is the concentration in a given period of time of the combat strength of a force; i.e., the sum of all its resources of destruction or disruption applied to achieving operational effects. Lt Col BRIANT Raphaël, Laboratory for defence research at Ifri.

<sup>(11)</sup> AUGUSTINE Norman R., *Augustine's Laws*, American Institute of Aeronautics, New York, 1982. At the end of the 1990s, the former president of Lockheed Martin, Norman R. Augustine, developed a law according to which the rise in costs of procurement and ownership of combat aircraft would be such that the United States would be reduced to possessing a single aeroplane by 2050.

<sup>(12)</sup> STEININGER Philippe, op. cit.

<sup>(13)</sup> In a speech by the President of the Republic on defence and deterrent strategy at the French war college on 7 February 2020 (https://www.elysee.fr/).

It therefore favours technology over mass. Moreover, our deterrent must by definition remain sovereign and independent. It is therefore essential that we support our defence industrial and technological base (DITB) to continue this mission. Which is why, in rationalising our combat aircraft model around a single effector for the deterrent mission, we are able to reduce development, production, ownership, instruction and training costs. In the decade following 2030, *Rafale* will be our sole combat aircraft for conducting all missions. It is evolutionary by design and has been modernised as threats have evolved. The *F3R* standard will from this year give way to the new *F4* standard which has better connectivity in particular. Nevertheless, the evolution from *F4* onwards will highlight differences between older *Rafale* versions, which will not all be able to receive the complete functionality of that standard. These differences will enable us to optimise our format between 'top-end' *Rafale* for high-intensity and permanent missions (technology) and the others, which will satisfy needs for crisis management and training (mass).

Once the model has been studied we can determine the number of aircraft necessary. To do this it is essential to take account of the operational tasking assigned to our combat aviation. Its format will therefore allow us to:

- conduct permanent deterrent and territorial defence missions entirely independently;
- conduct high-intensity missions without putting strain on the permanent missions;
- respond to crisis management missions in uncontested environments, and
- train our armed forces.

Faced with this requirement, a format of 185 multi-role *Rafale* is essential, and is the model endorsed for the current (2019-2025) Military programming law.

This number must nevertheless allow for peace time losses, (14) and in particular anticipate those in a potential future high-intensity conflict. Among other things it will determine our ability to sustain a conflict. In modern wars involving Western countries the attrition rate has been from 0.05 per cent (*Desert Storm* in 1991) to 0.02 per cent (*Iraqi Freedom* in 2003). (15) It is important to see these apparently low figures in the context of future high-intensity commitments. It is reasonable to think that the attrition rate in a future high-intensity conflict might be in the order of 1 to 3 per cent, especially when confronting adversaries who benefit from a far more dynamic export market than was the case in the past. In addition, it should be remembered that attrition affects not only aircraft but also crews. Regarding combat aircraft, the President of the Republic and the Minister for the Armed Forces have initiated studies with industry, the Directorate General for Armament (*Direction générale de l'armement*—DGA) and the armed forces to prepare a policy for a war economy. This strategy will lead to reducing production times to an absolute minimum. The increased production of the artillery vehicle, *Caesar*, prompted by the Ukrainian conflict, is a perfect illustration

<sup>(14)</sup> In 16 years in service, has lost only one Rafale.

<sup>(15)</sup> Attrition in combat is generally expressed as a percentage giving the number of losses per 100 air sorties.

of this. Silence often reigns over the loss of aircrew. Some 5 years are needed to train an operational combat pilot on *Rafale* after having had optimised training on the new *PC-21 Pilatus*. Loss of aircrew has heavy consequences on the long term ability to conduct a mission. To alleviate this, we maintain reserve crews among Headquarters Staffs, who continue to train regularly in a combat squadron. They may be employed at any time to fill a shortage of aircrew during a conflict. In these days of competition and contest, the Air and Space Force gives great importance to this reserve of personnel, which will serve as the backstop of the forces.

Since this attrition is not currently taken into account in the format, we need to study ways to minimise it and, if needed, to replace losses. Training is one of the principal ways. The level of quality of our crews must remain high if we are to use our capabilities to their best, and to achieve this the AAE has increased the number of high-intensity exercises. It holds an annual exercise called Volfa (Vols forces aériennes ≈ Air forces' flights) which brings together our and our principal allies' airmen for a number of complex scenarios. In addition, at the beginning of this year our aircraft took part in the joint exercise Orion, (16) which was the first step in a triennial cycle of modern conflict scenarios ordered by the armed forces' Central Staff to boost operational preparedness. The 2026 edition of Orion will have an 'air' flavour, where that in 2023 was more land-based. Moreover, to improve training, emphasis has been put on simulation. It is currently conducted in several simulation centres which will be interconnected in the future. Eventually, using Live Virtual Constructive Training (LVC-T),(17) the virtual and real worlds will exist side by side. This advance in simulation offers added value to increasing further the level of our crews' performance and compensating for the deficit in aircraft numbers.

### Conclusion

To conclude, in terms of the missions assigned to combat aviation we are today at a historically low level both of aircraft and crews. Our combat sustainability remains limited, shaped by a future war economy and by manipulation of personnel numbers. Despite that, the quality of our crews that has been acquired through training and decades of operations permits us to compensate in part for our current format. That training must not be reduced in any way. The format remains a complex equation whose solution is a function of strategic ambitions for power, yet also of its limits. The equation is continually reworked in order to arrive at a resilient and efficient model. So it is that, in the development of *Scaf*, it will be reworked yet again to take into account the advent of *Remote Carrier* and *Loyal Wingman*. •

Opération d'envergure pour des armées résilientes, interopérables, orientées vers la haute intensité, et novatrices. Loosely:
 Broad-ranging operation for resilient and interoperable forces focusing on high-intensity and innovation. (!)
 Using tactical data links, this simulation allows the inclusion of simulated objects during real operations. In this way

Jean-Paul BESSE

Colonel, head of the General prospective studies office (Bureau études prospectives générales—BEPG), Air defence and air operations command (Commandement de la défense aérienne et des opérations aériennes—CDAOA).

### Context

Our operational space is composed of contiguous, overlapping or separate environments in which our adversaries challenge our superiority, something we can no longer count upon. Forces and actors of many forms and origins evolve within it from competition to challenge to confrontation, a sequence of development that invalidates the notion of *peacetime*. Our adversaries and competitors are organised into complex systems of systems and upset our perception of their structures through their now normal use of strategic surprise. Moreover, the doubt now being cast over the post-Second World War security structure built by the West relieves potential adversaries and competitors of any reticence they might have had as they move towards a policy of *faits accomplis* intended to catch us unaware.

The threats to our freedom of action are two-fold: on one hand, courses of actions aimed at circumventing our power through the spread of new-generation materiel, and on the other, the development of special capabilities. The aggressor makes use of all domains of conflict—the fields of EM and information, plus the land, sea, air, space and cyber environments—in attempting to exploit our weaknesses by imposing a rapid tempo and capitalising on our difficulty in grasping the complexity of our adversaries.

It is therefore up to us to penetrate their operational space and to define ways to take advantage of their weaknesses in order to achieve our objectives. Because the opportunities to make such a penetration are generally short-lived, we need to have as many options as possible, the ability to put them into action rapidly and hinder the adversary's understanding of the situation in order to exploit the environment to our advantage. To achieve this it is vital to acquire and maintain our superiority in operational decision-making. Our freedom of choice, our ability to plan our operations by making best use of our assets in all or part of the five environments and two fields of

multi-domain operations (MDO), more than ever represents the *raison d'être* of our Command and control (*C2*) system. (1)

### A Picturesque Analogy

Imagine a judo contest in which our opponent is a well-trained giant of a man. If we do not have a single competitor of equivalent size, weight and skill we have to coordinate and bring to bear all our team members' efforts in order to achieve our objective, which is to throw him to the ground.

This would mean one of our judokas grasping the opponent's kimono at the shoulders while another pushes him at waist level and a third completes the throw with a foot sweep just as one of our supporters encourages the audience to applaud, thus influencing the referee and the watching journalists and sowing doubt in the opponent's mind. What is more, all these actions have to happen at the very moment a ray of sun appears through a slit in the blackout curtains of the dojo and blinds the giant!

While this example might seem a little far-fetched, it symbolises the nature of multi-domain operations; on top of this, the trainer has to be master of all aspects of combat, influence, the weather—and more yet. The added advantage is that our athletes will be far less tired at the end of the competition and able to do the same again straight away, albeit perhaps in a different form.

### Understanding the Environment

Any global operational space, and the forces at large within it, can only have any meaning if our comprehension of it encompasses all the domains of conflict that might be used by our opponents as well as by ourselves.

If faits accomplis, unpredictability and wrong-footing become normal, then perception, comprehension and anticipation will be our sole saving grace in preserving enough time to put our solutions into effect. To this end, the only way of remaining in contact with the operational space that now encompasses the entire world will be through permanent C2 structures established at all command levels, interacting seamlessly with our partners and allies. This structure will continuously assess the situation so that we can plan the combined responses that will be the bases of our operations, and set them in motion at a tempo that we will impose on our adversaries.

From that, we may deduce three things:

• Since the competition—challenge—confrontation sequence will occur before actual conflict, the C2 processes of intelligence, planning, conduct and assessment

<sup>(1) &</sup>lt;u>Translator's note</u>: the use throughout of terminology such as *domain, field, environment* and *integration* is intended to reflect French use in the context of MDO (in French, *Multi-milieux multi-champs*—M2MC) and may not correspond exactly to that which might be employed in a similar English language context. For an explanation of French use of this terminology, see Part 1, p.17, of: https://www.defense.gouv.fr/.

must function permanently; we will not have the time to build, arm and deploy ad hoc C2 structures once the crisis has developed.

- Since the operational space for MDO is now global, it harms the continuity and coherence of our operations if we continue to define operational areas in terms of geographical or, worse, environmental limits.
- Relationships between the various levels of command need to be reaffirmed; they have been blurred by three decades of low-intensity, low-tempo, essentially tactical and asymmetric operations. This division of responsibilities will lead to an overall strategic approach, strong operational integration and tactical delegation which in turn will allow us to achieve our aims with high levels of coherence, integration of operations in all fields of conflict and immediate exploitation of action on the ground.

### **Integrate Multi-Domain Activity: When?**

### Permanent integration

The range of threats has broadened and encompasses the pre-conflict period through to high intensity. This extension of the strategic framework increases the complexity and tempo of decision-making at the same time as the number of players in operations is increasing, so too the number of environments in, towards or from which the game is being played.

Crises once characterised by well-modelled phases of escalation and de-escalation are today evolving at an irregular rate which makes them difficult to predict and can give an impression of lack of coordination and focus in our adversaries' actions. It is nothing of the sort—these actions are well-considered and therefore more numerous; apparently more rarefied so less easily understood; and conducted in a vast environment therefore appear less focused. But they are no less coherent or less aimed towards a well-defined strategy. We have to do the same, but better and faster.

In this context, our actions that were once conducted in parallel, sometimes synchronised, and conducted by traditional land, air and naval forces are no longer sufficient to act effectively when faced with adversaries who use all means at their disposal—legal or not. Only coordinated integration of *all* the effects produced in *all* fields of conflict will allow us to achieve our aims, to protect our vulnerabilities effectively and maximise our survivability. In addition, it will shape our ability to continue in the long term by creating the best cost/effectiveness ratio.

### MDO Integration: Why?

### Integrate to master time

Maintaining mastery of time is one of the challenges of MDO C2. It applies to long-term mastery of the coherence functions—monitoring, planning, simulation and wargaming—which define the type of war that we *must* wage, and to very short-term

assessments for identifying and seizing every opportunity that arises from intelligence information, targeting and evaluation of effects to wage the war that we *are able* to wage. It will also be a function of its ability to take into account technological time, which is dictated by the means used to adapt ourselves to the war that *will be* waged. Technological time affects information handling, processing and dissemination, the transmission of orders and reports, and the computing time that goes with each.

Mastery of the long term depends on the ability of C2 to reproduce work processes systematically, so they can be shared and understood by all actors, whatever their environment or timescale of action. To this end, the vastly differing C2 tempos of each environment must be able to generate *synchronisation points* which allow the sharing of information useful to the conduct of operations at all levels of responsibility at rates adapted to the needs of each environment. This complex but essential, if sometimes counter-intuitive, mechanism allows us to control the clocks that create the connections needed to integrate the activities of the environments and the fields of conflict. It falls to the operational integrator to define priorities, based on allocation of assets and the aims to be achieved. This is the battle rhythm of MDO.

Mastery of the short term is at the level of each of the environmental C2 which, making use of shared knowledge of the environment and the ordered objectives, must be in a position to take the necessary tactical action to exploit the often fleeting windows of opportunity as quickly as possible. The principle of subsidiarity, or delegation, must now be added to this speed, adaptability and tactical creativity. Often mentioned, though rarely observed in its natural environment, subsidiarity is a founding principle of the operational decision-making process in an MDO environment, where the final decision is delegated to the most appropriate level to act upon it and to observe the results.

### It appears on two levels:

- In the overall chain of command: integration of MDO effects must be achievable by C2 structures of any size, be they at the domain, operational or strategic level.
- In a domain C2: if needed, permission should be given for decisions to be taken by the tactical echelon on the ground regarding commitment to the conduct of an operation. This capability adds to the overall resilience of the C2 chain since it ensures the continuity of decision-making, should the central echelon suffer some form of breakdown.

Advancements in digitalisation represent an opportunity to put this double subsidiarity into effect, although they also present a risk to respect for, and separation of, the various levels of command, each of which has well-defined responsibilities. Moreover, digitalisation's extremely rapid development imposes upon us its own tempo for our adaptation to, and acquisition of, the technology. We need to adopt better programme flexibility in this subject area. One path to explore would be to develop structures and policies of innovation that are closer to the users and operations.

### **Integrate for Surprise**

Our doctrine is freely available on internet, and is therefore well known. (2) Our competitors and adversaries have studied it closely: we have become predictable. The linear chronology of suppression of enemy air defences (SEAD)-air superiority—attack C2 nodes—maritime superiority—ground offensive—stabilisation, and its implementation are taught in all our adversaries' good staff colleges for them to establish their enemy's concepts of operation. Under such conditions, regaining the advantage of the element of surprise is far from easy. The MDO approach to operations will allow it: it makes us less predictable and more difficult to counter, and complicates the adversary's perception of the overall dimensions of the operational space we are going to employ against him while engaging parts of his systems of systems.

Nevertheless, if surprise is to be effective it has to be able to be produced by creating permanent uncertainty in the enemy's mind. Integration cannot therefore be a one-shot weapon which mobilises the entire range of skills of a heavily-loaded C2 chain towards a sole objective. It must be continuous, incorporated as standard in both planning and conduct of operations. It is the result aimed for by all the processes that make C2 function. Such processes already exist and development of the MDO approach does not invalidate them. They bring to our operations the focus needed to apply the political intent within a defined strategic framework. In short, the C2 processes are the guarantee that we are waging the war that we *should* be waging, not that which we *would like* to wage! It is now up to us to connect them in order to act in a coordinated manner, and to accelerate them so we can impose them upon the enemy.

### **Integrate for Access**

We can be denied access to the adversary's operational space by means and activities which undermine our technological and operational superiority, now increasingly under attack. Whilst taking all the fields of conflict into account increases the complexity of our understanding of the space, it also increases our adversary's areas of vulnerability—and he cannot protect all of them. We need to identify, exploit, and combine these vulnerabilities, in order to advance along the enemy's lines of least resistance. By doing so we maximise the benefits of our action whilst reducing our exposure. We shift the risk/benefit ratio of our investment to our advantage by obtaining effects which serve our aims in finding solutions to enter and act within the enemy's space.

In addition, the integration of effects produced by a wide variety of actors will by nature counter the lack of certain specialised capabilities or reduce the risks inherent in their use by casting aside the logic of *one effect in one domain by one dedicated effector*, and instead using the approach of *an effect resulting from the combination of several effectors in several domains*.

<sup>(2)</sup> Editor's note: CICDE, Architecture de la doctrine interarmées française (DIA), (Architecture of French joint forces doctrine) January 2023 (https://www.defense.gouv.fr/sites/default/files/20230202-planche-publications-DIA.pdf).

As an example, at high intensity, the acquisition, maintenance or re-establishment of air superiority—a pre-requisite for action in other environments—no longer comes down to the possession of an anti-radar missile and a sufficient number of air defence fighters. This approach proved extremely costly for a disappointing result during the first weeks of the Russia-Ukraine conflict. The inability of either side to impose its freedom of action in the air has led to immobility of land and naval forces on both sides and to irreversible attrition which no longer makes it possible to generate the force necessary to obtain it.

This superiority could have been achieved through a combination of effectors—airborne (EM intelligence), cyber (degradation of C2), spatial (intelligence and assessment), EM (offensive jamming), naval (engagement from the sea), information (deception) and land (ground engagement). The entire judo team at work again!

### Integrate for Sustainability

High-intensity warfare is back: it is a reality. There is no need to focus on the Russia-Ukraine conflict to convince ourselves; we simply have to look at the manner in which worldwide defence budgets have evolved over the past 20 years. The amount of weaponry available in the world has never been greater since the end of the Cold War. National armed forces are restructuring after several decades of focusing on asymmetric adversaries with few assets. Those asymmetric enemies counted on atypical courses of action and on exploitation of our weaknesses to compensate for their technological and operational disadvantages. Those operations required few resources and reduced the intensity, hence the impact, of our own modes of combat.

The consumption of resources in high-intensity combat makes our sustainability a matter of prime concern. That being so, creating courses of action that allow us to achieve our aims at lower cost while minimising exposure of our assets and personnel becomes a necessity. Though not the only reason why we are adopting the MDO approach to operations, such optimisation of use of assets is nevertheless a major benefit.

### M2MC Integration: What With?

Mastering the complexity of the operational environment and the action taking place there might seem contradictory to the acceleration of the decision-making tempo we wish to impose upon the adversary. As far as C2 is concerned, the key lies in the intellectual process set in motion in response to a given problem. It allows identification of the elements that will allow the problem to be resolved—understanding the scope<sup>(3)</sup> of the problem and what appropriate levers are available to respond to it. In particular, it guarantees that the actions decided upon and put into effect converge towards a single aim: achieving the desired end state derived from the political intent within a defined strategic framework. This process must be unbiased and permanent,

<sup>(3)</sup> To simplify the article, the notion of *scope* here is deliberately broad and all-encompassing, and includes understanding of the question asked, the factors of power, the actors concerned, constraints, restrictions, dangers and so on.

whatever the question posed. Applied to MDO, it means having standardised thought processes shared by all concerned which are able to determine the best possible combination of the seven keys on the MDO keyboard even if all seven of those domains are not necessarily called for in every response. The next question, of course, concerns where the MDO integration process should sit. Since it applies to all the domains of conflict, this integration has to be overarching and incorporate all levels of command of operations, yet with primacy afforded to the operational level in terms of planning and assessment. Created originally to coordinate effects between the environments of the traditional force components—land, sea and air—it is perfectly suited to the same function with a greater number of actors.

Under these conditions, one might legitimately ask what has changed? The change lies in the fact that this operational mechanism has now to be used permanently by the entire C2 structure, from the strategic to the tactical level. The delegation essential to the MDO approach to operations involves understanding and use of operational integration mechanisms down to the lowest level of the command chain. Maintaining coherence in operations, synchronising effects, and setting or altering priorities during operations conducted collectively by effectors in several domains and responsible to different C2 chains requires a domain-coordinating C2 which acts on the intentions of the planning-level C2 and is responsible for incorporating the action of each environment. Such a structure already exists, known as the 'beneficial support relationship' (in French, *Relation bénéficiaire en appui*—RBEA). Until now it has been applied to a complete phase of a joint operation that might last days or weeks. We now need to apply the same logic to a much higher tempo which could lead to some redistribution of roles and responsibilities between tactical C2 organisations in the course of any given day.

### **Key Resources**

This dynamic allocation of responsibilities for MDO action to one tactical C2 organisation or another requires compatible and connected processes which use and generate data that is made available to all the C2s involved.

To that end, two major resource pools need to be made available to all actors:

- Digitised C2 networks for connected combat, which will be central to the MDO approach to operations and their command and control. This is an ambitious and essential step, since it sits at the junction of three main routes—materiel, interfaces and a renewed policy of data management.
- The performance and resilience of C2 structures which make extensive use of digital resources will be based on the availability of personnel fully acquainted with all the processes of planning, conduct and assessment of operations at the tactical and operational levels. Our digital systems are under permanent threat from adversaries whose hybrid activities make extensive use of cybernetics. Only perfect understanding of the fundamental workings of C2 will ensure the vital capability to continue operations in a fallback mode. •

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Interoperability: The ability to act together coherently, effectively, and efficiently to achieve tactical, operational, and strategic objectives.

DoD Dictionary of Military and Associated Terms, (U) (2021, 110)

In *Allies That Count - Junior Partners in Coalition Warfare*, the French professor Olivier Schmitt explains that the utility of a junior partner's contribution depends on "whether the junior partner has a high degree of standing in the international system or on whether its military contribution is both integrated and of a sufficient technological quality to cooperate with US forces." (1)

While roughly a tenth of the size, some considers the French Air and Space Force (FASF) the United States Air Force's (USAF) most near-peer partner, one that is a fully capable, full-spectrum Air Force, backed by the political willingness to act. Admittedly, France remains a junior partner to the US in any Washington-led coalition, and asymmetry will remain a structural feature of the transatlantic ties for the foreseeable future. Yet, France is an *Ally that counts*, as much as for its political standing and willingness to use its forces abroad, as for the high-end, full spectrum capability of its forces. This explains why Minister of the Armed Forces Sebastien Lecornu and Secretary of Defense Llyod Austin signed a renewed joint statement in November 2022, reaffirming "the need to enhance our defense cooperation in order to enable our forces to jointly address the array of threats we face." And as Chief of Staff of the USAF General CQ Brown noted in his directive to "Integrated by Design", Allies, including the FASF and the USAF, need to "collaborate and make decisions together on interoperability, resource investment, information sharing, force development and strategy from the very beginning".

<sup>(1)</sup> SCHMITT Olivier. Allies That Count: Junior Partners in Coalition Warfare. Georgetown University Press, 2018. https://doi.org/10.2307/j.ctvvnh5h.

<sup>(2)</sup> Joint Statement of Intent between Mr. Lloyd AUSTIN, Secretary of Defense of the United States of America and Mr. Sébastien LECORNU, Minister of the Armed Forces of the French Republic, 30 November 2022. https://www.defense.gouv.fr/.

The FASF has long been a Day-One player in coalitions and conflicts along with the USAF and have started to collaborate more closely with the United States Space Force (USSF). This relationship must not be taken for granted, as there is risk of an "innovation gap" between the two sides of the pond and the emergence of a restricted "F-35 club" in Europe, from which the FASF would be excluded. As such, our two Air Forces must keep pushing hard in enabling them to operate effectively together in a high-end coalition, in a consistent and mutually reinforcing manner. If a lot has already been made, there is still "many a slip 'twixt the cup and the lips" to overcome the existing barriers.

### An already strong cooperation is in place

As America's oldest ally, France has a long history of cooperation with the United States that we can continue to build on. As epitomized by American Ace Eddie Rickenbacker who flew french planes the Nieuport 28 and the SPAD XIII in the "Hat-in-the-Ring" Squadron in WWI and the first African-American military pilot Eugene Bullard who joined the Lafayette Flying Corps in 1916, our Air Force roots run deep as well. Similarly, WWII saw French Airmen at the controls of US warplanes, partnering together across the breadth of Air missions. In a more recent past, operations in Iraq (1991), Bosnia (1992-1995), Kosovo (1999), Afghanistan (2002-2013), Libya (2011) and the Levant (since 2014) highlight that the FASF and the USAF have long been fighting alongside each other.

Operation Hamilton in April 2018 saw the French Rafale hold the overall Mission Commander role, with USAF B-1s, F-15s, F-16s and F-22s along with Royal Air Force Typhoon, engaged in combined air strikes on Syria, following the use of chemical weapons by the regime. This operation demonstrated the FASF's "Day-One player" prowess and serves as a model of interoperability, both in the planning and in execution of real-world present day kinetic warfare, albeit without a credible air or ground defense. In both the CENTCOM and AFRICOM AORs, the FASF is performing combat, combat support, ISR and tactical airlift missions throughout these theaters in close collaboration with the USAF.

Additionally, since 2018 the FASF have annually sent Rafale fighters, KC-135s & A330 MRTTs air-to-air refueling aircraft, and its new A400M airlift aircraft to the Indo-Pacific AOR to perform high intensity training in French territories as well as training, security cooperation (SC) and strategic messaging in this region. In 2021, the FASF conducted the HEIFARA mission and reached Polynesia in less than 48 hours and immediately generated fighter sorties after a projection of more than 17,000 km. After this initial phase, the FASF conducted air maneuvers with US Pacific Air Force's F-22As during WAKEA exercises to increase interoperability. Later this summer, the FASF will participate in the INDO-PACOM Large Scale Global Exercise (LSGE) with several Rafale, tankers and airlift aircraft in Guam alongside US F-35s. In addition to the LSGE, the FASF will engage with other French partners throughout the region, with SC stops in Singapore, Malaysia, the UAE, South Korea and Japan, and the French territories of France, intending to strengthen French cooperation in the

Pacific while supporting its Ministry of Armed Forces Indo-Pacific policy in the region where it has territories, citizens and interests.

Overall, FASF and USAF share a common strategic vision that uncontested air dominance is no longer assured, and our Air Forces must adapt to win in highly contested environments and contribute effectively to the joint warfighting effort. Beyond exercises and operations, the current operational Framework of bi-lateral cooperation includes *Operational Engagement Talks*, with proposals for a similar construct in the A5 lane as well as annual Vice Air Chief talks. Strong synergies exist between USAFE (USAF in Europe) and the FASF, particularly in USAFE's 603rd AOC and the FASF's CDAOA, reinforced by a tri-lateral FRUKUS (France-United Kingdom-United States) Air Force partnership. Last year for instance, this tri-lateral strategic initiative saw France host an *Atlantic Trident* exercise with 12 USAF F-35s at a French Airbase for over a month, the first time F-35s operated from a non-F-35 country. Later this year, the UK will host the next Atlantic Trident exercise, featuring F-35s and Rafale employing advanced tactics, techniques, and procedures in a full spectrum of mission sets.

France and the United States have also long been partners in the Space domain. France is considered as a top priority by the US Space Command in terms of cooperative efforts. Indeed, France has capabilities and a strong industrial basis all along the *Space* spectrum, not to mention has key terrain throughout the globe in strategic locations which serve as useful real estate for ground-based SSA capabilities. Most importantly France and the United States "have a common assessment of threats and share the ambition to confront them accordingly", as recalled in the December 2022 joint statement of intent. For all these reasons, our two countries are constantly enhancing our cooperation in the Space domain and have leveraged the Defense Space Cooperation Forum since 2009 "to advance shared objectives, such as information-sharing, developing mutual education and training opportunities, and building towards combined operations".

### Grab the challenges ahead by the horns

Notwithstanding, if the FASF is to continue to play its part, it must not be complacent nor rest on its laurels. By the same token, the USAF must strive to make General Brown's "integrated by design" imperative a reality rather than an aspiration which does not hold under scrutiny. This double effort is paramount to overcome the existing barriers to a deeper and wider collaboration.

First, the word "integration" may be understood differently from the two sides of the Atlantic. As CSAF General Brown explained during the International Air Chiefs Conference in September 2022, "Integrated by Design' is the USAF's approach to developing people, policies, and processes, starting with Allies and Partners in mind". The core idea is not new, but emphasizes execution rather than discussions, to "collaborate and make decisions together on interoperability, resource investment, information sharing, force development and strategy from the very beginning". In other words, it

aims at increasing integration at institutional *and* tactical levels, to maintain the leading edge over competitors. France is of course very supportive of this philosophy and is eager to see it become a reality.

But "Integration" also entails industrial risks for France, as a junior partner albeit a very important one—to the US when integration and interoperability consists in providing allies and partners with more American military equipment. This is why France is careful about the concept of "interchangeability", coined by the UK Chief of the Defence Staff Admiral Sir Tony Radakin: admittedly, it would be "the holy grail of tactical integration because it would dramatically ease the burden of planning coalition operations" but it would also come with a high level of dependence vis-à-vis the United States. In addition, US International Traffic in Arms regulation (ITAR) complicates cooperation between France and the US at the industrial level. In short, ITAR and the ever increasing US defense industrial muscle shed light on the difficulty for France to overcome the conundrum between a better integration with the US in all warfighting domains and the preservation of its strategic autonomy; the latter must not be understood in terms of decoupling, but rather self-sufficiency, that is the ability to provide more resources and the willingness to take more responsibilities for its own defense. Indeed, you can be part of an alliance, and yet be seeking for self-reliance in the face of new threats and security issues. To quote the former French Minister of Armed Forces: "Hesitating between strategic autonomy and Atlantic alliance is a bit like asking a child if he prefers his mother or his father".

For France, interoperability with the US, in particular, is essential to be able to continue to operate together seamlessly like we have over the last 100 years. One of the biggest challenges for the FASF will be to remain a "Day One player" with the USAF while preserving its ability to act independently, when necessary, in particular for the nuclear deterrent mission. Yet this challenge is daunting with by the massive arrival of the F-35 in Europe which makes it more difficult for France, as the FASF will not operate Lockheed Martin's flagship. It is a challenge for France, it is a challenge for NATO. In the current operating environment, with the resurgence of near peer competitors, the French Vice Chief General Parisot regularly warns that we cannot afford to have divided air power within NATO: the F-35 community and the others. Added to this current challenge of interoperability of the French Rafale frontline fighter with the growing F-35 nations and the JADC2/ABMS command and control networks is the fact that both the US and France are working on the next generation of fighter, command & control, and networked systems-of-systems, and it's critical that we are not developing these advanced systems without "Integrating by Design" from the start.

### A new framework to move ahead

"Coming together is a beginning. Keeping together is progress. Working together is success." Henry FORD

There is no further need to quibble about semantics, but rather to focus on actual implementation. To face the challenges ahead, overcome barriers to a better

# Remaining a Day-One Player Along with the United States Air Force in a High-End Coalition: the Challenge of Interoperability

integration at all levels, be ready to win as a team in highly contested air and space environment, and contribute effectively to the joint warfighting effort, the FASF and USAF could strengthen their cooperation along several lines of engagement, currently being staffed by both our Air Forces.

The first one concerns strategy, concept and doctrine. Indeed, interoperability is not only about technology and datalink. Gen Brown's "integration by design" imperative starts as soon as the definition of strategy, the deliberation and calculus regarding future threats as well as defining the operational approaches and future concepts and doctrines, to best define a combined approach against a common military challenge. Future operational concepts and analysis, such as wargames, scenarios, TTX or combined planning can help fix the gap in mutual understanding and discuss theories of air power. Far from being exhaustive, the list includes: (i) Human-To-Autonomy teaming; (ii) Collaborative Combat Aircraft; (iii) resilient basing and agile combat employment; (iv) Joint All-Domain C2 and advances battle management; (v) nearspace operations, etc. Concerning the latter, the Chinese spy balloon which floated across the US in early February could ignite a new avenue of cooperation between the USAF and the FASF, as France is about to release its strategy of Higher Airspace Operations in the one hand (HAO), President Biden has announced that an interagency review was underway "to study the broader policy implications for detection, analysis, and disposition of unidentified aerial objects that pose either safety or security risks" on the other hand.

Information sharing is vital to the success of multinational and bilateral operations, as discussed earlier. Consequently, the FASF and USAF can work on overcoming institutional barriers to change the information-sharing paradigm to allow more routine operational exchange of information.

The FASF and USAF acknowledge the dual value of common exercises, both for readiness and strategic signalling. As such, we can better synchronise planning whenever it is possible and desirable. FASF participation in the US PACOM-led Large Scale Global Employment 2023 offers a threefold opportunity: increase interoperability, test *Agile Combat Employment* concepts with PACAF; and signal French commitment to protect its interests in the region. Similarly, *Atlantic Trident 2023* and other exercises offer similar opportunities in the European theatre.

Education & Training are a critical line of efforts, whether it be through professional military education, combined training or specific formations, as well as expanding exchange and liaison officers positions within each other's operational units and staffs.

Additionally, the USAF and FASF could strengthen their cooperation in terms of capability development (including innovation) in relation with the French Procurement Agency and USAF/A5 for example, and within the joint Cooperative Oversight of Programs process (COOP) to consider the incorporation of each other's priorities, technology and systems much earlier in the development process, such as

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with the French FCAS/NGF<sup>(3)</sup> and the USAF's NGF as well as other advanced and future systems.

In parallel, the FASF and the US Space Force and US Space Command will continue to advance partnerships in the framework of the terms of reference signed in 2022 to develop information-sharing at increased levels of security classification, develop mutual education and training opportunities, and build towards combined operation in Space.

## Conclusion

"There is only fertile the great collaboration of the one through the other. And the failed step serves the successful one. And the successful step shows the path to the common end state to the one who missed his." SAINT EXUPERY (legendary French Aéropostale and French Air Force pilot and author of *The Little Prince*)

The FASF and the USAF must keep on working together to be more *integrated by design*. Yet integration does not mean assimilation and FASF will have to balance the need to strengthen integration with the preservation of its autonomy – for nuclear deterrence and for its industrial policy and in terms of strategic signalling. Admittedly and having observed, France is a very demanding ally, but reliable as much for its capabilities as for its will to use force when necessary. It is particularly true in the air and space domains, where France is—and must stay—a day-one player along with the United States.

In short, France and the US must continue to foster a comprehensive reflection on air and space domains, to discuss threats and challenges, and above all things, to put forward concrete policy orientations. Four key words must shape our strategic thinking: readiness, preparedness, sustainability, and interoperability to hedge against a more demanding future.

The new framework proposed is an opportunity to nourish ourselves on each other's experiences and perspectives in order to facilitate future military engagement and protect our common security interests. We can only be stronger together and as would say the famous French airman and writer Antoine de Saint-Exupéry, "there is only fertile the great collaboration of the one through the other". •

<sup>(3)</sup> Future Combat Air System/Next Generation Fighter.

# Arming our Airmen for Tomorrow's Commitments

Manuel ALVAREZ

Général de Corps Aérien (NATO OF-8), Director of Human Resources of the French Air and Space Force

#### A Human Resources Structure in Deficit

The General Public Policy Review (*Révision générale des politiques publiques*—RGPP), and the ensuing reform of the French Armed Forces, led to a drastic reduction in personnel, particularly in the French Air and Space Force (*Armée de l'Air et de l'Espace*—AAE), which was scaled down by 30 per cent between 2008 and 2015. Significant efforts were expended to meet this target, in terms of reorganisation, rationalisation, and outsourcing certain functions. There was a 30 per cent reduction in air base security and protection personnel, aeronautical maintenance lost 4,000 from 18,000 posts, and human resources (HR) management suffered a 40 per cent cut. Additionally, several air bases were closed, and headquarters staffs substantially reorganised. These efforts obviously put us in a difficult position, and it is now imperative to restore an eroded structure, undermined by years of cutbacks.

Since 2016 the AAE Human Resources Directorate has been working on rebuilding its manpower in order to support the modernisation of the AAE's capabilities, and to enable it to carry out its operational missions, within an increasingly tense international security environment.

Thirty years of political decisions have resulted in the distorted HR structure we are faced with today. The cohorts recruited in vast numbers after the 9/11 attacks are now reaching their first pension entitlement, and may therefore leave at any time. The structure also suffers from shortages in middle management, owing to the low level of recruiting during the RGPP years, yet it must now manage surges of new recruits. This situation has resulted in an increase in unwanted departures. The worst hit specialisations are aircrew, operational aeronautical maintenance, flight control and C2I.

In 2022, the civil aviation industry announced that it was seeking to recruit 15,000 specialists. This year, Airbus is calling for 13,000 recruits across its sites. An enticing and predatory private sector is thus competing for the specialist skillset required in our planned expansion. We must improve our attractiveness as a matter of necessity. As the President of the Republic said in his New Year's address to the forces in Mont-de-Marsan on 20 January 2023, retention must be made *an absolute priority*.

# Training Aviators for Tomorrow's Commitments

We must also permanently adapt our training procedures in line with changes in capacity and societal expectations.

### **Boosting our Appeal**

Recruitment is fed by appeal. It is a seed which requires constant nourishment, and suffers from periods of drought and frost - Human Resources abhor instability. Appeal is created step by step, through information campaigns targeting specific audiences, applying appropriate communication and marketing techniques. It is brought about through dynamic, appealing branding of the employer, and by airmen who are the ambassadors of their profession. The Air and Space Force's allure is also boosted by its operational successes, as is the positive image conveyed by state-of-the-art aeronautical exports.

A wide-ranging incentive plan, instigated in 2015, has enabled us to triple annual recruitment. The Air and Space Force's target is to recruit close to 3,800 young people in 2023. To achieve this, we have strengthened, regionalised and professionalised our recruitment drive. Our strategy has evolved to incorporate new methods, which include increased social media presence to access a pool of today's and tomorrow's youth. In 2022, 65 per cent of applications were submitted online, and 30 percent of the users on the French Air and Space Force's recruitment website, *Devenir Aviateur* (Become an airman), were online between midnight and 6 am. This has prompted us to rethink our recruiting process. Our wish to involve all airmen in this essential recruitment drive was also bolstered in an internal communication campaign coined *Aviateurs, tous recruteurs* (All Airmen are recruiters).

I must not leave out our 'ambassador airmen'. Around a hundred volunteers, coordinated via a specialised platform, advise pupils and students on their trades within the Air and Space Force. These personnel contribute to the success of our recruitment and to the noble task of informing our youth.

We must further intensify and optimise our online presence in the future, by streamlining our procedures, consolidating our marketing approach in all areas and ensuring we observe and adapt to societal changes.

#### **Retention of our Workforce**

The main challenge however, is retention. It calls for a holistic approach since the underlying issues are often intangible, and stem from emotions or feelings.

The Air and Space Force is addressing retention along to 5 lines:

• A rewarding level of pay: branch-specific retention bonuses have been created, which take into account service needs and retirement rates. This will also be achieved through a new military pay policy, which reaffirms the distinctive nature of military life, with better consideration of our community's constraints and obligations.

# Training Aviators for Tomorrow's Commitments

By adapting the compensation structure to current societal expectations and simplifying an opaque system, military salaries are made fairer and more attractive.

- Dynamic career paths, favouring internal promotion. This is a trademark of our institution, in which a Corporal can end up a General.<sup>(1)</sup> In this way in 2021, we doubled the number of junior-ranked airmen and women who became NCOs.
- Modernised, success-based training, which awards officially recognised competences. Digitisation plays a central role, as in the *SmartSchool* project, launched in 2017. This enables us to adapt to the needs of new generations, whilst optimising effectiveness and training time. Furthermore, the Air and Space Force aims to raise every airman to a higher level than that held on entry into the service, by offering professional certificates and diplomas. For instance, the NCO Training School in Rochefort has been approved to teach and to administer aeronautical technician certification exams.
- Personalised competence management, conducted through open dialogue. HR decisions, especially when unfavourable, can no longer be made behind closed doors. Here too, digitisation contributes to transparency, and ease of communication between managers and their staff.
- Lastly, an improved living and working environment. An ambitious policy regarding personnel conditions will benefit from dedicated budgets, under the control of each local commander.

Salary, career opportunities, training, dialogue with hierarchy and managers and working conditions: aside from these crucial elements, perhaps the most important criterion lies in the day-to-day relationships which bind our airmen within their units.

First of all, in the fraternal relationship between airmen, whether we call it cohesion, team spirit, a sense of togetherness or *esprit de corps*. This relationship is forged from the very start, in our basic training schools, where airmen are required to push their limits and create a team spirit. Recruits start thinking 'we' rather than 'I': this is paramount in the success of any mission. This spirit must live on, on our airbases, through preparative activities which demand mutual help and cohesion, right through to operational deployment. Naturally, the tougher the situation, the stronger the bond. We must therefore begin to foster it in peacetime, where the line between competition, challenge and confrontation, is fine. In his memoirs, *Pilote de guerre (Flight to Arras*, in the English edition), the famous French airman and writer Saint-Exupéry wrote: *Each is responsible for all*, *each is alone responsible, each is alone responsible for all*. Our bond of cohesion could not have been better summarised.

Second is the relationship between commander and subordinate. The commander is a vital focal point for personnel retention through his or her leadership style and the way in which it is exercised: by sharing the broader strategy along with the aim of mission at hand; by listening to, and getting to know, each of the subordinates and

<sup>(1)</sup> I exemplify this perfectly: I was a Corporal in December 1982, and became a Lieutenant General in September 2020.

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recognising the roles and tasks of each of them; by encouraging their work, and by making each responsible through delegation; by flexibility in work organisation, and assigning a variety of duties; and in the physical environment and material conditions commanders provide for their personnel, especially in terms of infrastructure.

The ability to command is not innate. General de Gaulle said that commanding is the culmination of a long-term endeavour: this is why the Air and Space Force invests in its officer training, and adapts to our society's evolutions, while preserving the fundamentals of the profession of arms: courage, hardiness, resilience, daring and agility.

## Adapting, Modernising and Optimising our Training

The training we provide guarantees the level of excellence demonstrated by the Air and Space Force in its missions. The expertise required to organise the maintenance in operational condition of increasingly complex weapon systems is ever more demanding. As new fields of conflict and new capabilities emerge, we must constantly adapt and develop our skills. We must train our airmen to be agile, ready to face up to the strategic, technological, technical and human challenges that are certain to appear in the future.

The Air and Space Force's training procedures are part of a transformational process based on digital innovation and on-the-job training. Technology enables us to adapt to both internal and external constraints, and allows us to improve the effectiveness of our training, through optimised teaching methods to meet the younger generation's expectations. By fostering apprenticeships, we can set our teaching into better context and at the same time alleviate pressure on our schools, reduce training time and satisfy our young recruits' eagerness to get hands-on experience of their future occupation.

We will strive to improve our training process, by designing relevant and interactive distance learning courses, accompanied by individual support when needed. These sessions will be combined with modern and effective face-to-face sessions in our schools and within the forces. They will enable us to perform better, train faster and in line with demand, and retain our spirit of achievement throughout our airmen's careers.

Human Resources are at the heart of contemporary defence challenges. We will need to modernise our capabilities to keep the upper hand and not fall behind on technological advancements. Yet behind every state-of-the-art device is an airman who needs recruiting, training, conditioning, and retaining. As recent events have shown, humans still have a relevant role in existential combat. We must continue to invest in the people who are, and will remain, the vital link in our forces' achievements. The qualities and loyalty of tomorrow's service personnel are being forged today. •

# Air Power and Moral Force

Amaury COLCOMBET

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If there is one generally agreed lesson that could be drawn from the Russian attack on Ukraine on 24 February 2022, it would probably be on the importance of moral forces in war. It is because he badly assessed the capability for resistance of the Ukrainian nation and its forces that Vladimir Putin has seen his 'special military operation' fail and turn into a long, bloody and costly war. Of course, there is nothing new in this lesson: Clausewitz made the will to fight the essential parameter of warfare. Moral forces are the cement that binds the three central elements of his paradoxical trinity<sup>(1)</sup> and as a result are the true target of strategy—the belligerents' centre of gravity. Nevertheless, a number of questions is now being raised from the very fact that all contemporary observers agree on the centrality of moral forces and their resilience as a vital lesson to be drawn from the war that has been raging in the East for over a year.

The first of these is to ask how we have managed to lose sight of such a basic axiom of warfare. The response certainly touches on the international context, coloured for over thirty years by the illusion of the triumph of universal values and the complete effectiveness of nuclear deterrence, and of their commonly-held corollary in warfare matters, that war had become the business of specialists and henceforth had a limited level of violence, now barely lethal. It was inevitable that this veil of illusion would be torn aside sooner or later, opening our eyes to the weakness of our defence arrangements in broad terms and to the magnitude of the reconstruction work to be undertaken.

Which leads us to the second question: how do we build the moral force of the nation and its armed forces? The Chief of Staff of the French armed forces has determined this as a strategic line of effort, one which requires strengthening of the link between the forces and the nation, consolidation of rear bases—families in particular—and tougher training for soldiers.

The third question relates to the previous one: how do we strike at the adversary's moral forces? This question is central to the tasks of military planning in both open warfare and deterrence. Current thoughts on merging captors and effectors,

<sup>(1)</sup> ARON Raymond, Penser la guerre, Clausewitz, Tome 1 [On War, Clausewitz, Volume 1] Gallimard, 1976, 472 pages.

full-spectrum targeting and influence have no other objective than that of injuring the adversary's will to fight.

Aviators clearly have a particular point of view on these three questions which arises from the fact that they are front-line combatants for whom operations are a permanent, everyday occurrence—they do not live the alternating cycle of operational planning and deployment on mission. For them, the mission sustains all activity; they operate from their air bases, from national soil. In a very particular way that conditions their relationship with the matter of moral force.

#### What Moral Force do Aviators Need?

The dual nature of air power (strategic and tactical) brings a form of tension to aviators' very identity, a tension evident at every level of this identity.

First, in the way he acts. The aviator is as much a 'knight of the sky', the solitary pilot admired by soldiers in the trenches in 1914-1918, as an anonymous crew member of a bomber flying over Germany in the Second World War. On one hand he represents the end point of a transformation of the isolated soldier, which began with Bonaparte's military columns as a reaction to the logic of the Greek phalanx and the Roman legions which still predominated in armies of the line in the 17<sup>th</sup> century. On the other, he is just as much a wing man who must discipline himself to keep to his position in the flight. The contrast between the hero and the phalanx has been drawn since the days of Herodotus, and is also seen in terms of virtues: the warrior fury of Homer's hero stands in opposition to the discipline of the Hoplite who had to hold the line and protect the man to his left with his shield. This contrast enabled the Roman legions to conquer the barbarians coming from the north and east; later, English archers triumphed over French knights at Agincourt but suffered the beginnings of a turnaround against Napoleon's conscripted armies. It was the furia francese (French fury), the shock action of the deep columns of the French Empire, that shook up the (admittedly smaller) armies still formed in lines. In the 20th century the same contrast was evident in the difference between the *Epinal* image, popular and idealised, of aviators as hotheads and the fact that when the Air and Space Force decided to define its values it went more for respect and service than courage and daring.

This decision also tells us that in reality courage and daring do not pose any problem for the Air and Space Force (Armée de l'Air et de l'Espace—AAE), nor indeed for allied air forces which have adopted more or less the same values (Integrity First, Service Before Self, and Excellence In All We Do for the US Air Force; Respect-Integrity-Service-Excellence for the Royal Air Force). Courage goes without saying for an aviator, first, because he has to overcome his fear to take the controls of an aircraft or helicopter and especially, as every tale and the entire history of military and civil aviation illustrate, because the mission is sacred, and because the mission forms part of aviators' daily life on their bases and elsewhere.

The tension at the heart of the identity of the aviator insofar as it concerns the use of air power is apparent in the difference, according to Clausewitz's distinction,

between strategic use, which is decisive in the war and whose direct end state is the enemy's will to fight, and tactical use during a battle, which is decisive in the theatre and whose objective is military victory. Giulio Douhet probably understood Clément Ader's premonition better than anyone, that the air arm would make face-to-face confrontation of forces obsolete, and allow the enemy's centre to be reached—his population to be attacked directly. Terror from the air has not always held its promise, except in the extreme case of the atomic bombing of Japan. The fact remains that the principle of a strategic air campaign conducted against the adversary's rear, targeting nerve centres, is virtually the sole mode of modern warfare that has been able to achieve its war aims among Western powers—the classic example being the Desert Storm campaign of 1991, but it was also the case in Kosovo in 1999 where there was no deployed ground force. The vision of an air arm exclusively dedicated to strategic use can find itself in opposition to one that is limited to tactical use in support of ground operations. A striking example of this contrast is related by the American historian Carlo D'Este in his history of the Normandy campaign. (2) During the operation to relieve American forces around Cherbourg, in order to support ground operations the allied high command had to be particularly resolute with the air operations command in order to 'borrow' bombers otherwise destined for attacks against Germany. The difference between the two schools of thought on use is well known to aviators, and is apparent in the equipment used, in doctrine and in the command structure. In reality, these two schools are complementary: they require from the air forces a level of agility that enables them to refocus their effort according to ever-changing political, strategic and tactical stakes. The multi-role capability of assets is one particular response to maintaining the balance, from the Rafale to the A330 Multi Role Tanker Transport (MRTT) via the A400M.

The tension is also apparent in terms of service identity: for many years, air forces were simply components of land armies. It was only the strategic use of the air arm, initially in the British Empire and later, on creation of the US nuclear deterrent, that gave birth respectively to the Royal Air Force in 1918 and the US Air Force in1947. In France, the Air Force gained its independence in 1934 as the result of a political compromise. Still today, the AAE is alone among the three services to be both an *army* in the primary sense of the word—that is, responsible for directly obtaining military effects (or even strategic or political ones, in the case of the AAE), and also a support or reserve force—in other words, more an *arm* than an army. Support of airborne operations and fire support to air-ground operations often reduces the Air Force to the level of helper or enabler, rather than leader.

One could discuss further the existential tension at the heart of aviators' identity. Even within our common experience it is evident: between the realist view of international relations of the combat crew and the more constructivist view of the transport crew. Suffice it to sum up these opposing views by saying that power from the air is, as ever, fundamentally renewing strategic debate by questioning its key concepts. That aside, what concerns us here is knowing how this tension acts on moral force.

<sup>(2)</sup> D'ESTE Carlo, Decision in Normandy, Collins, 1983.

In essence, the identity tension could be expressed very simply, even simplistically, as the contrast between barbarism and civilisation. On one hand the aviator is the modern knight who takes it upon himself to represent an entire nation in a singular combat whose outcome will be decisive. Symbolically, he is David facing Goliath, the Horatii against the Curiatii: he somewhat incarnates the civilisation that limits warrior-like violence. General Philippe Steininger<sup>(3)</sup> expresses this idea when he evokes the elitist character of air warfare. In stark contrast, in particular during the Second World War and in other more limited conflicts, the aviator has been the very person who unleashed all the blind brutality that technology could devise upon the civilian populations that several centuries of civilisation had managed to spare from the violence of war. Mass bombing has gone, thanks to the considerable progress made in targeting and accuracy of weapons, albeit it remains real in a virtual sense in the context of nuclear deterrence, even though the contrast with the other concept of attacking only centres of power is again telling here. To sum up, whilst air power can sometimes domesticate, civilise or even normalise this violence, it is also the means that makes possible and real an escalation to theoretical extremes, albeit judged impossible by Clausewitz. This alternative (barbarism vs civilisation) puts a heavy responsibility on aviators.

Responsibility: the key word with the double meaning of a burden to be both borne and faced up to. It is within the second of these meanings that aviators of all nations have developed their culture of responsibility, and it is in this culture that we find a response to the question of moral force.

It is logical, almost intuitive, to seek support from within the group (family, unit, regiment, arm, service, nation) in order to recharge the batteries of moral force. The famous French airman and writer Antoine de Saint-Exupéry expressed the reality of this very well in *Flight to Arras* (published as *Pilote de guerre*, 1942), '*I am of them, as they are of me*'. The feeling of belonging is at the heart of the notion of identity. Our family, friendly, professional and national relationships are like coordinates that define a point in space—they define not only where we are but also who we are.

That said, reinforcing the group is not sufficient to maintain the moral force of aviators, since their identity does not boil down to simple membership of a body: its essence is to be found in the notion of responsibility. Aviators are people who feel responsible: cultivating their resilience requires allowing them to accept their responsibilities. Because of this, the moral resilience of aviators is found in an ethos of action; the manner in which it is put into practice has been very well described by Lieutenant Colonel Florian Morilhat. On one hand it is the ability to do their job properly and on the other, to be ethically responsible for their decisions and for their ethos of conviction, according to the circumstances. This double requirement is summed up in the word *professionalism*.

<sup>(3)</sup> STEININGER Philippe, *Les fondamentaux de la puissance aérienne moderne* [The fundamentals of modern air power], L'Harmattan, 2020, 224 pages.

<sup>(4)</sup> MORILHAT Florian, Éthique et puissance aérienne [Ethics and air power], Économica, 2020, 112 pages.

#### What is the Role of Air Power in Destroying Adversaries' Morale?

This primary approach to the issue of moral force is nevertheless secondary to the wider matter of collective responsibility with regard to air power. Thus far we have examined the question from the angle of the individual, of what makes up his personal identity, as well as through the issue of belonging to the group. However, beyond the identity of an aviator, it is the identity of aviators which constitutes this collective responsibility. This is the fruit of mastery of the air environment, the sum of knowledge, skill, and practices which silently form a culture. Even without restricting the concept of culture to what the German-American political scientist Alexander Wendt referred to as the sum of shared knowledge, we can nevertheless recognise in common practice and daily experience of the air and space environment a fundamental element which leads to an original vision of the world. This collective responsibility generates obligations that go beyond those of individual responsibility which, when it comes down to it, is a matter of a single ethic—professionalism. Collective responsibility puts a moral duty on the group, in this case the family of aviators, with regard to those outside the group, the public, and in relation to the aim of the group, which in this case is air power, or air activity in general. Just as doctors have a collective responsibility in the case of an epidemic (of informing the public and publicising good practice), aviators have a collective responsibility towards the public. This involves ensuring that the country is warned of the implications of air activity in war and as far as possible is ready to face it. The notion of collective responsibility is not unique to aviators—it applies equally to sailors, soldiers, cyber-combatants and others in their respective fields. In the aviators' case, however, expertise and experience of the air and space is something difficult to share (here we find the notion of elitism), hence the responsibility that results from it is even greater.

The consequences of the intervention of an air force in war have a direct and immediate effect on the notion of resilience and morale. What finer, yet more tragic illustration of moral force could there be than the resistance of Londoners during the Blitz? Resilience was certainly needed to endure with such fortitude the war of attrition waged by Adolf Hitler: only the devastating power of the German bombers could test to that degree a people accustomed to the hardships of the continental blockade. The third dimension is the one that can extend beyond the front in order to reach the centres of gravity, whose collapse would lead to the destruction of the adversary's capability for resistance—more precisely, his resilience, be it moral or material. In this respect, the contrast between the 1991 Gulf War and the Russian campaign in Ukraine is striking. In one case, a month-and-a-half long air campaign with more than 1,000 daily sorties (100,000 sorties in 43 days), followed by a ground offensive lasting 100 hours; in the other, one brief day of 'preparation' from the air before a ground assault that was never completed because it was impossible.

Regarding moral force and resilience from the aviator's point of view, the challenge of what we are learning from the war in Ukraine after a year of fighting is precisely that we should avoid considering such teaching as definitive lessons. If we were to believe some analysts, air power has been made obsolete by air defence systems and the

major issue is the omnipresence of UAVs. They say we are seeing the return of fire-power (from artillery) and tanks. Indeed. These conclusions should not hide the fact that the Russians did not exactly conduct an air campaign before their ground attack. One must take note of the fact that if Western forces had planned the same operation, they would have set about it completely differently, as the history of recent conflicts illustrates. The Russian error probably stemmed from poor assessment of the capability for resistance of the Ukrainian State and the will for the survival of the Ukrainian nation—the famous moral forces. It might also come from the incapability of Russian forces, Russian air forces in particular, to reduce this capacity for resistance before starting ground operations. That is even without mentioning the necessity to reduce Ukrainian defence (which ought to have been the aim of the first phase of the campaign): the elementary points of the operational plan should have included assurance of control of airspace in order to guarantee freedom of action on the ground.

Put another way, both history and strategic science teach the central position of air power in modern warfare. Aviators' collective responsibility is therefore to show moral force (!) by calling upon it in both good and bad times.

### Conclusion: the Tyranny of the New

The war raging in the east of Europe is offering lessons to be learned for our Air and Space Force: the importance of Suppression of Enemy Air Defence (SEAD), of the use of drones, of drone countermeasures, of taking attrition into account when defining our format whose crew training activity can no longer be the sole parameter, the importance of the reserves—a corollary of attrition, all to maintain freedom of manoeuvre and decision for the President of the Republic.

Nevertheless, the principal lesson is probably the fact that we are collectively surprised to rediscover the fundamental importance of resilience and moral forces. Heraclitus said, 'No man ever steps in the same river twice', so Ecclesiastes answered, 'There is nothing new under the sun'. We must beware of thinking as new that which has always been the case and as permanent, that which is fortuitous. War remains a battle of wills, a business of passion, intelligence and determination, unchanging in its violent nature. The manner of combat, on the other hand, has changed since 1914 even if the Russia-Ukraine war might make us think the opposite. The security of the French and of European peoples is at stake and will play out first in the air and in space. It behoves the family of aviators to carry this message, and to organise themselves to ensure it is carried, at a time when strategic decisions are being made. For aviators, the matter of moral force is not so much one of developing it within their group, since courage has always been a natural value for each one of them and still is, but more of bearing it for the benefit of the whole nation. •



## Philippe ADAM

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pace pervades every aspect of current human endeavour and plays a growing role in defence and security matters. The strategic stakes it raises are encouraging competition between powers, and risk leading to contest for that domain. Space infrastructure confers on military operations an essential factor of operational superiority which will in the future be extended to collaborative combat systems. The conflict in Ukraine has recently demonstrated the strategic importance of the space domain, in particular through the role played by commercial organisations, whose support in terms of positioning, communications and remote detection has been made widely accessible down to the lowest tactical level.

## **A Space of Confrontation**

The continuum of competition—challenge—confrontation is the current standard interpretation of forms of conflict. Space is well-fitted to this approach since the space domain is a grey area that encourages the often insidious deployment of hybrid strategies. This grey area is characterised by the intrinsically dual nature of the spatial environment, of those who act within it and of their techniques and capabilities. Characteristic also are the absence of borders and territories, the difficulty in detecting abnormal or hostile behaviour in real time, its regulation mechanisms which are no longer suited to the growth of space traffic, and the arrival of new actors.

Given the acceleration in these new changes, the President of the Republic declared on 13 July 2018<sup>(1)</sup> that space had become a genuine challenge to national security. The national Space Defence Strategy (*Stratégie spatiale de défense*—SSD) presented in July 2019<sup>(3)</sup> echoed French concerns about the emergence of new space-related threats. The SSD is aimed at strengthening our strategic autonomy in space and ensuring our freedom of access to that environment, and sets the objective of

<sup>(1)</sup> MACRON Emmanuel, Declaration of the President of the Republic on defence policy and external military operations, Paris, 13 July 2018 (https://www.vie-publique.fr/).

<sup>&</sup>lt;sup>(2)</sup> Incorporated into the 2017 Revue stratégique de défense et de sécurité (https://www.vie-publique.fr/).

<sup>(3)</sup> SPACE WORKING GROUP, Stratégie spatiale de défense [Space defence strategy], Ministry of the Armed Forces, 2019 (https://medias.vie-publique.fr/data\_storage\_s3/rapport/pdf/194000642.pdf).

<sup>(4)</sup> Especially the activity of the Russian *Luch-Olymp* satellite.

protecting our space interests within respect for the peaceful use of space. There is also the question of revising our industrial model by benefiting from the opportunities that *New Space* offers and by contributing to (re)making France a driving force in Europe in space matters. Extension of such cooperation to operations in space is a further consideration.

The legal framework relating to activities in space is somewhat liberal and open to different interpretations. Favoured hybrid strategies combine conventional threats with concealment, access denial and harassment activity below the threshold of armed aggression, which confirms the use of the law as a strategic weapon of power. France is not inactive in this regard, and promotes responsible behaviour in space through a pragmatic approach at the European level.

Another structuring change is the emergence of what is referred to as *New Space*, which has eased access to space and to space capabilities. Thus, space is witnessing significant development and offering new opportunities, but is also introducing numerous risks and threats into what is now considered the fifth environment of conflict after those of land, sea, air and cyber.

European strategic autonomy is currently suffering economically, from the timescale between the end of the *Ariane 5* programme and the arrival of *Ariane 6* and structurally, from international competition, which is adapting to material that is (partially, at least) reusable. In 2022, of the 91 American launches, 61 were performed by SpaceX, which has announced 100 flights for 2023—a launch every 4 days! In 2022 there were also 64 Chinese and 22 Russian shots, yet only 5 European. Following a period of transition between the retirement of its space shuttle in 2011 and the appearance of a new model of governance, the United States now enjoys a sort of hegemony with its dynamic and competitive commercial sector and actors such as SpaceX, who have vertically integrated their value chain.

Once all of these challenges had been identified by the SSD in July 2019, it became imperative to implement it immediately at both structural and operational levels. Space Command (*Commandement de l'Espace*—CDE) was created, and took over from its predecessor, the Joint Space Command (*Commandement interarmées de l'Espace*—CIE).

# A Command Fitted to the Challenges of Controlling Space, Identified in the SSD

#### The Genesis of Space Command

On creation, the CDE had 220 personnel, divided across 4 sites (Creil, Paris, Lyon and Toulouse). The number has increased by about 50 each year, and by 2025 should reach some 500, who will work together in a new building in Toulouse.

Foreshadowing that date, administrative group 101 (Formation administrative 101) was created in January 2021. It is housed in modular buildings on the

Toulouse space centre (*Centre spatial de Toulouse*—CST) site in the National Centre for Space Studies (*Centre national d'études spatiales*—Cnes), where the core of military space operations (*Opérations spatiales militaires*—OSM) will be sited.

Space Command is tasked with ensuring control of military assets and space surveillance, contributing to alerting the population in case of an incoming danger from space, planning and conducting military action in space, ensuring the support of space capabilities and offering space support to operations.

#### The command centre, key to building up the strength of our organisation

Around 2025, the *Astreos* space operations information system will be the foundation of our military space system and will be the interconnected operational backbone of the space defence system. It will be essential to the conduct of space operations, control of the environment and support of multi-domain operations.

It was developed to support the C4 functions of space operations (command, control, communications and computers) and will be able to collect, store and handle considerable quantities of data in real time, connect and control all elements of our space system, direct our sensors in near-real time, call on major computing power appropriate to our operational needs and, lastly, to exchange information with other domain and allies' command centres.

To achieve these aims, the *Astreos* architecture will be built around a data centre. When associated with high performance computing, this will enable collection of all data coming from space-based sensors and handle it in a lead time suited to the conduct of operations. *Astreos* will therefore be material evidence of the build-up of space defence within the armed forces and a showcase of our capabilities and of our space expertise. For these reasons the development of *Astreos* to unite command and control of military space operations must be central to our considerations in the years to come.

Expertise in space with regard to the surveillance and protection of our interests in that environment is essential to the military services rendered by CDE and carries dual benefits. This duality requires coordination and sharing of information between the various actors. For example, the European IRIS<sup>2</sup> constellation (Infrastructure for Resilience, Interconnectivity and Security by Satellite) will enable high data rate, short timescale connectivity, able to cover the poles. The European constellation will also be able to offer an inter-satellite communication relay service, a transport layer which will contribute to the formation of an overall, resilient space architecture.

A further example of the duality is space surveillance. Responding to a need for space traffic management and for identification and attribution of activity in space the topic is being dealt with at the institutional level within the European Union Space Surveillance and Tracking (EU SST) framework. It is a partnership of 15 EU member states which are now putting together their national SST capabilities in order to offer three services: collision avoidance, analysis of atmospheric re-entry risks and analysis

of fragmentation of debris. It is intended that these services will broaden and diversify in the future in order to rise to the challenges posed by space becoming more and more crowded with smaller and smaller objects. The French large-array space surveillance radar, *Graves* (*Grand réseau adapté à la veille spatiale*), has recently been renovated and will be developed further in response to these mutual needs. The duality of use, to serve both the wider community (for safety aspects) and the military community (for security matters) is fundamental to the partnership with the commercial sector, which complements our national data.

### The Balance Between Public Sector and Services: Support of the Private Sector

The conflict in Ukraine is highlighting the role that commercial actors can play, be it at the strategic, operational or tactical level. Ukraine depends on space-related services, such as internet, telecommunications, optical, radar and infra-red imagery, and eavesdropping, often supplied by private, mostly American companies, a diversification of the actors in the ecosystem and of perspectives for dual applications. The presence of these new actors is an opportunity for complementing our national capabilities, which nevertheless remain essential to our independence of assessment. Military space operations have therefore been drawn towards making use of commercial solutions which are integrated into operations via a Commercial Integration Cell. The pertinence of including commercial actors in space defence has been demonstrated in the framework of the *AsterX* military space exercise, organised by CDE. Buying-in services increases the speed of procurement and adds dynamism to the national space sector by creating a virtuous circle, linking industry with orders from the public sector.

The way this cooperation works with the commercial sector allows CDE to build up its capabilities on three levels: the sovereign and extended core capabilities, and the complementary capability. The sovereign core corresponds to our nationally owned equipment, and the extended core guarantees us access to services from our allies or trusted operators, whilst the complementary capability focuses on purchasing services with no particular guarantee.

To be in control of this issue we need to have knowledge of our competitors' space ecosystem in order to measure their degree of use of the new private space infrastructure. On the other hand, we also need to take control of exports to protect against any form of misappropriation of national commercial capacity. Furthermore, we need to broach doctrinal matters—something Russia has already done in its declaration to the UN that commercial space infrastructure would become a legitimate target in the case of 'reprisals'.

As the public/private balance evolves, the innovation brought by the private sector offers responses to the highly strategic matters of improvement and diversification of revisit frequency. We will eventually need access to near-real time solutions from radar, multi-spectral and optical data integrated into our space operations information system.

#### Advancing innovation through symmetry between the private sector and the forces

In coordination with other actors in the field, a military space lab has been established in Toulouse with the help of Aerospace Valley, in order to get the best from the innovations offered by French New Space. The proximity to the Defence Innovation Agency (Agence de l'innovation de défense—AID), Cnes, the Directorate General of Armament (Direction générale de l'armement—DGA) and the French Aerospace Lab (officially, the Office national d'études et de recherches aérospatiales—Onéra) will allow pooling of ideas and facilitate definition of needs which will benefit future military space capability and, ultimately, bring innovative projects to life. The space lab is called Lisa, the Forces' laboratory for innovation in space (Laboratoire d'innovation spatiale des armées).

This new innovative wave, carried along by agile structures of new methods of production and management, is catalysing innovation and feeding on the expertise developed by past actors. It is not a question, therefore, of opposing *Old Space* with *New Space*; more one of benefiting from their complementarity.

#### Strengthening bilateral and multilateral cooperation

International partnerships have a particular importance in space matters. Above all, interaction is possible with all other actors independent of geographical proximity, added to which, partnerships are a measure of both operational effectiveness and resilience.

Though historically having focused on capabilities, international cooperation is increasingly investing in the field of military space operations. This new priority brings with it new challenges in terms of interoperability and information sharing in a field considered strategic: multilateral discussions in the EU or NATO are crucial here. In 2020 France joined the Combined Space Operations initiative, (5) whose aim is to set the boundary of future multi-national military space operations.

#### Objective 2025: Time is not on Our Side

The 2025 milestone will mark the end of the build-up of CDE since it corresponds with achieving initial operational capability to counter increasing risks and new threats.

# A cyber risk identified in the 2019 Space Defence Strategy, which has worsened since then

Though the consequences to the ground user segment have remained limited, some of the past attacks nevertheless confirm the strong interdependence between space and cyber domains, and the fact that such a mode of operation can carry a potentially

<sup>(5)</sup> Which brings together the Five Eyes nations (Australia, Canada, New Zealand, United Kingdom and United States) and Germany.

significant military effect on the adversary while remaining below the threshold of conflict.

Three major categories of cyber attack on space infrastructure can be identified: denial of service, misappropriation and seizing control, which amounts to sending spoofing signals on the up-link.

Lessons learned from the war in Ukraine about cyber attacks, availability to Ukraine of American commercial services for connectivity, observation and eavesdropping, and jamming of satellite positioning and navigation systems in the area which disrupted civil and military activity, all underline the relevance of the SSD regarding the importance of control of data.

#### A cyber risk demanding effectiveness and resilience in our control of data

In the context of *New Space*, we have to adapt the architecture of space systems on two levels: resilience in the face of new threats, and control of data.

We need to examine rapidly the question of active defence in order to face up to new threats in low orbit. Active defence has several dimensions and might be effected by lasers or patrolling surveillance satellites which could be put reactively into a chosen orbital plane. Innovation will be the key to rapid achievement of this ambition.

Our resilience will also be boosted by the implementation of the major impact *Action et REsilience Spatiale* (ARES—space action and resilience) programme with a view to increasing the forces' capability for action in space. Through it, a means of active defence will enter operational service in geostationary orbit before the end of the decade.

Reduction in the acquisition time for space data is critical, especially in the context of the Ukrainian conflict where private constellations have demonstrated their value. The aim of the *Chronos* project, which started in 2022, is to reduce the current delay between acquisition and availability of information, 24 hours on average, to under one hour in the majority of cases whilst improving the resilience of the acquisition arrangements. *Chronos* is based on national building blocks which largely already exist, and on capabilities available off the shelf or from service providers. The project is bringing together all actors in the domain, and is paying special attention to the French and European defence industrial and technological base.

#### Conclusion

Having demonstrated the relevance and interest in centralising the expertise and responsibilities of the military space domain, the CDE holds all the aces for achieving its objectives by 2025. Today it is essential to understand and control our environment if we are to continue to operate within it. This objective will be met in particular through deeper relationships with our national, international and commercial partners.

March 2023

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efinition of a defence system is initially established from an assessment of current and future threats. Recent analyses of strategic reviews found them to be the prevalence of extra-territorial terrorist groups threatening French interests. The French forces were therefore shaped to suit the type of operations France conducted in Afghanistan, and still conduct today in Africa. The physiognomy of our forces is of an expeditionary corps sized to respond to asymmetric or guerrilla wars against terrorist groups. Ground-based air defence—GBAD (in French, *Défense solair*—DSA) had no place in this arrangement because of the lack of any definite air threat in external (out-of-country) theatres of operations. Hence GBAD fulfilled its role as an operational link in the homeland air defence chain, primarily in support of the permanent air security posture (PPS Air).<sup>(1)</sup>

The GBAD component is preparing to join the Combat aircraft brigade (*Brigade aérienne d'aviation de chasse*—BAAC), <sup>(2)</sup> at a time when the air threat has been clearly evident for a number of years and we are recognising yet again that in adversity we need a credible and sturdy GBAD to contribute to control of the third dimension and maintain air superiority. After the budget reductions which led in particular to relocalisations and loss of personnel, and the consequential reduced aspiration to establish a massive GBAD force, we are rediscovering the advantages this capability brings in the face of a well-equipped and determined adversary who, with his conquest of the air hampered by these weapons systems, is unable to achieve his desired military effects.

In Nagorno-Karabakh and the use of drones by Azerbaijan, Russian A2/AD<sup>(3)</sup> (*S400* and other systems) used in Syria in particular, the Houthi attacks in Saudi Arabia and the United Arab Emirates (UAE), Ukrainian resistance to overflight of its territory, hypersonic weapons and loitering munitions—all of these examples underline the importance for our deployed troops and for our population to have a credible, agile, multi-layer GBAD which is effective in the long term. The war in Ukraine

<sup>(1)</sup> Posture permanente de sûreté aérienne—PPS: a standing priority mission of the Air and Space Force to ensure the sovereignty of national airspace, ward off air threats and bring assistance to aircraft in distress.

<sup>(2)</sup> This is one of the consequences of the *Altair* Plan, which aims to bring operational and technical elements together within the BAAC from the summer of 2023.

<sup>(3)</sup> A2/AD = Anti Access/Area Denial.

announced the return of a confrontation between two state armed forces: a high-intensity war, just the type of conflict with which GBAD is intimately associated. Sadly, we are living in a period which suits this specialist component of air defence.

## The Expertise of GBAD in the Air and Space Force

The 4 GBAD squadrons (*Escadrons de DSA*—EDSA) of the Air and Space Force (*Armée de l'Air et de l'Espace*—AAE) are particular in being multi-missioned and also having multiple systems, with the medium-range ground-to-air *Mamba* system (*Sol-air moyenne portée*—SAMP) fitted with *Aster 30* missiles, the new generation *Crotale NG* with its *VT1 MO2* missiles and counter-drone/UAV systems (*lutte anti-drone*—LAD). They contribute to PPS Air, the protection of nuclear-capable air bases, counter-drone activity, the support of operational ground forces and, more recently, to external operations. Moreover, their crews all train effectively to maintain a number of rare skills in terms of electronic warfare, mobility, coordination, tactical data links (TDL), work in non-segregated airspace with friendly combat aircraft and so on. Simulation is a further tool which permits us to maintain our capability to deal with very dense aerial situations, synonymous with saturation attacks of a type to be expected in high-intensity warfare. Attacks by salvoes of cruise or ballistic missiles have always been at the centre of our tactical thought in order to train our personnel for war and to push them to the limit on the principle of 'training hard for an easy war'.

We are ever-present on operations—indeed, few combat units are are as stretched between operations on national territory, recent returns from external operations, basic training and operational preparation. Such is the complexity of planning that we have little time for training new personnel and repairing materiel.

Looking a little closer at the missions achieved over the years, it is apparent that adaptability and expertise are characteristics of GBAD units. Their operational preparation means GBAD squadrons achieve excellent results during international exercises, such as during Aurora 17 in Sweden, where in under 15 days the deployed unit achieved integration into an air defence network via Link 16<sup>(4)</sup> to protect the city of Stockholm with a multi-layer layout of Crotale NG and Mamba. This mission demonstrated the skill of the teams in terms of interoperability and logistics and multimodal transport by rail, road and ship. These high-level exercises contribute to honing the skill of our operators so they can conduct support operations to the PPS Air. It is worth taking note of the extraordinary challenge presented by the deployment of ground-air systems armed with real missiles in the Paris region every year for the 14 July ceremonies: a deployment worthy of war, in peacetime. In parallel, since January 2021 external operations have become daily business for the GBAD: Crotale NG completed an air defence mission for the UAE against attacks from Houthi drones, and since May 2021, GBAD has been supporting NATO reassurance measures on Europe's eastern flank by securing Romanian airspace 24 hours a day with

<sup>(4)</sup> Link 16: NATO tactical data link that allows exchange of information between military units integrated into a single network

Aster 30 missiles and radars—an operational mission certified by a number of NATO AIRCOM evaluations. (5)

### **Multiple Challenges**

The multiplication of airborne threats, together with rapid development of adverse modes of operation in an international climate of rearmament, is echoed in the indispensable increase in the GBAD's activity. The range of threats to be dealt with by air defence, and especially by GBAD, has become very broad and necessitates great adaptability of personnel and systems. The range extends from mini-drones to loitering munitions, from hypersonic missiles to ballistic missiles, not to mention the cyber threat and electronic warfare.

Velocity, saturation and stealth are the three parameters characteristic of the air threat and which dictate the response needed. When these three parameters appear together, interception becomes particularly complex and imposes very short reaction times, which simply confirms the importance of promoting GBAD to front of stage to find appropriate ripostes and technical solutions.

#### Operational Challenges in an Uncertain World

In an environment of general rearmament and the return of high-intensity conflict on Europe's doorstep, the challenge presented to GBAD is vast and backs up the principle of multi-layer defence. The short and medium-range components need to be retained and increased in number. Assets would be deployed in national territory for air defence missions and in support of the PPS Air but could also be deployed abroad, as they are today on the eastern flank of Europe. ABM defence will be among the capabilities to be strengthened, with the considerable contribution of *SAMP NG* (new generation), which will replace the current *SAMP Mamba* around 2027.

Looking now at countering mini-drone activity, on the French mainland and with inter-ministerial collaboration there are some major events programmed—the Rugby World Cup in 2023 and the Paris Olympic and Paralympic Games in 2024. The transient and many-formed threat of the mini-drone is another distinct operational challenge that has also to be faced in theatres of external operations.

The coordination of ground-air assets is part of a greater entity, Air C2 (Command and Control), which has to incorporate an incredible amount of information to handle threats, maintain the overall picture and, ultimately, engage hostile targets with the most appropriate effectors.

At the same time, we have to prepare for conflicts in which non-standard cases arise and where we have to return to fundamentals and be able to work in highly degraded conditions, as the Serbs had to do when facing NATO aircraft during the battle of Kosovo, and as the Ukrainians are doing today. When communications and

<sup>(5)</sup> See in this volume the article by General DELERCE, p. 18-24.

data links are jammed, the *what ifs?* <sup>(6)</sup> and the rules of engagement drawn up and tirelessly studied during training start to make sense. The cunning, mobility and discretion of ground-based air defence operators will be what makes the difference in waging a kind of guerrilla ground-to-air war, should it be necessary.

#### Capability Challenges, or the Need for Systems of Systems

To maintain the concept of multi-layer GBAD through an air defence continuum structured on robust C2 it is essential to retain the short-range capability which was to be reduced on retirement from service of the *Crotale NG* in 2026-2027. A decision has recently been taken to offset the phased withdrawal of the first weapon systems by the purchase of short-range, vertical-launch Intercept, combat and self-defence missile systems (*Missile d'interception, de combat et d'autodéfense*—MICA). This buffer, or gap-filler, will serve until the arrival of a future system called lower layer ground-air (*Sol-air basse couche*—SABC), which will not be until around 2035. By continuing the short-range capability of the AAE we will calmly and efficiently be able to mount 3-dimensional air defence protection structures from ground level to space. From 2027 the *Samp NG* will be introduced into the forces, improving detection capability with the more powerful *GF 300* radar and interception capability with the *Aster30 B1 NT* (block 1, new technology) missile. This new weapon system will bring considerable added value to the battlefield.

Countering drones (the *LAD*), will also require new, highly adaptable and modulable systems in light of the permanent evolution of the threat. It will be necessary to focus on C2 systems connected to a considerable number of captors and sensors in order to ensure the best results for detection and neutralisation. This concept is already in use with the *BASSALT* system, which brings together information from various optronic, radar or goniometric sources. Innovation will be the key to avoid lagging behind in the face of a constantly evolving drone ecosystem.

The GBAD's expertise in coordination, part of the DNA of the Air and Space Force, will be retained in the Centre for 3rd dimension defence management (*Centre de management de la défense de la 3<sup>e</sup> dimension*—CMD3D), which again has a strong culture of a system of systems in which integration of all capabilities that react to the various threats will guarantee effectiveness of the command and also reliable, controlled integration of airborne effectors, notably combat aircraft and UAVs.

#### Challenges of Human Resources (HR)

The GBAD needs experienced personnel, *au fait* with new forms of conflict and in sufficient number to be trained and to fulfil operational tasking over the long term. The organisational requirements of GBAD squadrons mean much multi-tasking of personnel in order to fully man the teams operating weapons systems round the

<sup>(6)</sup> Set of non-standard cases envisaged during preparation of a mission and planned for in order to react as rapidly as possible, should they occur.

clock. Our current HR model needs revision and there needs to be considerable effort on recruitment in the coming years across all specialisations—operators, mechanics and network technicians.

Retention of qualified personnel will be a high-priority challenge in view of the amount of training to be completed in order to reach the required operational level. Our operators need to be multi-skilled to be able to communicate with combat aircraft pilots, air controllers, communications specialists, logisticians and their fellow sailors and soldiers, as well as with foreign partners. We are really speaking of a specialisation which combines mobile deployment on the ground, tactics similar to those of combat aircraft crews, control of the third dimension and connectivity using TDL in order to be totally integrated and interoperable. All this demands an extraordinary culture and an exacting ability to adapt—assets worth developing to maintain top-ranking GBAD within the AAE.

#### **Towards More Robust GBAD**

Ground-based air defence brings permanence to the field of operation, immediacy of engagement and formidable firepower. The ground-air component is now able to take on this level of coordination and optimisation of air defence cover in non-segregated airspace in real time, particularly through integration with other ground-air components such as the Army's *Mistral* very short range surface-air system (*Surface air à très courte portée*—SATCP). This requires a high level of technical ability and training, and perfect mastery of procedures.

The AAE's GBAD units mark achievements on every operational deployment. The specialisation demands a broad three-dimensional culture, deep knowledge of TDL and the ability to speak the language of all involved in air operations whilst remaining ground-based combatants. Despite having been kept on national territory for several decades, GBAD has continued to maintain a high level of expertise in weapon systems and unfailing selflessness whilst patiently waiting for a true operational commitment. For about a year, it has been doing exactly that in Romania, and it should be noted that the GBAD is now widely present on operations.

Ukrainian GBAD experience is indicating that we should revise our manuals on air defence. Some people seem to be rediscovering the importance of mobility of weapon systems and of minimising our EM transmissions. Mobility and discretion have been, are and will always be the two parameters to have perfectly under control in order to survive on the battlefield as a GBAD operator. It is enough to look at feedback from the war in Kosovo, in particular the eloquent lesson of the supposedly undetectable F-117 which was shot down by an old-generation Serbian system.<sup>(7)</sup> There is nothing new in the East.

<sup>(7)</sup> The witness:...sorry, we didn't know your aircraft was invisible, statement noted in 2021 by Lasha OTKHMEZURI and Nikola GRGIC, Guerres & Histoire, No 70, December 2022, p.34-42.

The Ukrainian GBAD force also relies on the number of weapon systems deployed in the theatre, how they are networked and on the high level of tactical sense of their operators. Feedback is beginning to emerge, but once again we need to analyse it carefully before drawing too-hasty conclusions.

We are now living in an era where weaknesses cannot be hidden. The increasing international tension is revealing our flaws, as are numerous studies and notably the National Assembly's Committee on national defence and the armed forces, which recommended more material and increased manpower. It is high time we strengthened this component! •

<sup>(8)</sup> COMMITTEE ON NATIONAL DEFENCE AND THE ARMED FORCES, Mission flash sur la défense sol-air en France et en Europe [Rapid parliamentary enquiry on ground-based air defence in France and Europe] (Rapport d'information No 866), 15 February 2023, Assemblée nationale (https://www.assemblee-nationale.fr/).

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*ronisation*<sup>(1)</sup> is a phenomenon now apparent in all physical operational environments. Western air forces have been showing renewed interest in drones since the war on terrorism, but the confrontations in Syria, Libya, Nagorno-Karabakh and now in Ukraine show that they now play a major role, whatever the nature of the conflict.

Western forces are therefore seeking the best possible balance between piloted and remotely controlled vehicles for coherence in their capabilities. Such considerations are particularly relevant with the return of high-intensity conflict in which the stakes of mass and cost, both human and financial, are determinant.

#### **Changing Trends in the Use of Drones**

#### The limitations of drones in non-permissive air environments

Because of their characteristics, which include endurance, cost-effectiveness and remoteness of the pilot, drones have been regularly presented as a substitute for piloted aircraft in the medium to long term. Nevertheless, their technical limits and considerations of future scenarios for the use of forces mean that this idea of the drone as the sole capability for the future needs to be refined somewhat.

Those who would advocate the all-drone solution base their arguments on feedback from drone use during counter-insurgency operations in Iraq and Afghanistan. In those cases, they were permissive air environments with no air-air, ground-air or air-ground threats and without any in-depth strike operations, so the field was left free for drones. The page would seem to be turning, and it is becoming more complicated for Western forces to impose air superiority. Whilst this might seem obvious in a dissymmetrical confrontation between two state actors, this hardening of the third dimension is now seen in low-intensity conflicts as well.

<sup>(1)</sup> Editor's note: in the context of airborne craft, the terms *unmanned aerial vehicle* (UAV) and *drone* are generally interchangeable.

This shift in the likelihood of losses puts the spotlight on several factors that limit the use of drones, starting with their lack of on-board means of self-protection. Even though drones have low radar cross-section and low acoustic signature, they are not *stealth* nor do they carry electronic countermeasures (ECM) or decoys. Moreover, their low speed and manoeuvrability reduce their survivability when challenged by even rudimentary enemy surface-to-air missile systems.

The majority of drones are also sensitive to the electromagnetic (EM) environment. A contested environment will affect the performance of the on-board navigation and electronic instruments: data links with the ground station could be corrupted or quite simply, cut.

#### The rush for small drones and rebalancing the offensive/defensive ratio

Small, tactical drones do not appear to spark the same criticism. Though the losses of these drones are considerable, they are compensated by their low cost, which means they are considered as consumable items. Both sides in the war in Ukraine are using small drones in massive numbers. The potential of these smaller models opens up new operational perspectives in terms of saturation attacks. Nevertheless, the military promise of the segment needs to be carefully considered, too. First, countermeasures now exist, and various jamming systems (including anti-drone guns and electronic warfare—EW equipment) have on several occasions prevented drone use in the Ukrainian theatre.

Second, improved defence systems will automatically lead to a shift in the force balance between sword and shield. Whether by improved sensors (surveillance and tracking radars) or effectors (directed-energy weapons and anti-drone drones), the proliferation of Counter-Unmanned Aircraft Systems (C-UAS) within defence industry augurs tipping the balance towards the defensive. The real question, though, is to know which system will offer the best defence against drones at a proportional cost.

# Current State of development—priority to complementarity of manned and unmanned craft

The current technical weaknesses of drones and the gradual improvement in air defence mean that prophesies of the end of manned aircraft in the near future need to be kept in perspective. Combat aircraft have technical characteristics that most drones do not have, and Unmanned Combat Aerial Vehicles (UCAV) have yet to demonstrate their effectiveness in relation to their development cost. The differences between the two types of vehicle are encouraging parts of the R&D sector to design an unmanned platform with technical and employment characteristics similar to those of combat aircraft. Although these combat drones offer advanced flight performance, greater autonomy and an increased and more varied payload, research is showing them to be just as costly as manned aircraft, which undermines their cost-effectiveness and their 'consumable' advantage.

More generally, the *dronisation* of the third dimension is being held back by social and cultural issues related to new debates over Artificial Intelligence (IA) and robotisation of the battlefield. Western countries' defence policies all lean towards retaining manned aircraft, whose deployment would be coordinated with Remote Carriers.

### The drone: a Quick Solution for Recovering Mass

In the year 2054, the entire defense budget will purchase just one tactical aircraft. This aircraft will have to be shared between the Air Force and Navy 3½ days each per week.<sup>(2)</sup>

Augustine's famous law sums up the problems posed by inflation in unit costs of production and maintenance operations. Inflation also drives the reduction in aircraft numbers in Western air fleets. Nevertheless, at a time when we are preparing for high intensity the question of organic *mass* arises in a new way. In that context, drones represent one of the best responses for halting the trend towards a combat fleet lacking in organic strength.

Western combat aviation has seen its numbers fall dramatically since the end of the Cold War. Since 1990 the number of aircraft has been reduced by a quarter in the United States and by over a half in Europe. Although this reduction has not always affected the total firepower of combat aircraft it has certainly had an impact on the availability of military materiel. There is, of course, a lower threshold of aircraft needed to be able to deploy substantial firepower, and to overcome attrition in a conflict and continue to conduct permanent missions.

The challenge for Western forces is therefore to possess an aviation force capable of acting across the full spectrum of conflict. In terms of capacity, the format will be a function of high-tech piloted craft and their remote carriers. Their combination within a system of systems will allow first entry operations at reasonable human and financial cost, and recovery of sustainable mass. The remote carriers planned for the Future Combat Air System (Système de combat aérien du futur—Scaf) will have to be considered as consumables, which implies strict control of development costs in order not to undermine the added value in capacity that is sought.

The overall plan for manned aircraft and unmanned sensors and effectors needs careful consideration of the balance to be achieved between platforms in order that each threat across the entire spectrum will receive an adequate military response in terms of desired effect and cost. Beyond the simple matter of flexibility in the air, this new format for capability will be an element of the general dynamics of collaborative combat sought by Western forces. In this way, drone-based airborne sensors and effectors would also be able to respond effectively to the requirements of land and maritime forces for pre-or post-action reconnaissance missions, strikes and direction of fires.

<sup>&</sup>lt;sup>(2)</sup> AUGUSTINE Norman Ralph, *Augustine's Laws and Major System Development Programs*, New York, American Institute of Aeronautics and Astronautics, 1982, 213 pages. His original law is cited here from *Defense Systems Management Review*, spring 1979, Vol 2, No 2, p.64. See: https://www.dau.edu/library/arj/ARJ/2/ARJ-72\_Augustine-reader.pdf.

#### Possible new operational fields

The use of drones in the conflicts in Libya, Nagorno-Karabakh and today in Ukraine illustrate several operational possibilities which might prove relevant during debate over the future format of air forces.

#### Protection of critical infrastructure and key assets

The events in Ukraine show the permanent need to review and adapt levels of protection of the air forces' footprint. The procurement of a sufficient number of small drones for this would permit defence of enlarged forward airspaces which would then no longer be limited to the operational range from their base. As an example, the *Skylark Lex NG*, produced by Elbit Systems Ltd and operated by the French Air Parachute Commando No.30 (CPA30) has an operational range of 20 to 40 km and 3 hours' endurance. Its ease of launch and use make it an ideal machine for protecting military installations on home soil and abroad by virtue of its capability to detect an enemy attack early enough to give added time to prepare their defence.

## Procuring 'contact' drones as key enablers for special forces

The technical characteristics of mini, micro and nano-drones would bring considerable added value to accomplishing special forces' (SF) missions. With their ease and speed of operation, stealth, robustness and low cost these drones would increase SF freedom of action in acquiring intelligence pre- and post-action (battle damage assessment), reinforce protection of the group and enhance the effect of deception manoeuvres against enemy forces.<sup>(3)</sup>

#### Increasing deep strike capability into enemy territory

This is a mission for the air forces, who already have the skills, the air-ground capabilities to give sufficient range to reach the enemy's rear, and the overall C4ISR functions of Command, Control, Communication, Computers, Intelligence, Surveillance and Reconnaissance that are needed. French capability for this currently relies on a number of medium-range missiles: the Modular air-to-ground weapon (Armement air-sol modulaire—AASM; range over 50 km) and the Long range air-launched cruise missile (Système de croisière conventionnel autonome à longue portée — Scalp; range in excess of 500 km). (4)

The capability to strike in depth raises three further issues. First, in numerical terms, a high-intensity engagement requires an adequate stockpile of precision-guided munitions. Second, the reach of air-to-ground weapons is increasingly being challenged by the increasing ranges of enemy defence systems. And third, the matter of cost

<sup>(3)</sup> On-board electronic systems can simulate the presence of an enemy force and distort the adversary's perception of the operational situation.

<sup>(4)</sup> AASM is also widely known, even in French, as HAMMER—Highly Agile Modular Munition-Extended Range. Scalp is known as Storm Shadow in other forces.

re-enters the equation, since it is higher when precision munitions like AASM or Scalp are used. An accountant's approach to in-depth air-launched ground strikes would be to seek less costly options.

The confrontations in Nagorno-Karabakh and Ukraine have demonstrated the role that loitering munitions could play, with their capability somewhere between that of a drone and a cruise missile. Azerbaijan employed the Israeli-built IAI *Harop* for SEAD operations (Suppression of enemy air defences) over Armenian territory. The *Harop* has an endurance of 6 hours and an operational range of up to 1,000 km, with a unit cost approaching 70,000 dollars. Hence these munitions mean that SEAD missions can be fulfilled at low cost. By way of comparison, the cost of the US *AGM-88 HARM* (High-speed anti-radiation missile) on board Ukrainian *MiG-29* and *Su-27* varies between 284,000 and 870,000 dollars according to the version. In the case of Nagorno-Karabakh, it was such a combination of EW, drones and this type of remotely controlled munition that demonstrated its effectiveness.

Whilst the majority of loitering munitions in Ukraine have a limited range of action (generally 40 km) and are only appropriate up to the tactical depth of the enemy, Russian use of the Iranian *Shahed 136* (called *Geran-2* by Moscow) is allowing its forces to strike deep into their enemy's territory. The vehicle shot down by small-calibre light weapons in Kyiv on 17 October 2022 would nevertheless indicate that the system is limited by the lack of self-protection and by its ineffectiveness against mobile targets: its guidance, which combines an inertial navigation system and GLONASS (Russian equivalent of GPS), cannot be corrected in flight. This model is said to have a range of 1,000 km (though Teheran claims 2,500 km) and a unit cost of some 20,000 euros.

Although ground-based fires are important in the Ukrainian conflict, artillery has a more restricted range, and its effectiveness often depends on reconnaissance drone missions: HIMARS has a proven range of 300 km, with possible extension to 500 km, and yet the cost of using these long range systems is also high. A GMLRS rocket costs 160,000 dollars and an tactical ballistic missile for ATACM, around a million dollars<sup>(6)</sup>. Artillery is therefore outclassed in terms of range and cost compared to the potential of some loitering munitions.

Here, national development of long-range loitering munitions, or purchase off-the-shelf would offer greater flexibility in in-depth strikes at lower cost. Procurement in considerable numbers would offer greater endurance and make saturation strikes conceivable. For Western air forces that have no real strategic bombing component (compared with the Russian Long-Range Aviation) this solution would fill the blind spots.

 <sup>(5)</sup> Harop has a 'man in the loop' function: the operator can take over at any time, particularly in the terminal phase in case of false target identification (decoying), and the drone can return to its base if no target has been engaged.
 (6) HIMARS=High Mobility Artillery Rocket System. GMLRS= Guided Multiple Launch Rocket System. ATACMS=Army Tactical Missile System.

#### Bringing UAV-carrying platforms into service

The deployment of robust drones from airborne platforms would increase their capability for endurance over theatres of operation, but would require a dedicated C2 structure able to handle the data flow from all the captors. The United States is developing a programme of this type— $Rapid\ Dragon$ , and the French company Turgis & Gaillard is offering several solutions for increasing the multi-role capabilities of the A400M, including  $SSA-1604\ Foudre$ , a system which enables the aircraft to launch munitions from its hold. (8)

#### Developing effective and robust C-UAS

During the Franco-American exercise *Warfighter*, held on 6-15 April 2021 at Fort Hood, Texas, after only five hours of manœuvres two battalions had been hit 'virtually' by a simulated drone attack, with the death of 800 troops.<sup>(9)</sup> This example illustrates the current vulnerability of ground forces to drone attacks and should encourage the development of high-performance C2, short-range C-UAS systems.

While current EW systems fulfil a function of self-protection of forces, other solutions are on the way, such as anti-drone drones and directed-energy weapons. In this regard, Israel has developed the *Iron Beam* air defence system to offer a response to the problems of saturation attacks by rockets or mortars or, in the near future, by drones. Given that an *Iron Dome* interceptor is estimated to cost between 100,000 and 150,000 dollars, *Iron Beam* could fill in for it at much lower cost.

#### Suppression and Destruction of Enemy Air Defences(10)

As long ago as 1982, during Operation *Mole Cricket 19*, the Israeli Air Force deployed drones as decoys over the Beqaa Valley in Southern Lebanon to force Syrian radars to transmit. A reactive combined reconnaissance/strike architecture of *F-4 Phantom II* then ensured the destruction of enemy surface-air missile (SAM) systems.

Whilst this technique thwarts the enemy's effect of surprise and guarantees acquisition of targeting information on SAM sites without human risk and at low financial cost, it nevertheless involves exposure of pilots when dealing with the target. The 1982 operation launched a debate in the Israeli Defence Forces over the procurement of new anti-radar platforms, as a result of which, IAI developed two loitering munitions to satisfy this specific requirement, *Harpy* and *Harop*.

<sup>(7)</sup> MALLARD Jules, *De l'avion-cargo au bombardier : le programme* Rapid Dragon [From cargo plane to bomber: the *Rapid Dragon* project], *Note* No 449, Césa, October 2022 (https://www.calameo.com/cesa/books/0069402883e399d1e698b).
(8) TURGIS & GAILLARD GROUPE, *Développement de systèmes* [Systems development] (https://www.turgisetgaillard.fr/).

<sup>(9)</sup> COMMISSION DE LA DÉFENSE NATIONALE ET DES FORCES ARMÉES, *Préparation à la haute intensité* [Planning for high intensity] (*Rapport d'information* No 5054), Assemblée nationale, 17 February 2022, p.39 (https://www.assemblee-nationale.fr/dyn/15/rapports/cion\_def/l15b5054\_rapport-information).

<sup>(10)</sup> The aim of a SEAD mission is the *suppression* of a SAM system's radar, generally using an anti-radar missile, whereas DEAD aims for the *destruction* of all or part of the system (radar, C2 or launch module), which might be done with a guided bomb and/or precision-guided missiles.

<sup>(11)</sup> Since the AS.37 Martel was withdrawn in 1999, the French Air Force no longer has an anti-radar missile.

Since then the range of anti-radar loitering munitions has diversified, with the Chinese ASN-301 and Turkish Kargi, for example. Some countries have also chosen to fit their drones with anti-radar missiles, such as the Chinese WJ-700 and Indian Rustom 2. Any of these solutions could form part of a more general order of battle, especially for first entry operation in a non-permissive theatre.

#### Reinforcing airborne detection and early warning capabilities

In a *system of systems* approach, a drone's ISR functions act as sensors for the combat architecture or as a force multiplier for manned aircraft such as AEW&C or AWACS. (12) The role as sensor for combat architecture is being considered with regard to the balance between Remote Carriers and 6<sup>th</sup> generation aircraft, whereas support to manned aircraft is already operational. As an example, Northrop Grumman *RQ-4 Global Hawk* flying out of Sigonella in Sicily, patrol the Black Sea and operate in liaison with NATO countries' airborne warning and/or control platforms. This arrangement allows the latter to operate on a racetrack at a safe distance while adding to their situational appreciation by the information gathered by a sensor positioned ahead of them, closer to the theatre.

#### Close Air Support (CAS)

Drones' capacity for endurance provides the JTAC/JFO (Joint Terminal Attack Controller/Joint Fires Observers) with highly reactive 'airborne artillery' in a loiter zone above a theatre. In a much reduced timescale a JTAC/JFO can requisition the effector that is best adapted in terms of load, speed, availability and cost in relation to the objective.

Though the endurance of drones is an advantage for dealing with targets of opportunity, they can also improve accuracy of fires, particularly in urban environments. From August to September 2016, during the recapture of Sirte, in Libya, over 70 per cent of *Reaper* strikes related to CAS, with some as close as 25 metres from the ground. (13)

For these missions, loitering munitions have the advantage of being reversible—in the case of a *hold fire*, they can return to the waiting area. Drones with greater wingspan offer other advantages: in addition to a heavier load, their operational ceiling means they are more discreet both visually and audibly and can thus add to the effect of surprise and cast an imperceptible, though real threat on the enemy and his morale. Additionally, the missiles carried have better reactivity: a *Switchblade 600* can reach 185 kph at optimum speed whereas a *Hellfire* can go up to Mach 1.3 and a lower probability of interception. The cost of a *Switchblade 600* is estimated to be around 220,000 dollars<sup>(14)</sup> against 70,000 for a *Hellfire*. Given that, for an equivalent number

<sup>(12)</sup> AEW&C=Airborne Early Warning and Control. AWACS= Airborne Warning and Control System.

<sup>(13)</sup> CLARK Colin, Reaper Drones: The New Close Air Support Weapon, *Breaking Defense*, 10 May 2017 (https://breakingdefense.com/2017/05/reaper-drones-the-new-close-air-support-weapon/).

<sup>(14)</sup> Pentagon ordered Switchblade 600 kamikaze drones for the Ukrainian Armed Force, *Ukrainian MinDef*, 21 September 2022 (https://mil.in.ua/).

of 'firing opportunities' a General Atomics *Mojave* drone carrying 16 *Hellfire* missiles is less expensive than using 16 *Switchblade* 600.

#### Electronic warfare

The EW capabilities of drones were diversified at the beginning of the century, and EW drones are designed as assets for support, protection or electronic attack. With informatization of the forces<sup>(15)</sup> they now play a determining role in military operations.

The war in Ukraine has given wider publicity to drone-carried EW: Russian forces have deployed the *Leer-3* EW system and its associated *Orlan-10* drone, for intercept of radio and telephone communications. Moscow also uses *Kronshtadt Orion*, one version of which carries a radar and communications jamming module.

On the French side, the Air and Space Force has a range of EW assets which only partially fills the capability gap. (16) While waiting for the *Archange* and *Cuge*(17) programme to enter service, EW drones could be a way of gaining mass, readiness and effectiveness at lower cost.

#### Conclusion

For aerospace power to play its role at each stage of competition, contest and confrontation it needs to possess high-tech weapons and equipment. To avoid falling behind strategically it would seem essential to capitalise on the advantages of drones yet without over-regulating their use. The right balance between manned and remotely-controlled airborne craft will offer a strengthened range of military options to the political decision-makers. •

<sup>(15)</sup> COMMISSION DE LA DÉFENSE NATIONALE ET DES FORCES ARMÉES, *Les enjeux de la numérisation des armées* [The stakes of digitisation of the forces] (*Rapport d'information* No 996), Assemblée nationale, 30 May 2018 (https://www.assemblee-nationale.fr/dyn/15/rapports/cion\_def/l15b0996\_rapport-information).

<sup>(16)</sup> COMMISSION DES FINANCES, DE L'ÉCONOMIE GÉNÉRALE ET DU CONTRÔLE BUDGÉTAIRE, *Projet de loi de finances pour 2023 - Annexe n° 14 - défense : préparation de l'avenir* [Draft budget for 2023, Annex 14—Defence, planning for the future], Assemblée nationale, 6 October 2022 (https://www.assemblee-nationale.fr/).

<sup>(17) &</sup>lt;u>Avions de renseignement à charge utile de nouvelle génération</u> (New generation reconnaissance aircraft with 'effective' load). These are modified *Falcon 8X* equipped with <u>Capacité universelle de guerre électronique</u> (Universal capability for electronic warfare).

Aerospace Sector Industries Facing the Possibility of a War Economy

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# Emerging Technologies and the Future of Air Warfare

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Since the advent of aviation, technology has always shaped the face of air warfare. Advances in micro-electronics in the 1970s rendered it even more lethal and decisive, as the resounding successes in the 1991 Gulf War demonstrated twenty years later. In the immediate one-sided aftermath of the fall of the Soviet Union, air supremacy became one of the instruments of US grand strategy, ensuring its almost unchallenged domination of airspace and exo-atmospheric space. (1)

To counter this asymmetrical advantage, China and Russia have established postures of anti-access and area denial (A2/AD). Principally designed to counter the comparatively crushing advantage of Western air forces, these postures have gradually mutated into tools for aggressive creation of sanctuaries<sup>(2)</sup> based on long-range strikes, air defence and anti-space assets, and also means of cyber warfare and electronic warfare (EW).

The war in Ukraine and the growing tensions in the Strait of Taiwan are clear evidence of entry into an era of inter-state competition marked by a lack of inhibition over the use of force, technological levelling and contest for common spaces. In this new strategic context the fight for control of different environments is quietly indicating the return of air power in its principal form, the use of force to achieve or contest control of airspace.<sup>(3)</sup> The technological dynamics that go with confrontation in the air environment raise the question of emerging technologies and the potential disruption they might cause to the conduct of air warfare. This article proposes to give some insight to this by outlining the future of aerospace action.

<sup>(1)</sup> POSEN Barry R., Command of the Commons: The Military Foundation of US Hegemony, International Security, Vol 28, No 1, July 2003, p. 8 (http://web.mit.edu/SSp/people/posen/commandofthecommons.pdf).

<sup>(2)</sup> ROSSELET Mélanie, *La crise ukrainienne a aussi une dimension nucléaire* [The Ukrainian crisis also has a nuclear dimension], *Le Monde*, 2 February 2022.

<sup>(3)</sup> Julian Corbett's distinction between strategy of control and strategy of denial is equally valid in the air environment. The use, albeit limited, of Ukrainian air and ground-based air defence assets is nevertheless a residual threat that the Russian air forces have to take into account. They are the incarnation of the concept of a *live fleet*, which could be brought into action in a strategy of denial of the strong by the weak.

# Emerging Technologies and the Future of Air Warfare

# C4ISR<sup>(4)</sup> Architecture and Control of the EM Spectrum: New Focal Points of the Air Campaign

The apparent lack of air superiority in the Ukrainian conflict<sup>(5)</sup> might wrongly lead one to believe that future high-intensity engagements could take place without air cover. Nevertheless, in the face of increasing threats, mastery of the skies is more than ever a central issue. In the first place, because without air cover ground forces are vulnerable to enemy bombing but also because the air arm is an essential link in the C4ISR chain which enables in-depth strikes even in a difficult EW environment.<sup>(6)</sup> In likely future conflicts, gaining temporary air superiority will remain essential for creating local 'hyper-superiority bubbles' within a framework of Multi Domain Operations (MDO). In particular it will be one of the links in a multi-sensor and multi-effector network which will offer an operational advantage over the adversary. Far from being marginalised, air power will expand in order to reconcile the demands of qualitative<sup>(7)</sup> and quantitative<sup>(8)</sup> superiority, command of the EM spectrum, MDO integration and interoperability.

To face these challenges and counter adversaries who had reached technological parity. (9) in 2014 the United States launched the Third Offset Strategy (10) which uses its technological superiority to benefit from advances in the fields of Artificial Intelligence (AI) and robotics. This compensation strategy relies in particular on a combination of emerging capabilities and new concepts for use, centred on the use of drones and autonomous systems. (11) Like any strategy, it has a dialectical element, since Russian and Chinese equipment strategies could be read as an movement to counter to the US Third Offset Strategy. In reaction to the growing importance of C4ISR architecture and connectivity in US concepts of operations, (12) Beijing and Moscow have sought to boost their anti-C4ISR and EW capabilities. The creation in 2015 of the Strategic Support Force (13) bears witness to the Chinese aim to put the concept of

<sup>(4)</sup> Command, Control, Communication, Computers, Intelligence, Surveillance and Reconnaissance.

<sup>(5)</sup> PAPPALARDO David, Guerre aérienne en Ukraine: le problème de Diagoras [The air war in Ukraine: the problem of Diagoras], Le Rubicon, 5 August 2022 (https://lerubicon.org/).

<sup>(6)</sup> For example, Russian EW assets, notably for jamming GPS, have been used in Ukraine to disrupt GPS-guided munitions. Dynamic targeting of fixed or mobile targets remains possible even in a jamming environment with laser designation or, in lesser measure, with inertial guidance. MIZOKAMI Mike, *How Russian Jamming Is Foiling Ukraine's GPS-Guided Bombs*, Popular Mechanics, 20 April 2023 (https://www.popularmechanics.com/).

<sup>(7)</sup> In 2030, nearly 1,600 multi-role combat aircraft will still be stationed in Europe: 600 Lockheed Martin F-35, 300 Dassault *Rafale*, 450 Eurofighter *Typhoon* and 230 SAAB *Gripen*.

<sup>(8)</sup> Development of semi-autonomous Remote Carriers and intelligent munitions at reasonable cost will, for example, increase detection ranges, limit human attrition and saturate enemy defences.

<sup>(9)</sup> BRONK Justin, Russian and Chinese Combat Air Trends: Current Capabilities and Future Threat Outlook, Whitehall Report 3-20, RUSI, 52 pages (https://static.rusi.org/).

<sup>(10)</sup> The 3rd Offset Strategy was launched in November 2014 by the US Secretary of Defense Chuck Hagel as part of the Defense Innovation Initiative. It aimed at ensuring US technological superiority with the objective of countering any technological catching-up and preserving a competitive advantage over the main strategic competitors of the United States.

<sup>(</sup>II) KREPINEVICH J<sup>r</sup> Andrew T, *The Origins of Victory: How Disruptive Military Innovation Determines the Fates of Great Powers*, Yale University Press, 2023, p. 495.

<sup>(12)</sup> Joint All Domain Command and Control (JADC2) and the Air-Sea Battle rely on the informational superiority and agility that should flow from integration of technological processes in the fields of AI, connectivity, robotics and space.
(13) The Chinese Strategic Support Force is in charge of conducting operations in cyber space and in exo-atmospheric space. It is also responsible for military intelligence and electronic warfare.

System Destruction Warfare into operation in order to drive an adversary into cognitive paralysis<sup>(14)</sup>. In the Chinese approach of *intelligentized warfare*, technologies such as AI, cloud computing and swarm operations will play a major role, even to the extent of changing the conditions for victory itself.<sup>(15)</sup>

#### Aerospace Action in 2040: a Favourable Context for Disruptive Technologies

Full consideration the impact of emerging and disruptive technologies on air warfare requires a clear outline to be drawn. First, we need to take strategic cultures into account, along with national systems for innovation and scenarios for possible engagements, whilst integrating current capability trends and existing orders of battle. Second, we need to set a sufficiently distant horizon so that technologies that are now still emerging can reach the necessary level of maturity to have a significant effect on the use of air power. Conversely, we must exclude from our approach those technologies whose development is too uncertain or whose predicted maturity will be beyond a reasonable horizon. This is why 2040 would seem a judicious choice. Third, insofar as air power has different aspects, and where it helps to achieve the effects required by both forces and political power, it would seem appropriate to focus on the most technologically intensive missions. That does not mean that technological disruption in other applications of air power will not have major strategic implications, (16) more that the technological building blocks and the multiplicity of their interactions in the future operational environment constitute one of the factors that could lead to the emergence of new concepts of use and to substantial improvement in military effectiveness on the battlefield.

By the 2040 horizon, the first operational capabilities of latest-generation air combat systems should have been announced. By then, too, the United States will have integrated the Next Generation Air Dominance (NGAD) initiative together with its accompanying drones, known as Collaborative Combat Aircraft, (17) into their inventory, where they will operate alongside some 225 *B-21* which should then be in service. The range of air-carried munitions should by then be expanded with hypersonic cruise missiles, (18) anti-IADS missiles (19) and very long-range air-to-air missiles. (20)

<sup>(14)</sup> Perspective on the Evolution of Winning Mechanism in Intelligent War, 瞭望新时代网, 26 April 2022 (https://www.lwxsd.com/pcen/info\_view.php?tab=mynews&VID=23346).

<sup>(15)</sup> WU Mingxi, ZHU Qichao and PANG Chaowei, *Intelligent Warfare: Prospects of Military Development in the Age of AI*, 1st ed., London, Routledge, 2022, p. xvi.

<sup>(16)</sup> The Air Force Research Laboratory (AFRL) is working on a leading project which uses a cargo rocket to transport up to 100 tons of freight as close as possible to theatres of operations in order to accelerate strategic logistics significantly. AFRL, *Rocket Cargo For Agile Global Logistics* (https://afresearchlab.com/).

<sup>&</sup>lt;sup>(17)</sup> In the budget request for fiscal year 2024, the initial order was for 200 NGAD and 1,000 CCA. These figures are only for the first tranche and are established on the basis of 2 CCA per NGAD and 3 per F-35. MARROW Michael, Next Gen Numbers: Air Force Plans first "Nominal" buy of 200 NGAD Fighters, 1,000 Drone Wingmen, Breaking Defense, 7 March 2023.

<sup>(18)</sup> Air-Launched Rapid Response Weapon (ARRW) and Hypersonic Attack Cruise Missile (HACM).

<sup>(19)</sup> TIRPAK John A., New SiAW Seen as Modular, Pathfinder Weapon, Air & Space Forces Magazine, 15 June 2022 (https://www.airandspaceforces.com/new-siaw-seen-as-modular-pathfinder-weapon/).

<sup>&</sup>lt;sup>(20)</sup> The AIM-260 Joint Advanced Tactical Missile (JATM) and the Long Range Engagement Weapon (LREW) are the main long-range air-to-air missiles under development in the United States—the first is intended to be carried in the internal bays of stealth fighters and the second, heavier and fitted with a ramjet, would be carried on an external pylon. Cf. HOLLINGS Alex, America has 6 New Air-To-Air Missiles Headed for Service, Sandboxx, 6 March 2023 (https://www.sandboxx.us/blog/america-has-6-new-air-to-air-missiles-headed-for-service/).

They will provide the US Air Force with missiles equivalent to the European *Meteor*, the Russian *R-37M* and the Chinese *PL-17*, whose estimated range is around 400 kilometres.

The Europeans and their partners will be starting to use the first equipment coming from the Global Combat Air Programme (GCAP) $^{(21)}$  and the Future Combat Air System (FCAS) $^{(22)}$  together with their associated drones.

The Russians are expected to have integrated no fewer than 76 *Su-57 Felon* stealth fighters and *Su-70 Okhotnik-B* combat drones into their arsenal.

Various versions of the *J-20* and *J-31* should by then be in service with the Chinese Air Force and Navy. (23) A wide variety of drones might add to this fleet of combat aircraft, providing Beijing with brand new capabilities. Without seeking to be exhaustive, it is worth mentioning the *WZ-8* supersonic reconnaissance drone, the *GJ-11*, *WZ-3000* and *FH-97* stealth combat drones, the *FH-95* EW drone (24) and the High Altitude, Longue Endurance (HALE) reconnaissance drones such as the WZ-7 *Soar Dragon* and the *Divine Eagle*. The latter has a double fuselage containing a low-frequency, bi-static radar which could possibly be intended to detect stealth aircraft: if this were the case, it would limit the freedom of action of the United States and its allies which use such stealth craft. It would also alter US strategic calculations of the cost of an armed confrontation. We must not forget the dominant role played by constellations of satellites for the C4ISR, targeting and early warning of each of the strategic competitors. In this field, too, China will be on an even footing with the United States in its area of interest. (25)

## Cartography of Emerging and Disruptive Technologies in the Aerospace Domain

In this strategic environment, what do emerging and disruptive technologies promise? Before deciding what their promise might be, we need first to look at what they are, then at what they could change in air warfare. There are several definitions of emerging technologies and disruptions. The European Defence Agency (EDA) and NATO agree on the main fields of application of Emerging and Disruptive Technologies (EDT), (26) though they differ in their interpretation: EDA considers them as technologies that will lead to radical change in the conduct of war in one or

 $<sup>^{(21)}\,</sup>$  A merger of the  $\it Tempest$  (United Kingdom, Italy and Sweden) and  $\it F-X$  (Japan) projects.

<sup>(22)</sup> Developed by France, Germany and Spain. (23) BRONK Justin, *op. cit.*, p. 32 and p. 41-43.

<sup>(24)</sup> XUANZUN Liu, China's FH-95 Electronic Warfare Drone Passes Performance Test, Global Times, 26 July 2022 (https://www.globaltimes.cn/page/202207/1271498.shtml).

<sup>(25)</sup> JENNINGS Peter, The Implications of China's Military Modernization for Australia and Regional Security in BATES Gill (dir.), Meeting China's Emerging Capabilities: Countering Advances in Cyber, Space, and Autonomous Systems, p. 26. TZENG Yisuo, China's Military Modernization in Autonomous, Cyber, and Space Weapons: Implications for Taiwan, in BATES Gill (dir.), op. cit., p. 38-41.

<sup>(26)</sup> Big Data, AI, robotics and autonomous systems, space, hypersonic, biotechnologies, quantum technologies, and new materials. Other classifications include connectivity and/or directed energy weapons.

two generations, (27) whereas NATO distinguishes disruptive technologies (28) from emerging ones. (29) Moreover, NATO adds that these technologies could combine and lead to the development of disruptive applications which cross connect to intelligent, interconnected, distributed digital systems. (30) Nevertheless, this vocabulary does not offer a practical view of the disruptive potential of these technologies in the aerospace domain. We therefore have to turn to other, more operational classifications which detail the technological building blocks themselves. The *Critical Technology Tracker* has counted 44, (31) while other classifications count up to nearly 200 technologies that could affect military security over the next thirty years. (32) In France, a 2022 reference document on defence innovation policy (*Document de référence de l'orientation de l'innovation de défense—DrOID*) gave some detail on emerging defence technologies: quantum detectors (ultra-stable, miniaturised micro atomic clocks and spectrum analysers, for example), stealth materials, ballistic protection, high-temperature materials, functional textiles, manufacturing additives, radar treatments, new optronic technologies, such as laser sources, active 3D imagery and energy efficiency, among others. (33)

The operational aerospace environment as it seems to be evolving is part of the complex dynamics of transformations in military capabilities. (34) Its trend is towards reduction in firepower and protection to the benefit of speed, range and precision, and also of capabilities that help win the competition between detection and evasion. (35) Emerging and disruptive technologies could therefore be arbitrarily classified as a function of their potential impact on the following characteristics of air power: speed, range, precision, detection, evasion, saturation, command of the EM spectrum and force generation. The table presents a grid of possible uses of emerging and disruptive technologies in future aerospace activity.

Although it is impossible to expand upon every case shown in this table, it is clear that there is potential for some of this technological disruption to change the face

<sup>(27)</sup> LOISEAU Nathalie, Beyond pragmatism—Towards the European Defence Union—Opinion Editorial by the Chair of the European Parliament's Subcommittee on Security & Defence (SEDE), European Defense Matters, No 18, 2019, p. 8-9 (https://eda.europa.eu/webzine/issue18/cover-story/sede-chair-nathalie-loiseau-towards-an-eu-defence-union).

<sup>(28)</sup> Technologies which could have major, even revolutionary, effects on NATO activities in the period 2020-2040.
(29) Those which will arrive at maturity in the period 2020-2040 and whose effects on NATO are not yet entirely predictable.

<sup>(30)</sup> NATO Technology Trends Report 2020-2040, 2020, p. 6.

 <sup>(31)</sup> GAIDA Jamie, WONG-LEUNG Jenny, ROBIN Stephan et CAVE Danielle, ASPI's Critical Technology Tracker: Who is leading the Critical Technology Race?, Australian Strategic Policy Institute, 2023, p. 8.
 (32) MINGXI Wu, ZHU Qichao et PANG Chaowei, Intelligent Warfare, op. cit., p. 24.

<sup>(33)</sup> AGENCE DE L'INNOVATION DE DÉFENSE, *Document de référence d'orientation de l'innovation de défense (DrOID) 2022* [Reference document on policy concerning innovation in defence], Ministère des Armées, 2022, p. 32 (https://www.defense.gouv.fr/sites/default/files/aid/DrOID%202022.pdf).

<sup>(34)</sup> KREPINEVICH Jr Andrew T., op. cit., p. 495. A future volume on this subject will be GROS Philippe, TOURRET Vincent, THOMAS Aude, TENENBAUM Élie et PÉRIA-PEIGNÉ Léo, Hypothèses stratégiques et transformations des capacités militaires à l'horizon 2040, (Strategic hypothèses and transformations in military capabilities by around 2040) Observatoire des conflits futurs, 2022, p. 44-46. Among the main current transformations they identify in particular are diffusion of the reconnaissance-strike complex, autonomous airborne systems and the transformation of space support structure. MDO integration, the arming of space, seabed warfare, robotisation of the ground environment and the transformation of air and missile defences are all included in emerging transformations. In his holistic view, Andrew Krepinevich evokes the democratization of destruction as the central element of the next revolution in military affairs.

(35) This is to translate in the least bad way the notion of Hider-Finder Competition, which is found in strategic literature.

<sup>(35)</sup> This is to translate in the least bad way the notion of *Hider-Finder Competition*, which is found in strategic literature KREPINEVICH J<sup>r</sup> Andrew T., *op. cit.*, p. 74.

of air warfare significantly. Just as range, precision and speed will be increased by the development of new materials and means of propulsion, so AI, autonomous systems and connectivity will contribute to accelerating the engagement cycle. Together they will boost the importance of the human decision maker in the collaboration between man and machine. In that context, AI will generate an agile mass from a distributed network of intelligent agents able to collect, compute, interpret, share and act within parameter limits set by humans.<sup>(36)</sup>

Paul Scharre, vice-president and scientific director of the Centre for a New American Security (CNAS), reminds us that the measurement of military power has changed in the digital age. Ships, aircraft, tanks and troops on the ground still count, but what counts more is their digital capability: sensors to detect the enemy, datahandling algorithms, networks for transmitting information, appropriate C2 (Command and Control) for making decisions, and intelligent munitions for hitting targets. (377) As evidence of the transformation underway, General Masaki Oyama, head of the GCAP programme in the Japanese Acquisition, Technology & Logistics agency (ATLA) stated that while the cost of integrated communications systems (ICS) and on-board electronics (Integrated Sensing and Non Kinetic Effects – ISANKE) could amount to 25 per cent of the total programme cost (compared with around 10 to 15 per cent in previous generations' programmes), they could contribute to over 50 per cent of the overall military effectiveness of the system. (38)



With the certification in March 2023 of the *F4.1* standard of *Rafale*, the Air and Space Force is also at the vanguard of current transformations. This standard in particular is said to offer improved capability for data exchange and better protection against cyber threats. (39) France is now on the front line for entering the era of connected, collaborative combat and is thus paving the way towards *FCAS*.

In the face of hardening of threats, agility, reactivity and resilience must guide strategic thought on the use of air power. The development of new logistic concepts such as the US Agile Combat Employment, for example, could permit the generation and deployment of forces in a more reactive manner. There, too, emerging technologies will be decisive and need to be considered within an overall approach that favours operational, technical and logistic interoperability.

<sup>(36)</sup> BROSE Christian, *The Kill Chain: Defending America in the Future of High-Tech Warfare*, New York, Hachette Books, 2020, p. 146.

<sup>(37)</sup> SCHARRE Paul, Four Battlegrounds: Power in the Age of Artificial Intelligence, W.W. Norton & Company, 2023, p. 278.

<sup>(38)</sup> WHITE Andrew, New UK-Japan-Italy Fighter takes Shape, with Electronics Details Emerging, Breaking Defense, 20 March 2023 (https://breakingdefense.sites.breakingmedia.com/).

<sup>(39)</sup> LAGNEAU Laurent, Le Rafale porté au standard F4.1 a été qualifié par la Direction générale de l'armement, [The F4.1 standard of Rafale now qualified by the Directorate-general of armament], Zone militaire-Opex360.com (https://www.opex360.com/).

Table 1: Non-Exhaustive Table of Emerging and Disruptive Technologies Applied to Air Warfare

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Force Generation / Endurance	,	Quantum calculation for optimisation of resources	New energetic materials	High-power lasers (SSL, fibre lasers); High-power microwaves	Variable-cycle engines (VCE); Electric motors	Predictive maintenance; Digital twins; Mixed reality; Synthetic data	Remote Carriers; UCAV; Automatic replenishment	Additive manufacture	Reactive launch
Spectum Dominance (connectivity, jamming, cyber, etc.)	Advanced integrated circuits; Anti-radar treatments (LPD/LPI)	Spectrum analyser/antenna (SQUIF, diamond NV)	Advanced semiconductors (III-V);	High-power lasers (SSL, fibre lasers); High-power microwaves	`	Advanced communications management (I.P.); Collaborative combat; Virtualisation technology; Edge computing / Embedded Al; Internet of things (OT)	Swarm technologies (communications relays)	/	Laser communications; 5G/6G
Saturation	/	,	_	High-power lasers (SSL, fibre lasers); High-power microwaves	`	Collaborative combat; Virtualisation technology; Edge computing / Embedded Al; Internet of things (IOT)	UCAV; Remote carriers; Smart weapon systems; Swarm technologies		Swarm technologies (for example, Phantom Space Strike)
Evasion (camouflage, stealth, manoeuvrability)	Advanced integrated circuits; Anti-radar treatments (LPD/LPI)	,	New intelligent coatings; Reflective coatings (anti- weapon or laser)	,	Active flow control (AFC)	Virtual assistant; cyber; Autonomous navigation; Mixed reality; Collaborative combat	Swarm technologies	4D printing	Space drones; New ASAT systems (satellites, cyber, lasers)
Detection (situational awareness)	Advanced integrated circuits; New optronic technologies	Spectrum/antenna analyser (SQUIF, diamond NV); Micro atomic clocks; Quantum illumination; Quantum gravimeters	Advanced semiconductors (III-V); Superconductors	,	,	Virtual assistant; Human-machine teaming. Mixed reality. Collaborative combat; Virtualisation technology; Edge computing / Embedded Aj; Internet of things (07)	Virtual assistant; Remote carriers; Smart weapon systems Swarm technologies	/	New space architecture (For example, NDSA); SBIRS tracking Layer
Precision	New optronic technologies	Quantum accelerometers and gyrometers; Micro atomic clocks	New materials	High-power lasers (SSL, fibre lasers); High-power microwaves	Active flow control (AFC)	Advanced targeting; Edge-Computing / Embedded AI; cyber	UCAV; Remote carriers; Smart weapon systems	Micro electromechanical systems (MEMS)	GPS III / Galileo
Range	,	,	New energetic materials	High-power lasers (SSL, fibre lasers); High-power microwaves	Variable-cycle engines (VCE); Hypersonic gliders	Cyber	UCAV; Remote carriers; Smart weapon systems		Space drones
Speed	,	,	High-temperature materials; New energetic materials	High-power lasers (SSL, fibre lasers); High-power microwaves	Scramjets; Hypersonic gliders	Cyber	UCAV (Unmaned Combat Air Vehicle)		Space drones
Field of technology	Sensors	Quantum technologies	Materials	Directed energy weapons	Propulsion	Al and Big Data	Autonomous systems	Design and manufacture	Space systems

Col. R. Brian

In conclusion it should be kept in mind that any innovation is the result of a meeting between technology, use and will. Victory in future air operations will therefore come as much from aviators' appropriation of emerging technologies as from the willingness of the forces to commit to the necessary transformations to encompass the new realities of war. In conflicts to come, digital transformation will be at the heart of the challenges of modernisation because it is the catalyst for the most disruptive of technologies. On it depends the operational superiority of tomorrow's air forces. •

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**▼** he continuing between Russia and Ukraine is having consequences throughout the world. European and NATO Member Countries are involved in particular through the various types of aid they are offering. After just over a year of conflict, and without claiming to be exhaustive, a number of lessons can be learned about policies for procurement of aeronautical material. Among them, the return of attrition with its implications on logistics, maintenance, stocks which need a certain critical mass: the role of ground-based air defence, effective and well-planned aeronautical doctrine and, more broadly, the ability of economies under budgetary constraint to transition towards an economy of war preparation, if not actually a war economy, are also put into perspective. From a historical point of view the latter notion indicates that all economic means are allocated to defence as part of the planning of arms production. In addition—and a direct consequence of the conflict—the donations of aircraft by some European countries to Ukraine will probably speed up their replacement, particularly in those countries which still have fleets inherited from the former USSR and for whom the war in Ukraine is an opportunity to break with the past (For example, the MiG-29 Fulcrum given by Poland and Slovakia).

Given this rapid evolution, which is incomparable with anything experienced in the past twenty years, these lessons will probably lead to changes in procurement practices. European countries in particular are committing to a new cycle of investment in, and renovation of, equipment, which will expand in the coming decade and which will shape their air forces for years to come. It is therefore reasonable to ask about the principal structural factors that guide a country's procurement policy for defence aeronautical equipment.

After studying the principal characteristics of procurement choices we will show that in Europe, the structural characteristics of supply and demand regarding procurement of equipment highlight a trilemma: technological challenges of defence equipment mean it is not possible to achieve concurrently three major aims of procurement policy—economic and technological spin-offs, strategic independence in terms of industrial skills and low unit cost.

Table 1: Principal factors influencing the procurement process (Source: authors)						
External strategic environment	Domestic strategic environment	Economic constraints				
External threats Alliance networks	National political agenda Presence and extent of defence industry	Level of GDPDefence budget Equipment cost				

#### The principal factors that drive nations' procurement policies

Before looking at defence procurement policies, we'll sum up the main factors that influence countries in their decisions.

First, external strategic considerations: the presence of an external threat to a country will drive procurement choices. Where there is a common threat, countries can cooperate to develop and produce their own aircraft or to buy aircraft off the shelf from their allies, particularly within the general framework of alliances.

Second, the domestic strategic environment is linked to the presence of defence industrial companies able to design, produce and support the equipment. This is a critical industrial constraint, since countries can be reluctant to abandon industrial capabilities for reasons of sovereignty or because recovery of lost capabilities is highly uncertain and costly. The procurement process therefore suffers from national bias.<sup>(1)</sup> That is one reason which explains the fragmentation of European defence industry.

Third, the strong budgetary constraints. Defence budgets have long been used as variables of adjustment: the policy of austerity that followed the 2008 economic crisis severely hit European defence budgets. The current trend (since 2014 in particular) in almost all European military powers is nevertheless towards increased defence spending. Moreover, since defence equipment requires high-level technology, inflation in the arms sector is structurally higher than in the civil sector and consequentially each nation's defence equipment buying power tends to diminish over time.

#### The various methods of procurement

The different procurement strategies possible, ranging from national preference (and independence) to international preference (so dependence) are worthy of study. Other intermediate strategies include cooperation and production under licence.

#### National production

Technically, a country can design, produce and provide the operational support of its equipment. It reflects the fact that defence industrial policy is a central

 $<sup>^{(1)}</sup>$  Kluth Michael, European Defence Industry Consolidation and Domestic Procurement Bias, Defense & Security Analysis, Vol. 33  $n^\circ$  2, 2017, pp. 158-173.

element of defence policy, particularly in the logic of a *strategy of assets*. (2) This choice has a number of advantages: initially there are questions concerning strict self-sufficiency, to avoid being dependent on foreign actors, but there are also major stakes in terms of employment, high value-added industrial activity, technological spin-offs and the reactivity and adaptability of the industry in case of conflict.

National preference nevertheless carries a high cost, especially in economic terms. A country has to bear the inherent costs at all stages of the equipment life cycle. Additionally, the monopoly situations created by the peculiarities of the defence market lead to an even higher cost connected with the preservation of national activities, which comes down to the price of independence.<sup>(3)</sup>

#### Cooperation

Cooperation might be seen as a benefit of club membership: it allows sharing of the R&D effort needed for development of material and its associated risk. The incentive to share costs is greater in view of evidence which shows that the R&D burden for defence equipment, while it has always been heavy, has greatly increased since the 1980s. Cooperative programmes allow some standardisation of equipment, favouring interoperability and genuine military added value in terms of greater power.

On the other hand, cooperation has a cost: the many diverging requirements at the start, and the changes to specifications during the programme add to development costs and delays, and to increased complexity throughout the supply chain, thus further programme coordination costs. Countries can benefit from cooperative programmes to fulfil the aims of their national industrial policy, notably during the development phases, by acquiring technological and industrial skills they lack, or have yet to develop fully. The requirement for a fair return on investment leads to multiplication of production sites in Europe, which partially erases the economy of scale and honing of skills initially sought. The *Eurofighter* project exemplifies such difficulties.

#### Production under licence

In contrast to cooperation, this type of procurement favours international collaboration by distributing production, though not the earlier design work. As a general rule, production under licence is subject to the technological domination of the country which designed the material, very often the United States.

Nevertheless, through production under licence countries see the opportunity to structure, develop or even save their defence industry through its upstream (R&D and suppliers) and downstream (for example, services, maintenance and retrofits) effects throughout the value chain. In Italy, for example, production under licence

<sup>(2)</sup> HENROTIN Joseph, *La stratégie des moyens dans le monde. Une diversité d'expressions* [The strategy of assets throughout the world. A diversity of expressions], *Défense et Sécurité Internationale (DSI)*, HS No 69, Dec 2019 to Jan 2020.
(3) LAGUERRE Cedric, *Is the Defence Market Contestable?*, Defence and Peace Economics, Vol. 20, No 4, 2009, pp.303-326.

after the Second World War progressively consolidated the helicopter industry up to the merger of Agusta and Westland Helicopters in 2001. This merger led to the founding of Leonardo Helicopters in 2016.

#### Purchase off the shelf

Off-the-shelf equipment purchase on the international arms market is often at lower cost, but imposes a degree of technological, even operational, dependence on the supplier. For those countries that do not have a sufficiently developed defence industry, the only realistic choice is to import equipment purchased from a third-party country. From an economic point of view, the United States is a very well-positioned supplier of aeronautical equipment, since its economies of scale make it highly cost-competitive. (4) US military protection and the perspective of becoming member of a strategic alliance are strong incitements to buying US material.

#### A trilemma

Given the existing procurement methods and the limitations highlighted here, countries in Europe are faced with a trilemma of dependence, unit cost, and economic and technological advantages.

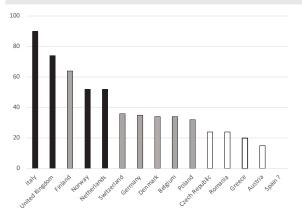
For example, by choosing to develop a wholly national programme based on entirely sovereign industry, a country will have to finance considerable R&D and production costs, but its dependence on foreign partners is minimised. A country such as France, which has a highly developed defence industry and whose nuclear deterrent is central to its strategy, will tend to favour this option. On the contrary, when a country buys off-the-shelf equipment it benefits from a lower price, which comes from the economy of scale, and the comparative advantages of the foreign manufacturer, but its dependence on foreign partners is increased. This is the case in Finland, Norway, Belgium and the Netherlands, for example, each of which operates a high proportion of American aircraft.

We can speak of a trilemma in the sense that no European country can at once achieve the three ideals of lowest cost, total independence and maximum economic and technological advantages. This trilemma slows the decision-making process, and can encourage withdrawal (from a project) or increase dependence on another country. Most European countries are therefore in a state of impasse, which explains in part their inability to make certain strategic decisions and the slowness of decisions regarding capability, in particular where they concern cooperative programmes.

This situation poses a problem when trying to draw lessons from the war in Ukraine, which is demonstrating the importance of uniformity of equipment, the quantity produced and of unit cost in maintaining a sustainable war economy. How

<sup>(4)</sup> TOCOIAN Oana, The Home Market Effect in International Arms Trade, Economic Inquiry, Vol. 53 No 4, 2015.

Figure 1: Number of actual and potential F-35 orders (© authors, from open sources)



Key:
Black: initial member countries of the F-35 project.
Grey: firm orders from non-member countries.
White: potential acquisitions by non-member countries.

can a country cater for the quantity factor whilst guaranteeing both air superiority and some form of independence?

European countries have great difficulty in creating something coherent and unified. Notable examples are the incompatible requirements in the 1980s which gave rise to two different projects, *Eurofighter*<sup>(5)</sup> and *Rafale*, and the current co-existence of two other major programmes, *Scaf*<sup>(6)</sup> and *Tempest*.<sup>(7)</sup> The US example shows that it is possible to overcome this trilemma if the domestic market is big enough—yet finding a big enough market is at the heart of the European problem. Individually each market is narrow but if the aircraft fleets of each country are summed together a 'critical size' emerges. To reach this size of market at a constant or increasing level of need, there are two possible routes: cooperation by harmonising needs, or exportation. But then, cooperation amounts to giving up some sovereignty, which leaves export—one of France's preferred solutions, even though this strategy risks leading to external dependence.

Nevertheless, despite some success of *Rafale* in Europe (Greece, Croatia), it has to be admitted that the current situation benefits the United States. Its considerable weight historically in the aircraft fleets of some countries (for example, the *F-16* effect in the 1980s in Belgium and the Netherlands, among others) will be felt again in the years to come with the Lockheed Martin *F-35 Lightning II*, whose European orders could exceed 600 aircraft, of which 500 are already firm.

This decision in favour of the United States is at the price of greater dependence, seen by some countries, France included, as a loss of sovereignty, especially for those countries that were not originally members of the programme: their economic and technological spin-offs could turn out to be more limited than initially forecast. For example, the Belgian press has suggested that the economic benefits could be as

<sup>(5)</sup> Developed by the United Kingdom, Germany, Italy and Spain.

<sup>(6)</sup> Système de combat aérien du futur (Future Combat Air System, FCAS), currently under development by France, Germany and Spain.

<sup>(7)</sup> Developed by the United Kingdom, Italy and Sweden. At the end of 2022, Japan joined the project, which was renamed *Global Combat Air Programme*.

low as 700 million euros, compared with the 3.69 billion euros anticipated at the time the contract was signed—the entire value of the contract.

Apart from the choice of traditional US partners, which was clear from the start of the programme, it is hardly surprising that some other countries whose aircraft fleet was already entirely of American origin would decide to acquire the *F-35*. Orders from some other countries, if confirmed, would be more surprising: for example, from the Czech Republic and Austria, whose fleets are composed respectively of former USSR or European (*Eurofighter*) aircraft. Moreover, the current environment is leading to even greater competition: Poland recently chose the KAI *FA-50 Golden Eagle* light combat aircraft built by South Korea.



Procurement choices are at the crossroads of technological, economic and industrial challenges. European countries are now held in the grip of severe budgetary constraints, industrial fragmentation and an exponential rise in aircraft production costs. The preferred strategy for future generation aircraft is therefore cooperation on major aeronautical programmes. It is as much a bringer of hope, especially if the economies of scale and acquisition of skills bear fruit, as it is of uncertainty over the division of industrial work and in the intellectual property of the technologies employed. Nevertheless, in relation to the trilemma discussed above, comparison with other choices would indicate that cooperation would work as long as the relative loss of sovereignty and economic return is compensated by sufficiently great advantages in unit purchase cost. Two factors for success have been identified for future programmes: applying the criterion of *best man for the job* to ensure industrial efficiency, and developing a credible business model that combines national orders and export contracts to give a sufficiently high production volume that guarantees the future of the aeronautical companies involved. •

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It is said that money is the sinews of war, yet munitions are essential for waging or winning it. The importance of possessing weapons and ammunition appropriate to the nature and environment of conflicts is constantly being reaffirmed. Firearms allowed European colonisers to win against Amerindian peoples armed with bows and arrows, the guns of German *Panzers* contributed to the success of *Blitzkrieg* during the Second World War and guided weapons contributed to victories in the Balkans and the Middle East with greater accuracy than ballistic ones—sufficient illustration of the progress made in the pairing of weapons and munitions. Though the performance of munitions might allow technical superiority over the adversary, their quantity is also a factor of success.

Combat units can only carry out their missions if they have sufficient stocks. Long-term conflicts exacerbate this problem: that was the case in 1941 when Churchill sought the support of the American Congress and more recently in the Russia-Ukraine conflict, when the Ukrainian President Zelensky launched appeals to his NATO and European partners. As the latter are currently ceding a part of their own resources there are discreet, though anxious murmurs everywhere questioning stock levels of munitions in France. These are legitimate concerns since they reveal uncertainty about the future—relief in seeing a conflict rapidly calming down or the possibility of being swallowed up in crises that put all long-term projects on hold? Of the belligerents, which will be the first to have his combat capability reduced if his stockpile were to run dry? Will France preserve its freedom of action with a sufficient stockpile of munitions to remain credible in an unstable world?

To answer these questions we need to understand for which purposes our stocks of munitions are constituted and how they are managed. For this, the Joint ammunition service (*Service interarmées des munitions*—SIMu) is the top-level operator. It acts as banker and asset manager for conventional munitions, administering a network of depots and dumps across French territory and abroad, and contributing to

operational manœuvres by delivering the resources the armed forces have banked with it at the right place, at the right time, at the right quality and in the right quantity.

#### The SIMu, a Trusted Bank

Rather like a banking network, the fourteen depots of the SIMu in mainland France and Corsica, plus five sites in French overseas territories and foreign countries (*Outre-mer et à l'étranger*—OME), offer a network of vaults appropriate to the stockpiling of munitions in optimal conditions of security taking into account their intrinsic risks, in areas enjoying defence protection, with respect for the environment and working conditions.

Activities in these depots are very strictly controlled. (1) Items containing active material are protected from the principal risk, which is fire, and from malevolent acts, through application of the principle of defence in depth. Physical barriers allow management of risk—pyrotechnic material is sealed within the munitions which are themselves encased in special packaging and stored in reinforced infrastructure within controlled areas. Each of these barriers conforms to the most stringent standards in force.

For protection against malevolent acts, each SIMu depot is situated in a protected area (*Zone protégée*—ZP), monitored by human and material means. These activities at risk are codified in French employment law (the *Code du travail*), from which are drawn studies on safety at work (*Études de sécurité du travail*—EST), commonly known as pyrotechnic studies. These enable appropriate procedures to be devised to cater for the potential risks related to the active material contained in munitions, in order to protect personnel operating in areas that would be affected in case of explosion of munitions. In addition to this consideration of risks within the pyrotechnic enclosure, the potential risks are analysed in order to protect the external environment by means of danger studies (*Études de danger*—EDD) which allow sites to be operated in accordance with the environmental code.

This exhaustive consideration of risks inherent to munitions, conducted strictly in accordance with the legislation, leads to a high level of confidence in the munitions banker, who is at the centre of the munitions supply chain. The SIMu is therefore an essential player in munitions support. Note, though, that SIMu deals neither with acquisition of new resources in the upstream phase nor their downstream distribution. In imitation of the central banks which issue banknotes, the armed forces deposit their munitions in the SIMu's vaults after purchasing them using their own budgets. On demand, the SIMu prepares packages of munitions for shipping. These 'funds' are then transported by the units which will 'spend' them or by organisations which will transport them as close as possible to their end users. So, in contrast to

<sup>(1)</sup> SIMu depots on the mainland are classified *Seveso–upper tier*. The EU directive aimed at preventing major accidents involving dangerous substances is called *Seveso*, in echo of the the accidental release of dioxin in 1976 in the eponymous Italian commune.

other pillars of the support services, the SIMu is not an end-to-end player, despite the popularly-held belief.

The SIMu is at the centre of the supply chain: it receives and stores munitions for the forces. The stockpile held is constituted on the basis of operational contracts agreed with the armed forces, which are themselves derived from political decisions arising from strategic reviews, plus training allocations. The SIMu is a rigorous retail bank: it supplies the munitions ordered by the forces at any time, anywhere, in quality and quantity. The service delivers resources to over 480 client units<sup>(2)</sup>, of which more than a sixth are in the OME. Such diversity and number of clients calls for a particular manner of operation.

The service headquarters directorate in Versailles (DSIMu) maintains an attentive back-office<sup>(3)</sup> role, but downward delegation is the principle of everyday operation. The directors of the five main munitions establishments (*Établissements principaux de munitions*—EPMu) on the mainland,<sup>(4)</sup> the liaison officers (*Détachés de liaison*—DL) in the OME depots and the Explosives Safety Officers—ESO (in French, *Adjoints interarmées du soutien munitions*—AISM) on operations and exercises, have delegated responsibilities for the depots and dumps in their respective geographical areas.

The current network of SIMu depots is the result of the merger of each armed force's individual network on creation of the service in 2011. It still has a degree of separation by colour of uniform by virtue of the particular needs of certain clients: for example, the air bases of Cazaux and Solenzara have dumps which support air-launched firing campaigns. Above all the overall storage capacities have to be optimised, which could mean that aeronautical munitions, for example, might have to be stored in sites that would never know the sound of a jet engine.

With its aim of maintaining resilience and capability to supply resources to the right level of need within its network, as a wise banker of course the SIMu does not put all its precious eggs in one basket.

It is in this way that the SIMu fulfils its tasks of reception, storage and availability of munitions for the forces<sup>(5)</sup> in optimal conditions of conservation, both for preserving them from external risks and for keeping control over their inherent risks. In addition to these storage services the specialist munitions banker proposes an asset management service for optimisation of the forces' stocks.

<sup>(2) 60%</sup> Navy, 25% Army, 15% Air and Space Force. The headquarters and services are attached to the forces' depots.
(3) The central administrative level of a bank which maintains an overall surveillance capability but has no direct contact with clients.

<sup>(4)</sup> Brittany, Centre-Aquitaine, Champagne-Lorraine, Mediterranean and Provence.

<sup>(5)</sup> Arrêté of 30 December 2020 defining the task and organisation of the joint munitions service (https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000042838893).

#### **Quality Asset Management**

Munitions stored by the SIMu are permanently monitored in order to maintain accurate knowledge of stockpile levels as well as guaranteeing the intrinsic levels of safety and performance of munitions. Supply chain experts have instant access to stockpile levels via the munitions digital data base: they organise stocks as a function of the rate of consumption and operational needs, ensure the best possible reactivity to serve the forces and are able to alert the armed services when stocks are approaching critical levels.

Continual improvement in munitions-related services relies in particular on evaluation of the quality of service rendered (*Qualité du service rendu*—QSR). On the other hand, the SIMu does not offer a credit service. Each item of munition that enters storage is allocated to the armed force that purchased it. Transfers between forces can occasionally be arranged but the munitions bank does not give advances on consumption!

There is constant iterative work between the SIMu and the operations support and transportation centre (*Centre du soutien des opérations et des acheminements*—CSOA, attached to the central defence staff) regarding the transport of munitions between the principal depots (equivalent of the central banks) and the local depots or dumps (equivalent of retail banks), both on the French mainland (*inter-depot flow*) and between French territory and OME or external operations (referred to as *shipping*). This comes down to the SIMu preparing the munitions for transport as a banker prepares bundles of notes, to be taken on charge by the security company—in this case, the CSOA, or more precisely, the units designated by the CSOA.<sup>(6)</sup>

In addition, whilst the SIMu is committed to delivering the quantities of munitions ordered by the users, provided it holds them, it also guarantees their quality. Munitions are regularly monitored by a system of sampling within batches for noncomplex ammunition, and individually for complex items<sup>(7)</sup> —those used by the Air and Space Force in particular.

The SIMu therefore guarantees the good management of the assets entrusted to it by the forces. To achieve this it follows resource levels permanently, spreads them in the most balanced manner for guaranteeing the reactivity of forces, overall resilience and the maintenance activities that contribute to supplying munitions ready for use. Management of the stockpile and organisation of the appropriate supply streams is a matter of the day-to-day commitment ensured within the SIMu's long-term vision.

<sup>(6)</sup> The CSOA calls upon either outside service providers or assets within the forces—in particular *via* the transport and surface transit centre (*Centre des transports et transits de surface*—CTTS), over which it has authority.

<sup>(7)</sup> Complex munitions are those which require specialised assembly or maintenance, notably missiles. Other munitions, such as ammunition cartridges are by default non-complex.

#### A Manager of Stocks and Flows

Whereas optimisation of munitions storage is a matter of compromise between many factors brought about by the criteria associated with the particular resource, stock levels reduce daily as a result of user consumption, transfers to third parties and eliminations and recover as a function of resupply streams.

The nature of munitions leads to multiple storage constraints which have to be taken into account in both stock management and stock flow. Munitions come in many shapes and sizes: some can be easily slipped into a pocket whilst others would not even fit into a garage for a car—aeronautical missiles in particular. This problem of dimensions drives consideration of horizontal shelving and vertical stacking of munitions within depots. Added to these dimensional constraints are restrictions concerning pyrotechnic risks. The classification of danger (*Division de danger*—DD) of each munition item, which relates to its explosiveness, defines the strictness of the storage measures to be taken. Each of the munition banks of the SIMu network must therefore adapt as best it can to these constraints whilst preserving the best capability to conduct maintenance operations and ensuring supply streams in line with the planned needs of the forces and operational complexities, including those relating to potential high-intensity conflicts.

On this subject, forecasting the rate of consumption of resources is the most important factor in avoiding breaks in supply upstream of the supply chain. Although training allocations are defined annually (albeit with slight revisions), it is far more complex to anticipate operational consumption and transfers to strategic partners as a result of changes in the international geopolitical situation. A number of *black swans*<sup>(8)</sup> appeared in 2022, in Eastern Europe and in Sub-Saharan Africa. Like banks who prepare for sudden, unexpected shocks, stock market crashes in particular, the forces, too, hold themselves ready to bounce back from internal shocks.

Moreover, whilst consumption of munitions is the main source of stockpile reduction, some munitions are eliminated when they reach their 'use by' date or suffer ageing problems such as exudation, obsolescence or unsuitability because of withdrawal from service of the system that fired them. They are then eliminated under state control by explosives disposal experts of the SIMu or by outside contractors who provide arrangements to guarantee that each item is rendered unfit for purpose. In the same way that the Bank of France withdraws and destroys worn-out banknotes, the SIMu ensures the disposal of munitions that might still be capable of being used.

Acquisition of munitions is a long-term process, especially for air-launched missiles, because of the contractual aspects in tight or closed markets and production and delivery times. The current crises which have generated problems in resupply of raw materials and in transport are also affecting munitions, and can lead to delayed restocking and initial outfitting. It is a matter of national sovereignty. This upstream

<sup>(8)</sup> See The Black Swan: The Impact of the Highly Improbable, Nassim Nicholas Taleb, Random House, 2007, 366 pages.

phase of the supply chain is fundamental to building up the stockpile, since the bank can only be full if the clients fill it!

The stockpile must therefore be analysed from two aspects: on one hand the dynamic management of flows, and on the other, maintaining a balance around thresholds defined by the contracts agreed with the forces. While technical expertise contributes to maintaining optimal stock levels of munitions, politico-strategic decisions determine their actual levels.

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In conclusion, the munitions stockpile of the French armed forces is constituted in the depots of the SIMu, which ensures their preservation, maintenance and destruction where needed, under the best conditions. The service is wholly dedicated to the task of munitions support and sits at the centre of the appropriate supply chain, acting as a central banker and responsible for a network of retail banks which serve the needs of armed forces' units.

Additionally, it works as a wise asset manager, scrutinising stock levels and spreading resources according to the best compromise between use, resilience, maintenance in operational condition (*Maintien en condition opérationnelle*—MCO) and storage capacity. On the latter point, it makes great effort to have available the necessary and sufficient storage space for munitions. Should the bank become empty it would then act for the forces, and the political decision-makers in particular, by financing resupplies at sufficient levels to regenerate supply streams to rebuild stocks. While there is flow, there is stock. As with the banking services, it is a matter of accounting! •

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#### Introduction

Space, once 'approached as a sanctuary and non-warfighting domain' (1) has been a key enabler of the Western way of warfare for over 30 years underpinning harmony to deliver operational success; (2) however, it is increasingly seen as an operational or warfighting domain by states and international organisations. This change in the approach to space negates traditional thinking. With 'space is vital to the UK's security and resilience' (3) the requirement for cogent space power thinking, innovation and development of capabilities for space as an operational domain is critical to ensuring that the UK can meet the National Space Strategy Goal 4 (Protect our national interests in and through space); (4) before you can effectively develop and employ space power you must understand its essence.

Space enables multidomain integration and as we have seen from the Ukraine conflict, space is able to underpin decision advantage, ensuring operational decisions can be made at the speed of relevance. According to UK MoD, the characteristics of space power, persistence, access, and perspective<sup>(5)</sup> enable space capabilities to support multiple operations across the globe simultaneously, for example a geosynchronous communications satellite can enable can support communications for multiple operations within its field of view.

The international security context is characterised by persistent, aggressive state competition with capabilities that threaten our access to space. Russia, China and India have all conducted tests of anti-satellite missiles. Russia has developed complex electronic warfare systems that can jam satellite signals such as Global Navigation

<sup>(1)</sup> McCall Stephen M., Space as a Warfighting Domain: Issues for Congress, Congressional Research Service, 10 August 2021 (https://sgp.fas.org/crs/natsec/IF11895.pdf).

<sup>(2)</sup> BURT Kelly D. (Maj.), Space Power In Small Wars: The End of Asymmetric Advantage?. School of Advanced Air and Space Studies, Air University, June 2010, p.3 (https://www.hsdl.org/?view&did=816832).

<sup>(3)</sup> HM GOVERNMENT, National Space Strategy. September 2021, p.10 (https://assets.publishing.service.gov.uk/).

<sup>(5)</sup> HM GOVERNMENT, Defence Space Strategy: Operationalising the Space Domain. London: HNG, February 2022, p.18.

Satellite Systems and satellite communications, used novel methods to conduct sophisticated, on-orbit activities and threaten on-orbit capabilities using missile interceptors. (6) Cyber threats, both state and non-state based, have the potential to deny, disrupt or deceive satellite data, and the increasingly pervasive nature of both military and commercial Space-based Intelligence, Surveillance and Reconnaissance (ISR) is increasingly affecting the conduct of military operations.

The growth of the Space industry and the acceleration of technology within the space domain offers opportunities for rapid innovation within Defence to integrate space across the spectrum of Defence's activity including operational planning, doctrine, capability development and training. To keep pace with the technological change being driven by industry and capitalise on the dual use capability applications that space presents, Defence needs new, agile acquisition processes, increased experimentation, and the ability to evolve cutting edge operational demonstrators into fast-paced capability programmes. To meet future security challenges, Defence needs to aim for a timeline from design to on-orbit in months.

#### **New Space**

Since 2010, New Space has been used to describe modern commercial space activity. New Space can be described as "a global industry of private companies and entrepreneurs who primarily target commercial customers, are backed by risk capital seeking a return, and seek to profit from innovative products or services developed in or for space". (7) New Space exists because of the broadening commercial market for space technology, which, particularly in the US, has triggered significant investment in small fast-moving, start-up style businesses which seek to disrupt the established order of aero-space companies offering services in and from space. (8) The key difference between the traditional space and New Space companies until recently is their customer base. Traditional primes focus on state customers and New Space on commercial customers. Whilst for the foreseeable future the state will remain coupled to the space economy, as the state must make the domain "accessible in legal, technical and economic ways" (9) through regulation and investment, this provides Defence with an opportunity to increase the speed of its' capability development by utilising New Space's rapid development of technology and government funding in the space sector.

<sup>(6)</sup> WRIGHT Timothy, 'Russia tests Space Based Anti-Satellite Weapon', IISS, 9 September 2020 (https://www.iiss.org/blogs/analysis/2020/09/mdi-Russia-tests-space-based-anti-satellite-weapon).

WEINZIERL Matthew and ACOCELLA Angela, 'Blue Origin, NASA, and New Space (A)', Harvard Business School Case 716-012, February 2016 (Revised May 2016), p.1.

<sup>(8)</sup> MADRY Scott, Disruptive Space Technologies and Innovations: The Next Chapter, Springer, 2019, 252 pages.

<sup>(9)</sup> SHAMMAS Victor Lund and HOLEN Tomas B., 'One Giant Leap for Capitalistkind: Private Enterprise in Outer Space', *Palgrave Communications*, 2019, p.6.

#### **Policy enablement**

The Integrated Review 21<sup>(10)</sup> committed the UK to be a 'meaningful actor in space' with an integrated civil and military space policy but also to take a more active approach to building and sustaining strategic advantage through science and technology. The Defence Command Paper went further focusing on Research and Development in space to accelerate the development and adoption of new technologies<sup>(11)</sup> to meet the national ambition of being 'a meaningful actor in space' and underpin the UK space commercial sector. The National Space Strategy<sup>(12)</sup> and the subsequent Defence Space Strategy<sup>(13)</sup> developed the concepts and ideas outlined in the Integrated Review and Defence Command Paper into actionable concepts to deliver space activities out to 2030.

Integration is key to success in modern warfare, and space is a key enabler in integrating the joint force. The Defence Space Strategy highlights as a key tenet the fundamental importance of integration to deliver the national ambition, between domains, government, partners and allies, industry, and academia. Complimentary to integration is resilience and the UK aim to ensure that it collaborates with Allies to provide the resilience and complementary capabilities to enable a safe and secure space domain. Integration and resilience of the space domain will support deterrence, enhance resources, and enable mission assurance. (14) The Defence Space Strategy outlines three strategic themes to deliver the national ambition. First is Protect and Defend, which focuses on the development of capabilities and processes to enable the UK to protect and defend its national interests in and through space. Second is Enhance Military Operations which enables the integration of space and provision of assured space services into all aspects of UK Defence. Finally, Upskill and Cohere focuses on developing the UK Defence space workforce including how to recruit, train and retain space professionals in Defence. These three themes along with the key tenets of integration and resilience enable the UK capability management priorities for the Defence Space Portfolio which enhance the UK's ability to understand, decide and act. The capability priorities balance the need for space support to the joint force as well as the need to provide capabilities to support space as an operational domain.

Learning lessons from capability development in other domains, and in particular the Air and Cyber domains, is vital to enabling rapid innovation and capability development in space, there must be a recognition that space is different and must adapt acquisition processes accordingly. Reviewing how partners and allies enable their capability development can generate an understanding of best practices which enable the ability to conduct rapid innovation to deliver capability. (15) Ultimately, however,

<sup>(10)</sup> STRACHAN Hew, 'Global Britain in a Competitive Age: Strategy and the Integrated Review', *Journal of the British Academy*, No 9, p.161-177. https://doi.org/10.5871/jba/009.161.

<sup>(11)</sup> Defence Command Paper, p45. https://assets.publishing.service.gov.uk/.

<sup>(12)</sup> HM GOVERNMENT, National Space Strategy, op. cit.

<sup>(13)</sup> HM GOVERNMENT, Defence Space Strategy, op. cit., p18.

<sup>(14)</sup> *Ibidem*, p.16

<sup>(15)</sup> RETTER Lucia, BLACK James, and OGDEN Theodora, 'Realising the Ambitions of the UK's Defence Space Strategy: Factors Shaping Implementation to 2030'. Santa Monica, CA: RAND Corporation, 2022. (https://www.rand.org/).

there are attributes of space that require unique considerations and trade-offs, such as payload or fuel, to be made when developing, acquiring, or operating and supporting capability in this domain, (16) especially when you consider the baseline and finite resource available. The UK "cannot simply replicate the approaches of larger or more established space powers such as the United States or even France". (17) Therefore, innovation both in capability and process is required to deliver space capability and the UK has developed the 'Own, Collaborate and Access' framework.

#### **Own, Collaborate or Access**

Assured access to Space and associated industrial capability is vital to operational independence and to protect the sensitive technologies. (18) Own, Collaborate or Access (19) framework sets out criteria against which "technologies and services will be identified, developed and generated depending on the level of ownership and control required" (20) which will impact the speed at which those capabilities are developed. Below the simply articulated 'own, collaborate or access' framework is a complex set of criteria that leads to a multitude of combinations and methods of engagement with industry partners and Allies, each having different benefits, costs, and risks.

Space is, compared to the traditional domains, significantly less platform centric and focused on a system of systems approach. Individual spacecraft are, by their nature, part of a wider system (space, link, and ground segments) and integrated into that system to deliver their mission and often multiple missions are onboard a single satellite. The system of systems nature of space capability is complex with multiple different systems, activities and actors involved, especially when considering upstream activities such as design, manufacture, and launch. Building a resilient industrial base which has a mix of primes and agile start-ups coupled with the agile processes and procurement structures to ensure that Defence can access the technological advances of New Space at the speed of relevance is complex and will need support from Defence. Therefore, space capability choices are likely to contain a blend of options across the holistic system of systems to meet the Defence requirements.

Defence can identify through its requirements those options which could be considered to lie at the extremes of the framework, such as those options which Defence must own, due to the requirement for sovereign ownership of the capability for operational effectiveness. Additionally, Defence must think critically about those

<sup>(16)</sup> *Ibid*.

<sup>(17)</sup> Ihid

<sup>(18)</sup> HM GOVERNMENT, Defence and Security Industrial Strategy: A Strategic Approach to the UK's Defence and Security Industrial Sectors, March 2021 (https://assets.publishing.service.gov.uk/).

<sup>(19)</sup> Defence Space Strategy, p18: Own. Where the UK has leadership and ownership of new developments, from discovery to large-scale manufacture and commercialisation. This will always involve elements of collaboration and access. Collaborate. Where the UK can provide unique contributions that allow us to collaborate with others to achieve our goals. Access. Where the UK will seek to acquire critical science and technology from elsewhere, through options, deals and relationships. This will always be conducted within the bounds of the MOD's Assured Capability Framework, cognisant of the fact that there will be differing national levels of assured access requirements.

capabilities that can be accessed through commercial solutions. Whilst the Ukraine conflict has highlighted the criticality of space to modern warfare, it also has highlighted the value of commercial technologies. Ukraine has successfully employed use of commercial satellite systems to access near real-time ISR, space-based internet services, and Position Navigation and Timing solutions. These capabilities, and the unclassified nature of the products, have also helped to counter the Russia's authoritarian disinformation campaign on the global stage. Therefore, Defence needs to toughly scrutinise its information requirements to understand exactly the blend of sovereign, allied and commercial data required.

Whilst the extremities of the framework are somewhat easier to rationalise for capability programmes, those that fall into the middle of the framework and have the ability to be a blend of options require an understanding of the balance of investment considering:

- affordability and value for money,
- · operational and decision advantage,
- supply chain security,
- interoperability with partners and Allies,
- international engagement,
- · prosperity agenda,
- innovation and generation of Intellectual Property,
- risks and timeline for fielding the capability. (21)

Each programme balance of investment will bring benefits and disbenefits which will need to be balanced over the whole space portfolio to ensure that the strategic objectives are achieved whilst still moving at a pace that enables capability procurement to be able to capitalise on technological innovation. Portfolio management with the overarching view, is key to ensure that the blend of programmes and their dependencies, benefits and risks is balanced to ensure a sustainable level of risk and opportunity through innovation within the portfolio. •

<sup>(21)</sup> RETTER Lucia, BLACK James, and OGDEN Theodora, op. cit., p5.8.

### French Air and Space Force

## Aerospace Power & High Intensity Warfare

The 54<sup>th</sup> edition of the Paris Air Show provides an opportunity for the *Revue Défense Nationale* (*RDN*) to dedicate a special issue to the French Air and Space Force (*Armée de l'Air et de l'Espace*—AAE), and the theme of aerospace power in particular.

In a context marked by the return of great power competition, the return of war to Europe and the militarisation of high airspace and space, *aerospace power preeminence is constantly and firmly established*. The war in Ukraine serves as a reminder: there can be no freedom of action on the ground without prior mastery of the third dimension. Through its operational characteristics (speed, range and accuracy) and the versatility of its resources, the AAE contributes directly to France's strategic autonomy and offers political leaders decisive effects to "Deter—Defend—Defeat" a potential competitor or adversary.

Addressing the future challenges of aerospace power involves considering *its adaptation to looming threats*. While this reflection implies considerations on technical capabilities, it also encompasses the issue of human resources: each day, airwomen and men devote their proficiency and competence in the name of excellence, thus allowing the AAE to meet its operational requirements.

Lastly, this issue rounds off with an analysis of the consequences of the transition from a peace economy to a "war economy". It will enable the reader to grasp the importance of industrial and logistics issues that constitute one of the foundations upon which aerospace strategy relies.

The aim of this special issue of the *RDN* is to draw an overview of today's preoccupation, but most importantly, to anticipate tomorrow's challenges.







Lancée en 1939 par le Comité d'études de défense nationale (Association loi 1901), la Revue Défense Nationale assure depuis lors la diffusion d'idées nouvelles sur les grandes questions nationales et internationales qu'elle aborde sous l'angle de la sécurité et de la défense. Son indépendance éditoriale l'autorise à participer activement au renouvellement du débat stratégique. La Revue Défense Nationale permet de garder le contact avec le monde de la défense et apporte, grâce à ses analyses, la réflexion à l'homme d'action.