

Space As Warfighting Domain

From Education To An Enhanced Global Space Strategy

By Jonathan Bescheron and Pierre Gasnier

Space, one might say, is not as far away as it used to be. From the pioneers and the first technical capabilities of the 1960s to today’s increasingly common tweets from Elon Musk about the n^{th} launch of SpaceX, a huge evolution has occurred in the domain. Yet in many ways, it has been so subtle an evolution that few people really consider how their daily life is linked to space.

Missions to the moon, the mining of asteroids for minerals, and visible Internet constellations are but a few examples of how space will dovetail with human objectives over the coming decades. And these examples further illustrate both the expansion of new frontiers and the accompanying, ever increasing stakes in a resurgent, space-centric great power competition (GPC). For while this new “space race” spans economic, environmental,

communication, and scientific spheres, its effects are increasingly being felt in the military domain.

Inevitably, due to this rapidly evolving situation, it becomes important to enhance awareness among both military and civilian leaders—current and future—regarding the issues related to the new “space race.” To do so, it is necessary to rethink the educational



Lt. Col. Jonathan Bescheron and Lt. Col. Pierre Gasnier, both authors are members of the French Air and Space Force.

framework related to space and, accordingly, reform professional military education (PME) to better train leaders in the multiple, interrelated domains of politics, economics, diplomacy, and industry. Once this objective has been reached, states will have a more comprehensive global space strategy, integrating the military component. Additionally, this would enhance cooperation between the defense and commercial space sectors, in turn contributing to reinforcing resiliency and security for both.

This article begins with an overview of the new space environment and the distinctive characteristics of this dual-sector currently facing a marked democratization. However, and despite the very real need to consider the current framework of space-related legal issues and their potential evolution over the coming decades, our focus here will be on PME as it pertains to education regarding space. Once the requisite elements of this revised PME are established, this article will continue by identifying how the French military considers the issue, striving to develop a better understanding of space as a competitive environment, or even a warfighting zone. Finally, we will conclude with a few proposals for attaining space superiority while simultaneously increasing national resiliency.

THE EXPANSION INTO “NEW SPACE”

An Exponential Development: “New Space”

Space has of late become democratized. Access to Low Earth Orbits (LEO) has been simplified with the appearance of less expensive launchers and the emergence of non-state actors (such as commercial industry) meeting military and civilian needs. We have moved far beyond the first conquest missions and now face expanding industrial development worldwide involving a host of new actors.

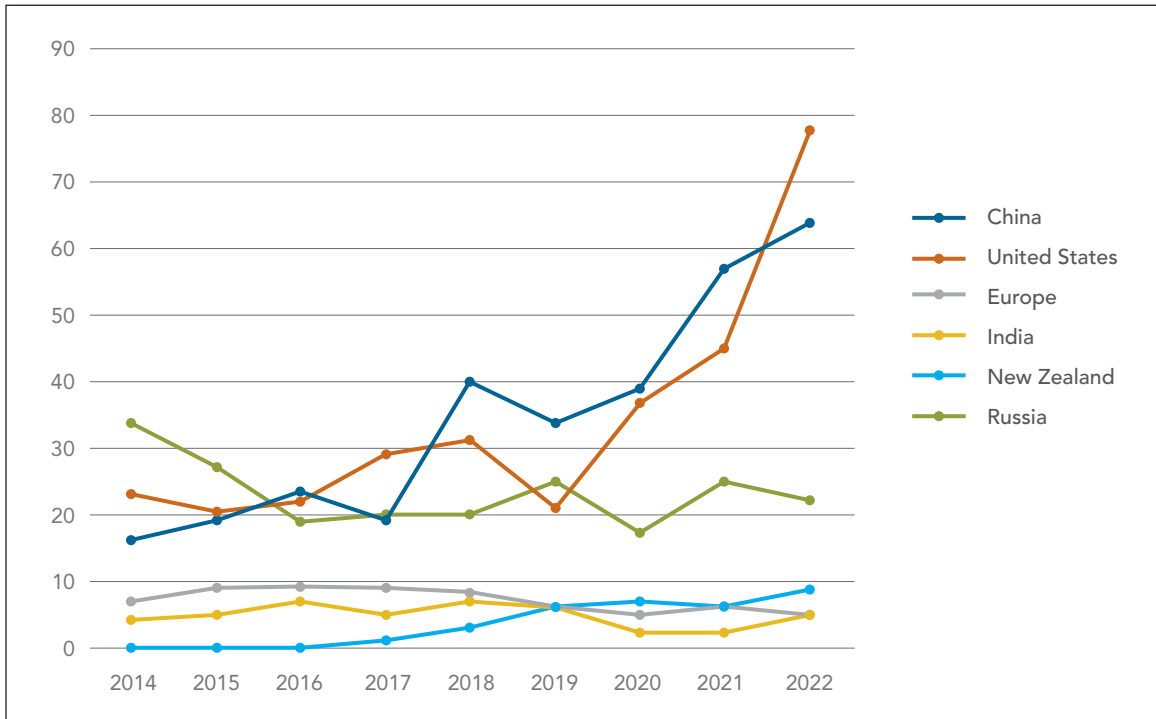
This emerging commercial space industry—as opposed to government-funded space programs—includes, today, smaller firms as well

as the traditional aerospace actors. Focused on developing new technologies and services while increasing access to space, these actors present new perspectives regarding the use of space, including notions such as reusable vehicles and space tourism, all predicated upon reducing costs to increase the use of space. Consequently, the number of satellites has doubled within the last five years and will only continue to increase: according to different space agencies, an estimated 30,000 satellites are predicted to be in orbit by 2030, many dedicated to providing capabilities that improve our everyday lives.¹ This compels us to redefine space as a sort of “commodity” and, further, clearly identify different users—military, industrial-technological, corporate, and civilian—in order to separate the related systems and stakes. Certain political systems in place nowadays keep close watch on space technologies, and the space stakes range now from the globally strategic to the quotidian: positioning systems, international trade markets, intelligence gathering, and scientific research, to name but a few.

As a direct consequence of this democratization, access to outer space (above 50 km in altitude) requires only low-tech tools to attain certain objectives. As an example, newer space actors, such as India and Japan, are now able to launch nanosatellites from relatively simple rockets. Longstanding GPC powers now must deal with such users in this formerly restricted or far less easily accessed area, thus increasing competition between state as well as non-state (private) actors. This “weak against the strong” strategy introduces a new kind of competition, one that threatens direct confrontation along with the more traditional GPC.

The increasing democratization of space is the result of the simultaneous expansion of related sectors, the military and the commercial. Further, today’s industrial actors are outpacing government development in the domain, obtaining contracts owing to their greater competitiveness and agility.

Figure 1. Evolution of the number of rocket launches



Dual-Sector Space

Previously, space was managed militarily via national state agencies such as NASA, as governments had both military and scientific/exploratory interests in space. This paradigm generated different schools of thought, each with its own goals and related stakes. “The first one saw space largely in scientific and explorative terms. ... The other schools of thought saw the future of outer-space exploration and exploitation in terms of the natural rivalry between societies and states common to history. Space could not be divorced from the political reality of the world.”²²

Moreover, during the Cold War, GPC reached its apex between the two blocks led respectively by the United States and the Soviet Union. Ballistic missile development, based on Werner von Braun’s V2 program, prioritized both intelligence and deterrence. Thus, the creation of the

National Reconnaissance Office (spy satellites), the development of early warning capabilities, and the expansion of GPS as a dual-use PNT technology (Positioning-Navigation-Timing, initially for military yet used worldwide today) are but a few examples of this transition of space technology from state issues to common use. In France, the first Ariane rocket was based on the development of the ballistic missile program. It is now the primary space launcher for national and European interests.

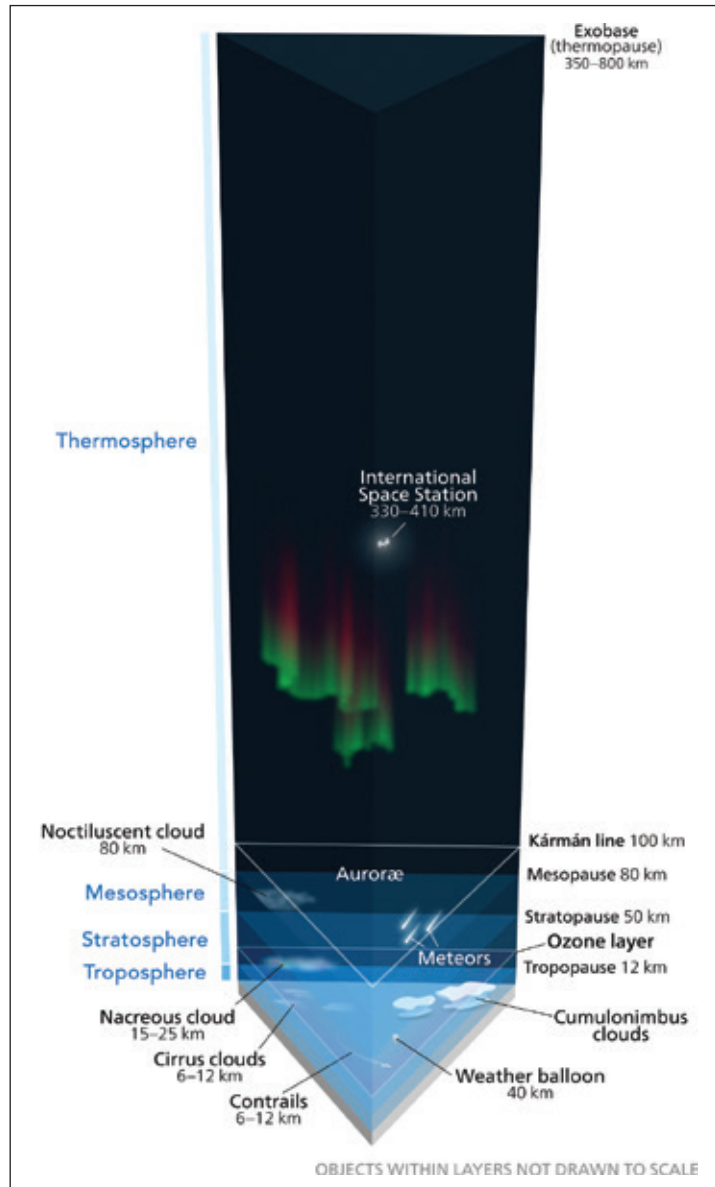
According to the Outer Space Treaty of 1967, outer space is of common interest to all humanity: “The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.”

As our ancestors did centuries ago with the conquest of the sea, considering superiority at sea to be tantamount to control of the world, the principle of “first come, first served” is de facto applied to space by certain countries, like the United States, of course, but also Luxembourg and the United Arab Emirates. For such countries, resources in outer space can be exploited according to their own needs and agendas. Indeed, dating to 2015, the U.S. Space Act allows any U.S. citizen to exploit space resources: “A U.S. citizen engaged in commercial recovery of an asteroid resource or a space resource shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell it according to applicable law, including U.S. international obligations.”³

Meanwhile, many companies and international organizations are focusing on space and starting new programs or are developing new technologies while improving existing ones. The examples of Space X and Rocket Lab show clearly how states today have come to rely on commercial firms. Yet space can still federate actors around a common cause: many international or private entities, such as the United Nations (UN), are structuring their strategies around space issues. One example, the UN project Space2030, is even considered to be a “driver for peace,” advocating for peaceful international cooperation in the domain.

Such oversight or coalition-building has existed since the very beginning of the space race. For example, the International Telecommunication

Figure 2. From Earth to deep space - “first in, first served”



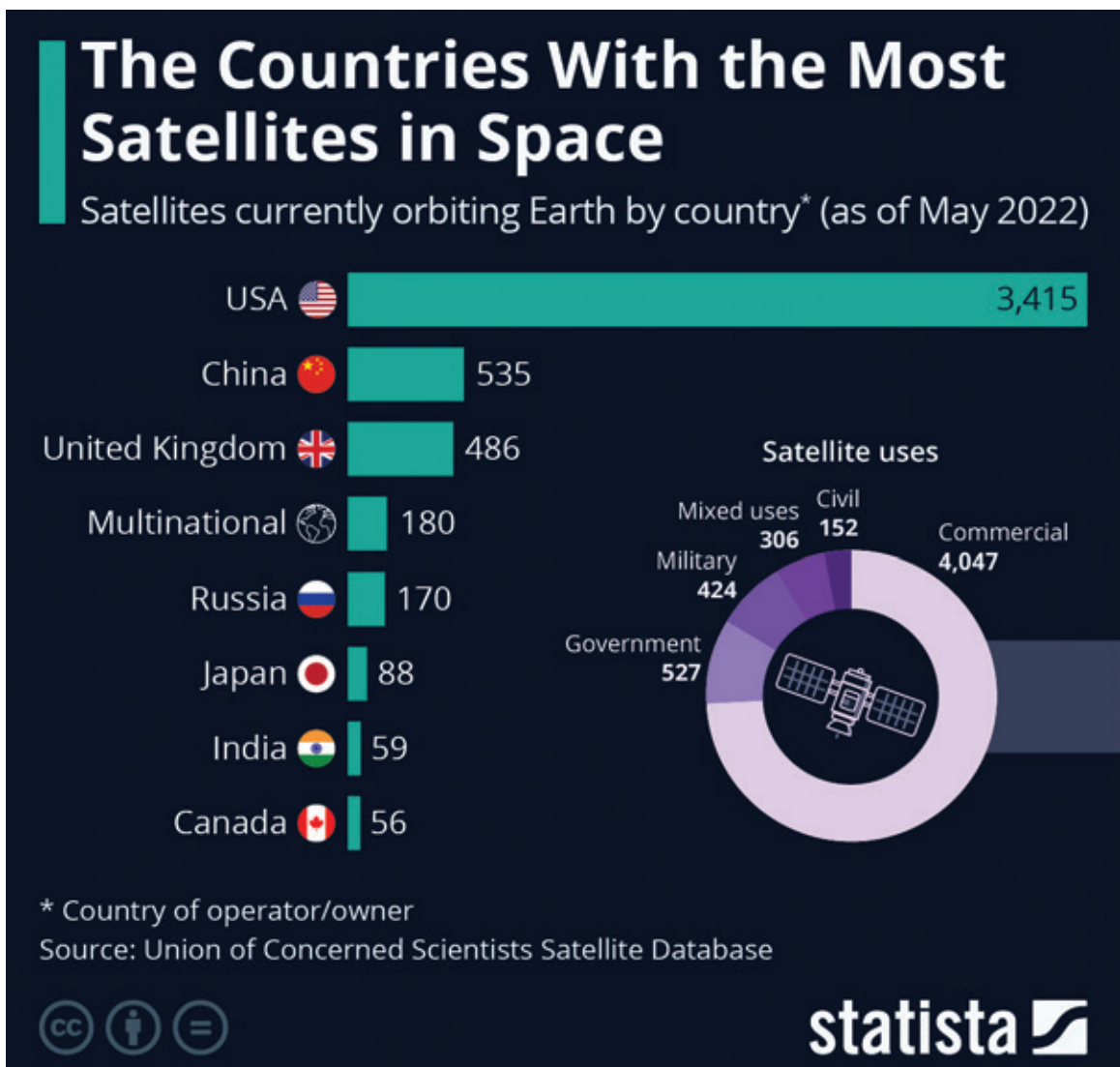
Union has long overseen coordination and allocation of frequency spectrums and orbits in space; although, in actuality, the original GPC countries were the only ones to use the space allocated spectrum for many years. With the development of new actors, resources such as frequencies and orbits

will become rarer; indeed, we are already in an era of increased competition and contestation for the space-relevant spectrum. Worldwide, examples of positioning technologies, such as GPS/Galileo frequency allocation or the privately held Starlinks constellation are well-known. Former U.S. President Donald Trump confirmed this notion of “first come, first served” by Executive Order on 6 April

2020:⁴ “Outer space is a legally and physically unique domain of human activity, and the United States does not view it as a global commons.”

Furthermore, space resiliency relies today on dual capabilities wherein the commercial space sector is part of military strategy, even for the GPC countries that have a commercial sector. Existing partnerships between NASA/DARPA and SpaceX or

Figure 3. Comparison of the number of satellites by country



between DGA (*Direction Générale de l'Armement*, in charge of the equipment plan of the French forces) and Airbus or Thales illustrate how deep this duality is entwined with resiliency.

An Enlarged GPC

For a long time, only the traditional GPC countries were able to develop space programs. The democratization of space technology, alongside new opportunities presented by this domain and the increased will toward national sovereignty, have encouraged other countries to develop their own space programs. Beyond the Indian and Japanese programs, the United Arab Emirates, for instance, are developing quite ambitious space programs to increase their international reputations as a medium space power. The Hope mission aims directly at Mars and Khalifa satellites provide autonomous Earth observation capabilities. Such medium-sized space powers now can launch, develop, and control satellites.⁵

Another good example of space duality is the Iranian space program based on its ballistic missiles program, designed to enhance Iran's capabilities and gain autonomous access to space for their own satellites. By upgrading their rockets, they increase the range and payload of their ballistic missiles equipped with conventional or, in a likely near future, nuclear warheads. In November 2022, the Iranian government announced the construction of a hypersonic ballistic missile, offering more possibilities and capacities to the Iranian government in the space domain.

Beyond competition between more or less "Great" states, we must not overlook non-state actors able to apply the above-referenced "weak against strong" strategy with potentially devastating consequences on national or international structures. In this context, space appears as a potential new warfighting domain, one central to the defense of sovereignty and the protection of state interests.

Clausewitz saw war as an extension of politics by other means; similarly, this consideration of space as an extension of the warfighting zone must be considered for its geo-political implications. As Florence Parly, former Minister of the French Armed Forces, explained: "...space has become a space of conflict. We must not be naive; we must be able to protect what is vital for the functioning of our transportation systems, our air systems, our hospitals ... and what is essential for the proper functioning of our forces." This is why it is important to differentiate between the warfighting domain and the war zone, from competition to confrontation.

This all-important link between sovereignty and state interests is particularly true in space. In modern warfare, space-based services are essential, controlling and conducting operations; indeed, targeting, communications, and navigation are all reliant on space-based support to varying extents. This was exemplified in 1990 during the first Gulf War, a modern symmetrical conflict, where the massive use of space assets led the U.S. armed forces to victory against the third largest army in the world in only a few weeks.

Accordingly, over the past decades many competitors have developed courses of action to destroy or disable space assets, such as GPS jamming, anti-satellite missiles (ASAT), rendezvous and proximity operations (RPO), and space projectiles. On 24 February 2022, Russia demonstrated that it had mastered such strategies by paralyzing, via cyber-attack, many control terminals of the Ukrainian satellite network just one hour before launching its initial offensive.

Of course, it is also necessary to consider the economic and financial aspects of this new space-related GPC. The development of new space capacities increases competition between states in many tangential sectors, such as the requisite mastery of technologies related to the management of mass data gleaned from observation satellites. The processing

and analysis of such data by means of artificial intelligence is also becoming necessary because of the immense quantity of data being produced and collected. This mastery is closely related to the economic and financial investment capacities of the respective powers, and national sovereignty is at the heart of such issues.

Moreover, growing dependency on space capabilities leads to increased vulnerabilities with replacement of Earth-based capabilities by space-based ones, primarily to cut costs but at the risk of decreased resiliency. Competitors, adversaries, or malign actors can easily identify these vulnerabilities and develop counterstrategies to limit states' operational effectiveness. With space contestation seen in this light, the question arises: what might be the consequences of this on freedom of action within the domain?

As with other environments—land, sea, or air—obtaining and maintaining freedom of action in space seems to be prerequisites to countries and actors first establishing, then guaranteeing superiority. The latter superiority entails physical and non-physical lines of communication: space infrastructure, access to space, control and management of orbits, to name but a few; and “lawfare”—a contraction of law and warfare—is at the heart of this freedom of action. While drawing up an exhaustive list of the legal stakes is beyond the scope of this article, we can underline some of the major elements central to such a study.

The last treaty on space dates to 1967. Since that time, and as stated above, the use of space has become increasingly democratized and the principle of “first come, first served” governs this domain. This is consistent with strategies underpinning GPC because it does not limit the actions of the (Great) countries concerned. However, for medium power states or those countries that do not have space capabilities, the development of a “lawfare” strategy can be used to influence or obtain rights in the use of

space, as predicted by Jonathan Klein in 2019: “The less capable will use their influence to propose international treaties and resolutions to limit the status of the most capable powers.” Further, certain new situations underscore the lack of related legislation, and the need for it. For example, what constitutes an offensive maneuver in space? Or, what is the acceptable minimum distance between our own satellites and those of our competitors? Finally, the issue is that states, especially great powers, might be expected to act in what their government or leaders deem that state's best interests.

Both the French Defense Space Strategy and the U.S. Space Force have addressed this topic. The United States perspective is as follows: “We will actively use interactions, consistent with applicable law, to shape norms of behavior that enhance national security and reduce the opportunities for a competitor or potential adversary to misinterpret intentions.”⁶ The issue also relates to the problem of Space Traffic Management (STM) and the need to establish common rules to ensure the safe use of orbits. These rules may be decided by an international regulator, as the International Civil Aviation Organization (ICAO) has done for aviation. The ICAO serves as an example of successful cooperation, even during the Cold War. In this new space age, regulating the use of space is fast becoming a necessity to safely sharing this domain.

Further consequences on the freedom of action and use of this domain remain to be established, considering the main issue of potential “space area denial” through congestion or saturation by space debris. As explained by Jacques Arnould, “The stakes of the space war, whether it is the war by space, for space or in space, are not only a question of territories and borders to defend, but also a game of interests to preserve, to conquer.”⁷

As defined above, the new space must be considered as a set of issues “inherent” to national security. Whether it is a question of space as a venue

Figure 4. Increase of States owning satellites



for national intelligence gathering (e.g., communications, surveillance, navigation) or dealing with space debris—considered an enormous threat to national space capabilities—space is truly changing the competition between states, or powers both great,

medium and small. Therefore, the ability of leaders to understand all the issues related to the space environment is becoming increasingly crucial for any actor seeking to attain or maintain its place in this rapidly evolving GPC.

PME AND SPACE EDUCATION: WARFIGHTING DOMAIN AND POTENTIAL WAR ZONE

Space Expertise: from Specialization to Generalization

Space-related expertise was once reserved for those in scientific and engineering fields, as extensive scientific training was required to understand this environment and develop capabilities to exploit it. Of course, possessing a solid knowledge base attained through scientific training remains important owing to the increasing complexity of space and its many (inter)related issues. In the military domain, space capabilities must facilitate the planning and control of operations in all environments, not just in space. The number of trained personnel within the space-related fields must increase to meet this new need. Concurrently, PME must evolve to provide scalable training to match tactical, operational, and strategic requirements at all echelons of the hierarchy. According to General Philippe Lavigne, former French Air Force Chief of Staff, PME must not only keep pace with technical evolutions but also the associated human stakes, “and, in parallel, [requires] conceptual reflection on employment, recruitment, and the establishment of training to meet these needs, and this at all levels.”

Originally not widespread, training on space matters within the French military has evolved from a strategy of scientific preparation restricted to a few specialists to the implementation of a shared military culture regarding space. At the same time, the military command strives to develop an environment of trust with space experts, such as those working within universities or industry. The French Air and Space Force has forged a particular link with the third dimension and, beyond, with deep space. The first French astronaut, Jean-Loup Chrétien, was a fighter pilot in the French Air Force; and our

most recent astronaut, Sophie Adenot, is a test pilot just recently out of the French War College. Indeed, today all officers of this force undertake space courses in the French Air and Space Force Academy (FASFA).

French Air and Space Force Academy (FASFA)

As in certain U.S. academies, such as the Air Command and Staff College with its Schriever Scholars Program or the West Space Seminar at the Air War College, increased awareness of space can be seen within the FASFA PME programs. The education of French officers is clearly evolving to cover the range of military issues and specialties, providing trainees with general space training, at a minimum, or more scientific and technical training, depending on the career to which they aspire. And while FASFA PME programs used to include space mechanics for all trainees during the first three years at the academy, today’s training has been redesigned to cover all officers; meaning, in the French Air and Space Force model, career officers, contracted officers, and internal granted officers.

The FASFA PME courses include a basic, one-day course on space intended for all officers, not only career officers. It covers the Force’s current and future capabilities in space, basic notions of space operations—i.e., how space can support other military components—and orbital mechanics. The intent here is to make all officers aware of the key space-related issues regarding their future military assignments: space mobility, space contestation, and space threats, for example. In addition, officer cadets are introduced to space imagery, battle damage assessment, and site surveillance. More advanced courses are available to career officers. These are interspersed throughout the three years of FASFA PME and cover all recruitment profiles, from the scientific to the more literary. During their first year at the academy, student officers take

a three-day Space and Defense Seminar (SPADS), strategizing on space issues and thereby enabling students to better face challenges to space-based service delivery in real-world situations. “Games” are organized to cover many topics: space situational awareness, rendezvous with satellites, and uncontrolled atmospheric reentry of spacecraft back to Earth. Over the course of this seminar, students have the opportunity to not only meet members of the French Space Command and the French Planning and Controlling Operations Center (*Centre de Planification et de Conduite des Opérations*, or CPCO), but also executives from the space industry and the French Study Space Center (*Centre National des Etudes Spatiales*, or CNES). Finally, an entire day of conferences and round tables facilitates discussion on current and future space topics.

SPADS is evolving to integrate North Atlantic Treaty Organization (NATO) participants, such as U.S. Air Force personnel serving as mentors, or joint officers (French Navy or Army), the objective being the creation of a first step toward a joint military-space community. Today, it also aims to prepare a segment of military general officers, sensitizing them to the main space-related stakes—hugely important, given their high level of responsibility within the French military.

Beyond those courses aiming to develop a first level of space competence, Master-level classes enable student officers to delve more deeply into space as a competitive and transversal domain. Significantly, these courses include a period of practical work: For example, students may participate in the development of a ground-space interface or another project done in collaboration with industrial partners such as Thales or Northrup. Master-level courses go far deeper into the space environment, developing knowledge that is more robust, having been developed for a more science-focused population. During the second

and third years at the academy, students follow at least 50 hours of space courses, addressing very technical domains such as thermal and optical rules, space engineering, and space environment constraints. These additional hours of courses are divided into three parts:

- Image technology: for instance, how to exploit and improve space imaging via new technologies and artificial intelligence;
- Communications: covering all issues surrounding SATCOM, such as time of visibility, mega-constellations, and antenna centers;
- Roundtables: discussions with space, scientific, and military domain Subject Matter Experts (SMEs) from, for example, ONERA (*Office Nationale d’Etudes et de Recherches Aérospatiales*) for radar, CNES for geolocation, and the French Space Command (PME).

This dedicated space course option eventually leads in an end-of-study internship of four to five months. One of the main partnerships is with the United States Air Force Academy, involving studies on space propulsion and space surveillance. This exchange continues a collaboration initiated more than 50 years ago between our two Air Force academies, thus consolidating our ability to operate together in future space operations.

Thus, the French Air and Space Force continues to upgrade its space course program with the objective to instill an initial, more general knowledge of space in its trainees. Different projects remain works-in-progress. For example, a proposed course of study would integrate student officers into a space seminar organized by different French aeronautical schools or academies. Some French military space experts are already involved in this seminar, bringing their expertise to the students of civil engineering. The goal here is: begin integrating into the space community future-facing industrial-military partnerships.

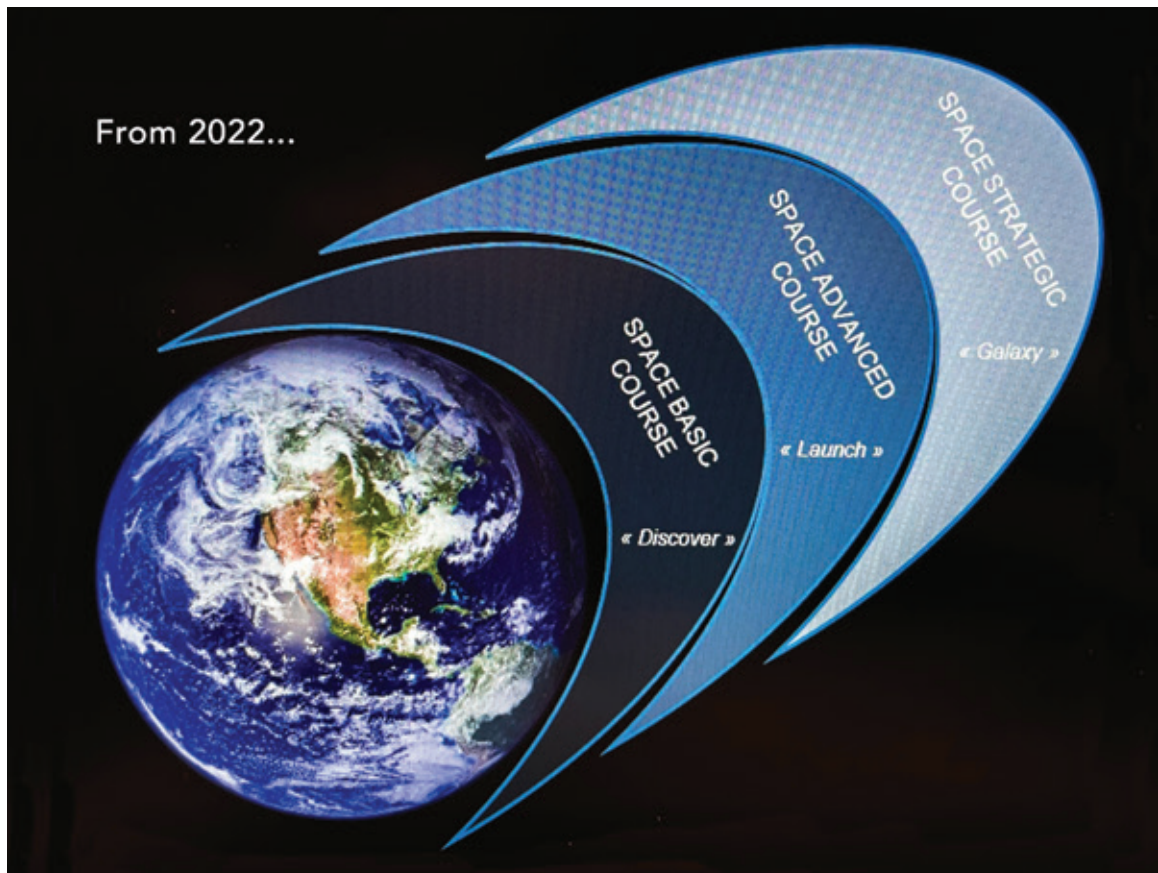
French Space Command

PME is also evolving within the French Space Command, with a dedicated structure in place to educate personnel working on space operations. This training, provided by the Center for Military Space Operations (*Centre de Formation aux Opérations Spatiales Militaires*, or CFOSM), offers three different courses to upgrade trainee comprehension of the space environment: basic, advanced, and strategic courses.

The three-day basic course deals with more general space stakes. The main goal is to provide a global comprehension for people working in support of space operation specialists. The advanced course

is at the heart of French PME. Its objective is to give a full spectrum vision of space operations to people involved in this domain. This course is open to all French officers, from each branch, as well as selected specialists from within the foreign office. (The last of these courses, the strategic course, is detailed below). Specialists in specific domains deliver these courses. Many officers of the French Space Command are involved, such as specialists in space operations, legal issues, and space device programs. In addition, civilian specialists are invited to supplement perspectives with their own points of view. For example, CNES personnel might detail the increasingly problematic issue of space traffic management.

Figure 5. What to teach, when to teach - a French space PME project



A MULTI-DOMAIN SPACE EDUCATION

Recent increased awareness of Air and Space Force needs to be reinforced elsewhere, via other PME components. Indeed, neither the Navy nor Army integrate space stakes in their officer academies. At best, those young officers follow a single conference introducing generalities about space. These military academies continue to educate their officers for their first employment at a tactical level where space assets are still considered mere tools used in support of an operation. However, the French Navy is increasing its operational preparation, especially regarding threats such as a space black out. Indeed, assuring resiliency is critical regarding potential space contestation—a failed rendezvous with a French satellite, for instance, could lead to the delay or cancellation of an entire maritime operation.

The French War College aims to prepare future military leaders, especially as regards operative planning. To do so, different planning courses are developed around strategic scenarios to enable student officers to face a global and multi-domain war-game, using NATO Comprehensive Operations Planning Directive (COPD) doctrine, which defines space as a global component (operational domain) in NATO operations through the Allied Joint Doctrine for air and space operations—AJP-3.3. Although these training scenarios integrate the space domain as a supporting component and not as a domain in its own right, they nonetheless allow future military leaders to develop space-relevant skills and ways of thinking within the joint environment of the War College. Meanwhile, the main difficulty remains imagining our future space capabilities during this technological transition phase for the French military: anticipation is constrained by the evolving French space environment, caught between reality and its future objectives.

It is interesting to note that the French War College involves its student officers in French space

exercises such as ASTERX23, organized by the French Space Command. Indeed, some students assume operative functions and responsibilities within the space operations center. Their feedback will be worthwhile in developing space expertise at this level. In addition, certain exchange officers are able to follow space courses delivered by the U.S. Air War College in Montgomery, Alabama. Via those courses, they develop and hone their ways of thinking regarding space issues.

For its part, each year the French War College integrates civilian auditors into the different courses it provides. This melting pot enables student officers to expand their minds by dealing with space industry executives on issues of strategy, resiliency, and superiority within their civilian environment. This is an effective way to consolidate space defense culture, a common objective perpetuated via the French IHEDN (Institute for Advanced Studies in National Security)⁸ structure. The IHEDN is comprised of officers of the rank of military lieutenant colonel or higher and high-ranking civilian (corporate) executives. Under the command of the French headquarters, IHEDN directly contributes to generating a national defense spirit around French military and industrial skills. Space is one of the Institute's main topics, enabling its civilian and military members to debate these strategic questions.

Concerning space as a joint domain, it is important to prepare military joint leaders to integrate the space stakes into their current and future operations. The French Air and Space Force has recently considered creating a dedicated space profile in its human resources division to generate a pool of experts on space. Creating such a dynamic profile of a career is sure to attract and retain top-level talent.

As we have seen, each aviator takes a dedicated course in the Air and Space Force Academy. The other armed forces consider space at a joint component level, primarily as supporting means; therefore,

their officers only receive education regarding the space stakes once joining specific units or commands related to space. However, the French Navy recently asked the French Space Command to integrate the “space advanced course” during the first part of naval officers’ operational careers. In this way, many naval officers will gain a far better understanding of the space stakes.

Beyond being a “supporting” domain for each military component, space is also a supported one. Indeed, a given space operation may require specific component effects to reach its objectives. This means space operations are multi-domain and must be managed at a joint level. In the French military organization, dedicated officers for military space operations are integrated in a “J space cell” at the joint level in the French CPCO. This organization needs military staff able to understand both their specific environment (Army, Navy, Air Force) as well as the space domain. Today, the CFOSM contributes to educating those joint officers, but primarily through “on-the-job” training. Finally, it is interesting to note that today’s “J space boss,” previously an airman, is now in charge of “informing” the French Chief of Staff on military space stakes via different meetings or written productions.

Still other ways have been developed to consolidate this shared willingness to generate a kind of space community in both military and civilian environments. Indeed, the French Air and Space Force deploys certain of its officers, who might be assigned to the space domain, into prestigious aeronautical French academies to enhance their skill levels in this specific field. For one year, those officers follow in-depth technical training, especially pertaining to space, within renowned schools such as SUPAERO or SUPELEC. Once returned to the Air Force, these officers constitute a real force in making space mastery more efficient. Furthermore, this year of technical space education allows those officers to establish relationships with future civilian space

engineers, a network that will only grow in strength and influence over the years.

As far as the political domain and space issues, the French government began showing a greater interest in space in the early 2000’s. At this time, some working groups began to list major risks, both real and potential, facing the French state. However, given that all ministries are concerned, this seems to have resulted in a recent change in mindset of the French Secretary for National Security and Defense. This department, under the control of the French Prime Minister, oversees national security and defense issues concerning the various ministries. Today, with space vulnerabilities a major concern at every strategic level, it is paramount to consider the space stakes while clearly identifying the risk matrix for each ministry. For this reason, and to serve this purpose, the Space Affairs Desk was created one year ago to force all ministries to address their weaknesses concerning space issues. This mission is directly linked to the recent French National Resiliency Strategy and will take many months before its work is done. Its work is this: forcing political structures to (re)think space, anticipate issues, and devise strategies that integrate space as an opportunity for success, thereby mitigating the related risks of failure.

PERSPECTIVES ON ATTAINING SUPERIORITY IN SPACE

Defending National Interests: Develop a “Global Strategy”

As mentioned, applications based on satellites are becoming more and more vital for many strategic sectors, and the loss of such capacities could paralyze a country, especially when there are no alternatives. This statement implies the need to integrate space stakes into what General André Beaufre has called a “total strategy.”⁹ Developed at the political level, this strategy is necessary to design

and prepare for full-scale conflict. This overall strategy is subdivided to encompass four main domains: military, economics, diplomacy, and politics.

In France, only a military strategy is well-developed through the National Strategic Review and the Space Defense Strategy. Stakes identified at the military level should lead to identifying national risks directly linked to space concerns in other departments under the aegis of the prime minister.

Integrate Risks into a Global Risk Management Strategy.¹⁰

Each French department has a high-ranking official dedicated to defense and the security of its vital infrastructures. However, historically, the law limits their actions to the physical. For example, they can prevent a physical intrusion into a nuclear plant but they cannot legally pursue a cyber-intrusion, according to the French document titled “*sécurité des activités d’importance vitales*” that deals with the security of vital importance activities (SAIV).¹¹ Thus, an attack against a vital satellite cannot automatically be considered an attack against vital infrastructure, as this would require a more flexible interpretation of “lawfare” issues. The evolution of the SAIV is in progress, attempting to bring French law into line with European law. Nevertheless, according to M. Mario Pain, Deputy Senior Defense Official at the Ministry of Ecological and Solidarity Transition, the risks linked to dependence on the space environment are only beginning to be studied, including, in particular, the consequences of a space “blackout” on the continuity of services.

Raise Space Awareness in all Ministries

Today the comprehension of the space stakes differs greatly between each state agency. Nevertheless, comprehension is the first step in elaborating a dedicated general strategy in each domain—military, economics, diplomacy, and politics—as detailed by General Beaufre. In 2019, the French Space Defense

Strategy discussed the creation of a Space Academy to instill space expertise through different kinds of education, and not only for space experts but also for high-ranking managers. According to then Minister of the Armed Forces Florence Parly, “The expertise and training on offer at the Space Academy will be open to interdepartmental partners.” This ambitious program entails partnership among the French Air and Space Force Academy, the Space Command, and the renowned *Ecole supérieure d’aéronautique* (an aeronautical engineering school, known as SUPAERO). Unfortunately, this project has been put on hold due to the difficulty in agreeing on the academy model and the mode of governance between these three entities. These difficulties should be rapidly resolved to give future leaders the opportunity to develop a common space culture and, together, envision a general strategy.

PROPOSITION 01: Establish a global matrix focusing on all the national risks linked to the space domain, enabling associated actors to define/redefine an inter-ministry space strategy as part of a global National Resiliency Strategy.

PROPOSITION 02: Resume the French space academy project, possibly by developing new partnerships with our allies (USAF, for instance), in order to create a base of space-related KSA (Knowledge, Skills, and Abilities) for our future leaders.

DEVELOPING SPACE EXPERTISE

Develop an Interdepartmental Space Education Structure

As General Philippe Adam, Chief of the French Space Command, explains: “This increase in power requires the training of specialists, in association

with our allies, and the development of activities and exercises, such as the space exercise AsterX.”

Using National Guard capabilities for Space Force Command may be an interesting way to ease the burden on active forces in those domains. By National Guard capabilities, we mean civilian space experts hired under military status for a specified period. Having a National Guard engaged in space activities would provide the ability to link up with innovative concepts, equipment, and ideas through its private sector members with many years of experience, often gained via careers within the same companies that build space and counter-space systems for states. Alliances can also be formed within this National Guard. These would help establish an environment of trust and help shape a coherent space strategy among allies; or a kind of space alliance to counter opponents’ domination initiatives, much like the U.S. Space Partnership Program, or SPP.¹² In France, the National Guard could go further in the recruitment of civilian elites in order to foster knowledge sharing between the French Air and Space Force and the European Space Agency (ESA), consolidating those space centers of excellence previously mentioned. Furthermore, this National Guard status could help maintain a high level of confidentiality for future military space operations. However, it would be necessary to reflect on the prioritization of the employment of such personnel in case of simultaneous needs by the military and the private sector.

In the meantime, CFOSM is developing a strategic space course to fill the gap between expert and generalist training. The first edition is expected in September 2023. Beyond tactical issues, military forces are used to analyze risk and opportunities at the strategic level. The objective of this course is to explain strategic stakes in space to military, industrial, economic, and political leaders. Organized around roundtable discussions, it allows for high-level networking and a shared national understanding of the issues.

The development of a revised PME should thus engender a space community uniting experts and informed leaders sharing a common vision of the space stakes; further, this space community must span, at a minimum, those four domains identified by General Beaufre. Beyond technical expertise, having a “global strategy” in space will require strong political commitment. An understanding of this domain at the political level is a key point that this space community could help implement.

PROPOSITION 03: Develop a space community between military and civilian space structures by developing a National Guard incorporating civilian space experts.

CREATING OPPORTUNITIES FOR INDUSTRY AND COMMERCIALIZATION

As General Charles De Gaulle said in June 1940, “Struck down today by mechanical force, we will be able to overcome in the future with a superior mechanical force.” De Gaulle clearly understood the link between industry and operational superiority. Industrial capabilities may also be linked with commerce, trade, and business to build a great economic power that can be used to prepare the armed forces. That is why, following the invasion of Ukraine, President Emmanuel Macron stated his desire to develop a war economy through better cooperation between the defense industry, the financial sector, and the armed forces.

In the new conception of space, many commercial entities are developing new services. The defense environment has the opportunity to develop a “trust circle” to take advantage of this new triptych of innovation: new capacities; resiliency; and subsidiarity. The French Space Command is not yet deeply involved in incorporating the defense industry

into its strategy; therefore, to right this, a dedicated structure was established to keep innovation at the heart of the defense space strategy.¹³ Called LISA,¹⁴ the structure's mandate is to ensure, within the ecosystem of national civil actors, dual solutions based on space technologies to meet the needs of the four armed forces. To this end, main actors within the space industry were invited to participate in the space exercise called AsterX, in 2022. This “win-win” partnership provides the opportunity for the military to explain to them the space stakes, such as that maneuverability in space is a pre-requisite to the freedom of action mentioned above, one of Marshal Foch's three principles of war. The role of this Commercial Integration Cell (CIC) could be tailored to take advantage of synergies, both in the technical field and in the conception of space maneuvers.

PROPOSITION 04: Consolidate synergy between military and industrial structures by involving space industries in the military space environment—especially via common space exercises—as participants and mentors.

DEVELOPING RESILIENCY IN COMMAND AND CONTROL

In accordance with its Defense Space Strategy, France will develop defensive and offensive capabilities in space by 2030, based on the ARES¹⁵ major effects program. This will be based on a renovation of the GRAVES and SATAM surveillance systems and the launch of the experimental satellite called YODA,¹⁶ the first steps toward a patrol satellite. Command and control being essential to ensure the efficiency of space operations, the C2 structure will have to evolve to adapt to the challenges of massive data fusion, AI-based decision support, and the need for supercomputers to track and control satellite trajectories.

This evolution will only be possible through reliance on experts trained in the requisite fields. While it is obvious that the defense industry plays, and will continue to play, an essential role, the armed forces will have to be vigilant to ensure the internal operationalization of these systems. The use of an adapted National Guard and the recruitment of commissioned officers in highly specialized fields, such as big data or artificial intelligence, should therefore be prioritized.

Beyond the military domain, President Macron has already tasked his prime minister with elaborating a national resiliency strategy, one that incorporates space resiliency. This inter-departmental project will lead to a better understanding of space dependency through a space blackout exercise and the elaboration of an interdepartmental space doctrine.

In France, space resiliency is quite different from space defense. That is why it is also important to discuss space defense before defining an effective C2 structure. The Department of Defense has the authority to command and control military space operations to defend their own satellites; however, does it also bear responsibility for protecting commercial ones? This is not clear in the written prerogatives defining the Space Defense Strategy. This observation illustrates the need to clarify the legislation governing the action of the state in space. This is also why improvement of the command and control structure is closely linked to this topic. U.S. Space Force General B. Chance Saltzman, Chief of Space Operations, has clearly identified this link by recently stating: “We have a responsibility to secure the space domain to defend U.S. service members in harm's way. ... A resilient force is one that can withstand, fight through, and recover from attacks.”¹⁷

The French military has established two higher levels of command: CPCO, considering space as a supporting actor in their joint operations, and the French Space Command, aiming to conduct space operations by requesting joint

support from the other components. It would be interesting to build the operative level of the French Space Command so that it would be able to elaborate space operations, including joint courses of action to achieve shared objectives. In this conception of space operations, the J-space would remain the interface between the Space Force and the Joint Operation Center. Enabling joint actions for a space operation, they would no longer be in charge of the joint effect plan. This transfer of command might well improve the French space command and control process to attain more efficient effects and conduct joint space operations led by space command and control experts.

Additionally, multinational cooperation remains essential to enhance national resiliency and to improve our own command and control structure. Today, this cooperation looks well developed through bilateral and multilateral actions. As was recently seen during the official meeting between President Biden and President Macron, bilateral cooperation with our United States partner is essential to bridge gaps in French space warfare expertise. The United States has a huge advantage in this domain; therefore, the French Air and Space Force, especially via its Space Command, is very interested in involving its officers in space-related PME sharing. The recent JPME partnership between the U.S. Space Force and Johns Hopkins University may be a good opportunity for bilateral cooperation. The main goal of this would be to acquire new abilities and experience through attending courses and participating in space exercises. Today, the National Security Space Institute (NSSI) opens its SPACE 200 course to French students. Upon graduation, they are able to apply operational expertise at the joint level, gaining a far better understanding of resiliency in a contested space environment. In the near future, expanding access to the SPACE 300 course could prove very beneficial in educating

senior military officers in charge at the strategic level. Beyond space courses, participation in U.S. space exercises such as the Shriever Wargame would allow French military space experts to gain firsthand experience in space warfare.

Regarding the multilateral environment, France is included in a quorum of “5 eyes and France/Germany” under the Combined Space Operations (CSPO) initiative. This group of participating countries is key in the multi-domain space environment facing high operational, legal, and capacity stakes. It facilitates communications on interoperability through materiel capability and space doctrine. In the contested domain that space is, and will remain, it is also a good way to arrive at shared views on major lawfare issues.

Simultaneously, the implementation of the NATO Center of Excellence (COE) on Space in Toulouse, in the south of France, will be a significant challenge yet will provide opportunities to share experiences and discuss space doctrine. At the same time, the evolution of the AJP 3.3 “Allied Joint Doctrine for Air and Space Operations” is also in progress and may lead to a better comprehension of joint space stakes, especially those based on the expertise of U.S. partners. The evolution of this doctrine is essential to further developing military integration into the space stakes. For instance, AJP 3.3 states the need to understand “how military space operations can be integrated in military operations to achieve alliance security objectives,”¹⁸ yet does not detail how military operations, and other “traditional” components, can also be integrated into military space operations.

PROPOSITION 05: Define a strong space C2 structure, from the strategic to the tactical level. Explain the role of each space entity, especially those among the Space Force (Space combatants, capacities) and Operation Command (Joint strategic effects).

PROPOSITION 06: Reinforce space cooperation within a bilateral (especially U.S./FRANCE) or multinational environment to develop global space doctrine regarding the C2 domain (interoperability) and space education sharing, and to reinforce shared resiliency through space superiority.

CONCLUSION

We have seen the increased stakes inherent in a new space race, whether among the traditional great power competitors or emerging countries. As today's space environment is a dual one, split between national and commercial issues, it becomes all the more important to clearly define the conflicting interests and motivations of the public and private sectors.

Simultaneously, states continue to develop their space strategies, first by establishing new military structures such as space forces or commands, then via the consolidation of Professional Military Education programs. France is not too far behind in this domain and, as a longstanding space pioneer, the country continues building its National Resiliency Strategy, involving all domains and services pertaining to space issues and stakes.

However, France will not be able to meet the major challenges ahead on its own. In fact, no country will be able to do this, hence the importance of continuing existing international alliances while forging new ones, optimizing space structure interoperability and future space operations.

As was recently seen with the Chinese balloon¹⁹ event over the United States, developments both "to and in" space are growing increasingly common and illustrate the need to anticipate every actor impacting space and its raised stakes, whether diplomatic, political, military, or private. Otherwise, traditional actors risk being surprised in this new, high-stakes space competition.

Based on our research as well as extensive discussion with civilian and military experts, we grow ever more convinced of how crucial it is to reinforce our common interests and strengthen our partnerships within space to assure our mutual national superiority.

Prepare leaders, develop joint strategy, consolidate resiliency. PRISM

APPENDIX 1 – SUGGESTED SPACE PROGRAM FOR CAREER OFFICERS

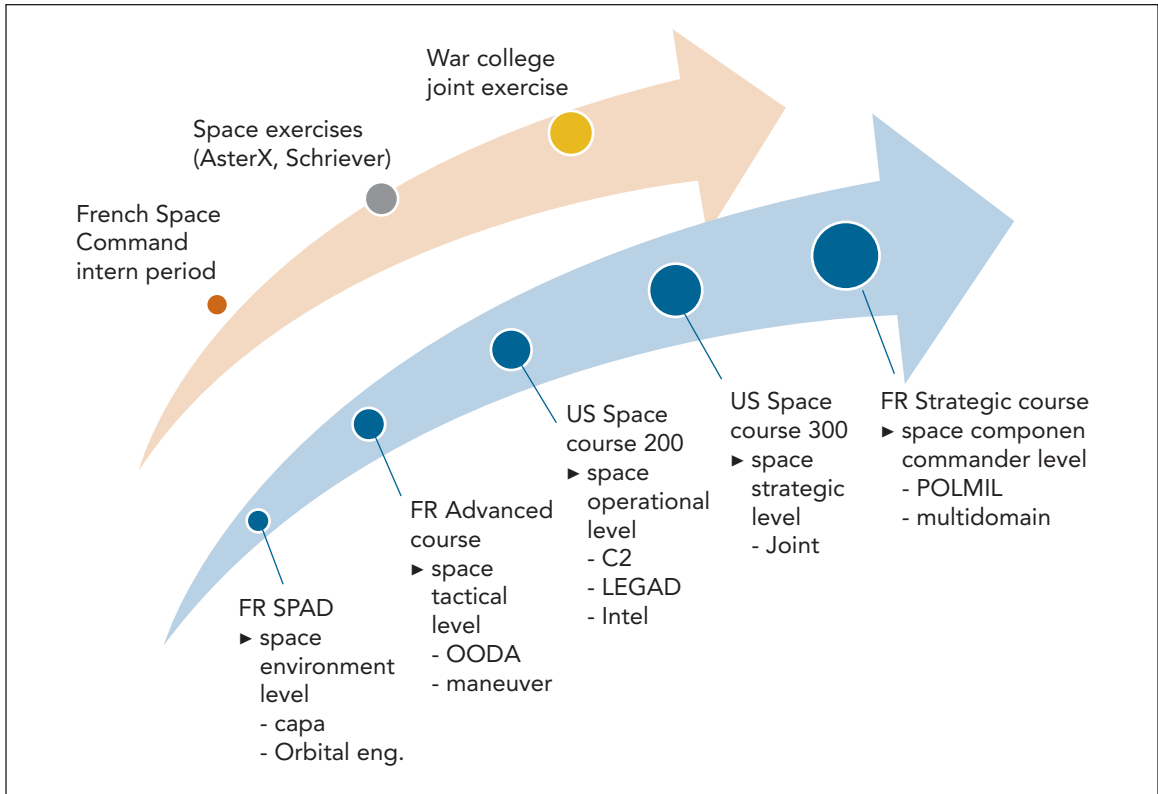
As two officers currently finishing our Joint War College studies, we would like to propose here what we envision as a dedicated PME program to prepare and educate future military leaders.

Based on our own tactical and operational experience regarding courses existing today, we have conceived of a sort of space education timeline that we believe would be useful in addressing space issues in war and dealing with the stakes existing around space C2, especially in a joint and strategic environment.

Our paper is, in parallel, based on our own involvement in some of the larger joint exercises the French military has conducted over the last thirty years. For the first time in our military history, a space component was engaged in these operations. As war college students, we have been involved in the different structures of the SPOC (Space Operation Center), from the "combat plan" division to the "combat operation" one. We have learned a great deal regarding domains related to space and we have transmitted much advice, based on our operational experience, to young space experts. The results were remarkable after just three weeks, achieving effective knowledge-sharing dedicated to space operations. We are proud to have taken part in such operations, and to have experienced firsthand the difficulties and issues we have identified in this paper.



Figure 6. Suggested space PME for French career officers



ACKNOWLEDGMENTS

The authors warmly thank the following eminent persons for offering their time and expertise in domains relevant to this paper:

Major General Philippe Pottier, Director of the French War College;

Brigadier General Thierry Auboin, Deputy Director of the French War College;

Navy Captain Christophe Merieult, French SGDSN;

Colonel Guillaume Bourdeloux, French Space Command;

Colonel Pierre Conchon, French CPCO J-space;

Colonel Jérôme D'Oliveira, French Space Command;

Lieutenant Colonel Vincent Lochet, French Space Command;

Navy Commander Alexis Hourlier, French Space Command;

Major Corentin Jimenez, French Air and Space Force Academy;

Major Yann Bidaux, French Space Command;

Captain Béatrice Hainaut, space research specialist at IRSEM;

First Lieutenant Justine Mignonat-Lassus, French Space Command;

Professor Xavier Pasco, director of FRS (French Foundation for Scientific Researches);

Laura André-Boyet, French Air and Space Force National Guard member and astronaut instructor at the European Space Agency;

Yves Préaux, French Naval Academy;

Emilie Cléret, Director of English Foreign language of the French War College; and last but not least, James Reese, English professor.

Notes [Most of these do not contain basic information]

¹ Xavier Pasco, Director of the *Fondation pour la recherche stratégique*, a foundation studying strategic stakes.

² Wilson W.S. Wong and James Fergusson, *Military Space Power*, « A guide to the issues. »

³ U.S. Commercial Space Launch Competitiveness Act, 25/11/2015.

⁴ Jacques Arnould, *La guerre de l'espace aura-t-elle lieu ?* l'Harmattan 2022, 75. Jacques Arnould is a scientist and oversaw ethical issues for CNES.

⁵ Deganit Paikowsky, « The Space Club – Space Policies and Politics, » paper presented at the 60th International Astronautical Congress, Daejeon, Republic of Korea, October 2009.

⁶ General John W. Raymond, Chief of Space Operations' Planning Guidance, November 9, 2020, <https://media.defense.gov/2020/Nov/09/2002531998/-1/-1/0/CSO%2520PLANNING%2520GUIDANCE.PDF>.

⁷ Jacques Arnould, *Icarus' Second Chance : The Basis and Perspectives of Space Ethics*, Springer Vienna, 2011.

⁸ *Institut des Hautes Etudes de la Défense Nationale*.

⁹ General André Beaufre was a French expert on strategic stakes.

¹⁰ Admiral Rolland, conference at Ecole de guerre, December 2022.

¹¹ SAIV: Security of vital importance activities

¹² Christopher Stone, *Space Partnership Program between the USA and allied countries*, The Mitchell Institute for Aerospace Studies.

¹³ Colonel Quéant, Chef de la division capacité, Commandement de l'Espace, interviewed in *Smart Space. L'innovation au coeur de la stratégie spatiale de défense* (04 11 2022).

¹⁴ *Laboratoire d'Innovation Spatiale des Armées*.

¹⁵ *Action et Résilience dans l'Espace*.

¹⁶ *Yeux en Orbite pour un Démonstrateur Agile*.

¹⁷ General B. Chance Saltzman, Chief of Space Operation, U.S. Space Force.

¹⁸ NATO, AJP-3.3, *Allied Joint Doctrine for Air and Space Operations*, Edition B, Version 1, April 2016.

¹⁹ "U.S. declassifies balloon intelligence, calls out China for spying," *The Washington Post* (February 9, 2023).