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Mastery of Space: France, European strategic autonomy, and the weaponization of space

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Abstract

Traditionally, France has held a "Gaullist" view of foreign and defense policy encompassing a dogmatic belief in sovereignty and political independence, and the principle that only France can be "the master of its fate" in terms of security. This paper argues that France's belief in strategic autonomy is a driving force behind the French pursuit of independent space systems, military space institutions, and greater military spending on space. [1] French participation in expeditionary military interventions in the Persian Gulf, Africa, Kosovo, Afghanistan, and elsewhere suggests France favors military force for political aims. In keeping with its belief in "strategic autonomy," France seeks an independent military space posture that may include coercive capabilities. As the third nation to independently launch a satellite in 1965, France has been a global leader in space capability development and launch services and hosts ESA's launch facility at the Guyana Space Center in Kourou, French Guyana. In 1995 France was the first European country to deploy a military imaging satellite, HELIOS 1A. France was

[1] Bastien Irondelle, "European Foreign Policy: The End of French Europe?," *Journal of European Integration* 30, no. 1 (March 1, 2008): 156.

also a lead advocate for the EU's Galileo navigation satellite system (GNSS), a collaborative effort to develop a European alternative to the American global positioning system (GPS).[2] In 2010, the French military created a Joint Space Command (commandement interarmées de l'espace, or CIE), and in 2019, its military space service, l'armée de l'air et de l'espace. The same year, the Armed Force Ministry released a space defense strategy that highlights the need to develop the means to conduct military operations in space to "preserve freedom of access to and action in space" while thwarting adversaries and their ill-intentions with French space capacity.[3] Florence Parly, the French Armed Forces Minister, remarked in July 2019 that France could not stand idle while its allies and adversaries militarized space.[4] Parly spoke at the French Air and Space Force base in Toulouse, France, to present the French Space Defense Strategy and a new space armament program to increase French spacepower called "maîtrise de l'espace" or the command of space.[5]

[2] Brian Harvey, *Europe's Space Programme: To Ariane and Beyond* (Chichester, UK: Praxis Publishing Ltd., 2003), 347.
[3] Ministère des Armées, "Stratégie spatiale de défense: Rapport du groupe de travail 'Espace'" (DICoD Bureau des editions, Juillet 2019), 38.
[4] Ministère des Armées, "Allocution de la ministre des Armées, florence Parly, sur la stratégie spatiale française de défense. https://t.co/37JDLdEaVb," Tweet, *@Armees_Gouv* (blog), July 25, 2019, https://twitter.com/Armees_Gouv/status/1154343383772618753.
[5] "Florence Parly dévoile la stratégie spatiale française de défense," Ministère des Armées : Actualités, Septembre 1, 2020, https://www.defense.gouv.fr/actualites/articles/florence-parly-devoile-la-strategie-spatiale-francaise-de-defense.

Introduction

Once considered a sanctuary, space is now an operational domain in which various space actors exercise power and influence through commercial and military means. The European Union recently announced a space policy that earmarked €14 billion to shepherd the EU's peaceful space programs through 2027. Meanwhile, France is embarking on an ambitious space armament program called "maîtrise de l'espace" to preserve the French (and European) ability to act independently in an era of great power competition. What explains this behavior?

This paper argues that France's commitment to French and European strategic autonomy, coupled with the threats of the modern space age, drives France to pursue an independent military space posture in three ways. First, France has developed independent space systems to exploit vital space functions supporting military operations, including independent space-launch capabilities that form the basis for European space access. Second, France has reorganized its military institutions to operate independently in the space domain and expressed a willingness to use force to defend its space systems. Finally, France has increased its national spending on military space capabilities to reflect its high strategic space priorities.

France's pursuit of military space power is consistent with a Gaullist view of France's role in the world that seeks to preserve national independence and capacity to act without relying on support from a stronger power. Despite EU concerns of a looming space arms race, and recent efforts to promote norms against the use of debris-producing anti-satellite weapons, congestion in Earth's orbital regimes and the proliferation of non-kinetic counterspace technologies increases the risks to space systems. In calling for a more coherent European approach to global and security affairs, France leads Europe in attaining the capabilities required to ensure Europe's

strategic autonomy, including in space. Such capacity to act independently requires access to space-based capabilities necessary for modern societies, economies, and militaries.

In 1965, France became the world's third space power when it successfully orbited the domestically developed satellite A-1 – nicknamed Astérix – atop a French Diamant A rocked from France's space launch facility at Hammaguir in Algeria.[6] Although nominally a scientific mission, the A-1 launch benefited from the military's ballistic missile program, which demonstrated an ability to launch military payloads. Unwilling to rely on American commitments to nuclear deterrence, French President Charles de Gaulle directed parallel efforts to develop nuclear weapons and ballistic rockets that could range the Soviet Union or other threats and deliver a nuclear payload, thus providing France with an independent nuclear deterrent capability. France's space program, developed in tandem with its nuclear capability, was thus a hallmark of Gaullist France's exceptionalism and autonomy during the Cold War.

The renewal of strategic competition in the 21st century involving the United States, China, and Russia, increases the risks that armed conflict could extend to orbit.[7] Due to shifts in the balance of spacepower and the proliferation of space technologies that could hinder Europe's access to and freedom of navigation in space, heightened threat perception is driving the French military response. In 2019, France established its military space arm in response to the growing vulnerability of orbital systems to emerging threats. France also published a national space defense strategy describing its intention to field active space defense measures. France remains a party to international and intergovernmental processes to limit the threat of a space arms race,

[6] United Press International, "France Launches First Satellite," UPI Archives, November 26, 1965, https://www.upi.com/Archives/1965/11/26/France-launches-first-satellite/7861511630886/.
[7] Saadia M. Pekkanen, "Neoclassical Realism in Japan's Space Security," in *The Oxford Handbook of Japanese Politics*, ed. Robert J. Pekkanen and Saadia M. Pekkanen (Oxford University Press, 2021), 769.

including the UN Office of Outer Space Affairs (UNOOSA), which holds the Committee on the Peaceful Uses of Outer Space (COPUOS). However, in the French view, securing space is necessary for preserving Europe's ability to act independently on Earth and in space.

The paper proceeds as follows. First, it briefly reviews the literature on space security and summarizes the evolving weaponized character of the space domain. Second, the paper briefly describes the historical military context of space flight, France's history as the world's third space power, and the early stages of European cooperation in space. The paper then describes the three growth areas in France's military space posture. The paper concludes with preliminary insights, the implications for French and European strategic autonomy, and areas for further study.

Space Security Literature, Weaponization, and 21st Century Threats

Space security and strategy remain under theorized, but a growing body of literature advances several key concepts of space power, security, and strategy to explain how states exploit the space domain to pursue political goals. Broadly, space security refers to the right to free access to, use of, and navigation in outer space according to international laws and treaties.[8] However, space security differs in the military dimension for states that rely on access to space functions to augment the effectiveness of their land, air, and maritime forces.[9] Space and satellite capabilities provide vital space functions that support military operations on Earth. Space support functions include positioning, navigation, timing (PNT); early warning and threat assessment; environmental and earth monitoring; communications (SATCOM); intelligence, surveillance,

[8] Michael Sheehan, "Defining Space Security," in *Handbook of Space Security: Policies, Applications and Programs*, ed. Kai-Uwe Schrogl et al. (New York: Springer Science and Business Media, 2015), 21.
[9] Colin S. Gray, *Modern Strategy* (New York, NY: Oxford University Press, 1999), 260.

reconnaissance (ISR); and space situational awareness (SSA). For states that rely on space systems, including the great powers and France, space security includes the security of the environment from phenomena such as orbital debris and the systems themselves.[10] Thus, space-reliant states need resilient systems that can withstand attacks and the capacity to neutralize threats in orbit, either through coercion or denial.[11]

Spacepower refers to a state's ability to operate in space and pursue activities in or from space to pursue political objectives. Spacepower differs from space power, a state that can operate independently in the space domain. Brad Townsend asserts that a sound theory of spacepower must drive military doctrine and investments to situate these capabilities within the broader military context.[12] While humanity lacks experience fighting in space, several authors draw from existing theories of sea power to describe a theory of space power.[13] Borrowing from Julian Corbett and his principle of sea power as achieving command of the sea lines of communication, John J. Klein describes space power as the ability to ensure access and use of celestial lines of communication to support the instruments of national power (such as key orbits and satellite data-link connections to ground stations).[14] He adds that space activities, especially those with a military dimension, operate within the context of a state's overall political goals.[15] Jim Oberg takes a more holistic approach and emphasizes spacepower as the ability to leverage

[10] Sheehan, "Defining Space Security," 11.
[11] Sheehan, "Defining Space Security," 12.
[12] Brad Townsend, *Security and Stability in the New Space Age: The Orbital Security Dilemma* (New York, NY: Routledge, 2020), 87-88.
[13] Brad Townsend, *Security and Stability in the New Space Age: The Orbital Security Dilemma*, (New York: Routledge, 2020), 90.
[14] Key orbits include advantageous low- and medium-Earth orbit (LEO and MEO) as well as geosynchronous orbits (GEO) that allow satellites to match the Earth's rotation, often a requirement for weather and communication satellites. John J. Klein, *Space Warfare: Strategy, Principles, and Policy*, (London; New York, NY: Routledge, 2006), 61. See also "Space Capstone Publication: Spacepower" (United States Space Force, August 10, 2020), 24, https://www.spaceforce.mil/Portals/1/Space%20Capstone%20Publication_10%20Aug%202020.pdf.
[15] Ibid, 155.

all aspects of a state's space activity, including civilian and military systems, to obtain information about the world from orbit.[16] Both writers consider space operations as a subset of national power and goals. Townsend combines elements of Klein's theory with Oberg's to propose a functional theory of space power, in which: space power is proportional to a state's presence in space; the value of space power derives from a state's ability to gather, transfer, and obtain information from space; and that space is a supporting domain to the degree that it influences events on Earth.[17]

Bleddyn E. Bowen discusses space power in the context of military strategy to advance a theory of space power that is inherently geocentric and rooted in classical land-based military strategy.[18] Citing the 1990-1991 Persian Gulf War, which Bowen and others refer to as the "first space war," Bowen describes space power as a series of capabilities to support speed and lethality on the terrestrial battlefield.[19] The space domain is inherently part of the international system; therefore, spacepower is an instrument of national power that enables nations to leverage modern diplomatic, informational, military, and economic power in pursuit of political objectives. States derive spacepower from both orbital capabilities, such as satellites and from the ability to leverage the space domain from the ground through various means.[20]

An early example of spacepower at work was the precision navigation and targeting afforded to the United States-led coalition against Iraq during the Gulf War. The American satellite-based global positioning system (GPS) enabled coalition forces to maneuver large formations across a featureless desert to envelop Iraqi forces while delivering precision-guided

[16] James E. Oberg, *Space Power Theory* (Colorado Springs, CO: USAFA Government Printing Office, 1999), 125.
[17] Townsend, *Security and Stability in the New Space Age: The Orbital Security Dilemma*, 93.
[18] Bleddyn E. Bowen, *War in Space: Strategy, Spacepower, Geopolitics*, 1st ed. (Edinburgh, United Kingdom: Edinburgh University Press, 2020), 20.
[19] Bowen, *War in Space*, 20.
[20] Bowen, *War in Space*, 21.

munitions against targets. On the other hand, China's 2007 anti-satellite (ASAT) weapons test against a derelict satellite demonstrated an ability to place space-based capabilities at risk while adding to the problem of orbital debris – the satellite's destruction generated substantial debris that remains in orbit today, drawing condemnation from across the international community. Bowen argues that the United States, as the dominant space power, views the growing number of space actors, and their demonstrated capabilities (such as China's ASAT test), as potential threats to its space power.[21] This threat perception is consistent with the previous discussion on the challenges to space security and the security dilemma in the space domain. To ensure its self-professed space dominance, the United States is developing capabilities and concepts to deter aggression against its space assets by other actors.[22]

Militarization of space is not new, and states have sought to exploit the military utility of orbital systems since the earliest satellites flew in the 1960s. However, the more alarming trend is the weaponization of space, whereby states deploy coercive capabilities that can directly attack satellites through kinetic or non-kinetic means.[23] The United States, China, Russia, India, and Russia have demonstrated a direct-ascent ASAT weapon.

In this context, the United States recently published its Defense Space Strategy, following the establishment of the United States Space Force (USSF) as the sixth branch of the military and the reactivation of the United States Space Command (USSPACECOM) as the eleventh unified command.[24] This document describes how the United States advances spacepower to "compete,

[21] Bowen, *War in Space*, 31.
[22] "2020 Defense Space Strategy Summary" (Department of Defense, June 17, 2020), 7.
[23] Jean-Daniel Testé, "Future of French Space Security Programs," in *Handbook of Space Security* (Cham: Springer International Publishing, 2019), 4,
[24] U.S. Space Command previously existed from 1985 to 2002, when it was disbanded in lieu of U.S. Northern Command. U.S. Strategic Command (USSTRATCOM) oversaw U.S. military space activities from 2002 to 2018, when the current USSPACECOM was activated as the newest unified command. Gary Shugart, "Reestablishing U.S. Space Command," *Purview*, October 1, 2018, https://purview.dodlive.mil/2018/10/01/reestablishing-u-s-space-command/.

deter, and win" in a complex security environment.[25] The U.S. views space as a warfighting domain and is orienting its military posture, capabilities, and investments to expand its presence in space and defend its assets in orbit. The strategy acknowledges U.S. reliance on space-based capabilities to project and employ its modern military power on Earth and views Russian and Chinese behaviors and capabilities as potentially threatening the U.S. and allied military effectiveness.[26] Such declarations remain consistent with other U.S. strategic documents, including the National Security Strategy and the National Defense Strategy, which characterize the current security environment through the lens of great power competition. The document describes how the U.S. intends to integrate allied and partner operational capabilities to build resilience, align space policies and promote favorable norms and standards of behavior in the space domain.[27] But the strategy stops short of expressing what the United States considers to be armed aggression in space or declaring that the United States will uphold its alliance commitments by defending allied space assets from aggression. The strategy is largely threat-focused and centers on assuring U.S. dominance in space by building its spacepower, reinforcing the security dilemma in space vis-à-vis Russia and China.

As the U.S. asserts its military superiority in space, especially with the advent of the U.S. Space Force, several European allies are distancing themselves from the U.S. and its approach to space. For example, the EU invested in and launched the Galileo global navigation satellite system (GNSS), an independent orbital positioning system, to reduce EU member states' reliance on the American GPS or Russian GLONASS and maintains the system under EU civilian

[25] "2020 Defense Space Strategy Summary," 1.
[26] "2020 Defense Space Strategy Summary," 3.
[27] "2020 Defense Space Strategy Summary," 9.

control.[28] Within the EU, France stands apart from other members as a rising space actor recognizing the military and security dimensions of space. In 2019, France created a military space command within the French air force. It announced plans to develop a satellite-based defensive capability to protect French space assets from Russian and Chinese aggression.[29] France's role as both a NATO and EU member and a nuclear power puts it in a unique position to advocate for shared capability development for NATO while promoting more explicit commitments to European collective defense in space. As both a provider and consumer of space-based capabilities, France perceives Russian and Chinese behavior in space as a potential threat to French space systems. Presenting France's space strategy in 2019, French Armed Forces Minister Florence Parly recognized the risks of weaponization and declared the need for France to defend its assets in space.[30]

Weaponization and 21st Century Space Threats

Technology proliferation has democratized space access and increased the number of state and non-state actors operating in space.[31] Although the U.S., Russia, and China, the world's legacy space powers, still operate the greatest number of space systems, the "New Space Age" reflects growing congestion in Earth's orbital regimes. Additionally, orbital debris poses an indiscriminate risk to space flight and compounds problems of congestion due to the increased

[28] The EU initiated the Galileo GNSS project as an alternative to U.S. and Russian systems to mitigate the risks to the EU economy. Harrison, "The Role of Space in Deterrence," 122. See also "Galileo," European Global Navigation Satellite Systems Agency, April 17, 2020, https://www.gsa.europa.eu/european-gnss/galileo/galileo-european-global-satellite-based-navigation-system.
[29] Brian G Chow and Henry Sokolski, "The United States Should Follow France's Lead in Space," *Spacenews*, September 9, 2019, https://spacenews.com/the-united-states-should-follow-frances-lead-in-space/.
[30] Florence Parly, "Présentation De La Stratégie Spatiale De Défense," https://satelliteobservation.files.wordpress.com/2019/07/discours-de-florence-parly-prc3a9sentation-de-la-stratc3a9gie-spatiale-de-dc3a9fense-c3a0-lyon-le-25-juillet-2019.pdf.
[31] Saadia M. Pekkanen, "Governing the New Space Race," *AJIL Unbound* 113 (2019): 92.

number of actors.[32] However, weaponization in space is the more alarming trend of the New Space Age, especially in the case of debris-producing anti-satellite weapons (ASAT).

Recent scholarship suggests threat perceptions and uncertainty about capabilities and intentions in the space domain drive the deployment of space weapons, including kinetic ASATs, by great and middle powers alike. The United States, Russia, China, and India possess explicit or, in the case of Japan, latent counterspace capabilities resulting in a multipolar security dilemma.[33] As humanity continues to place more objects in low-earth orbit (LEO), and as terrestrial activities become dependent on space systems, satellites are vulnerable and lucrative targets during a potential military confrontation. Given that spacepower enables modern military power on Earth, systemic rivalry between the U.S. and China increases the risk of armed conflict on Earth extending to outer space.[34] A shooting war in space involving kinetic weapons would be disastrous to future human space flight. The resulting debris would linger in LEO for decades and render space flight prohibitively dangerous and expensive.[35]

Additionally, satellites can maneuver and alter their orbits to rendezvous with other platforms. Known as rendezvous and proximity operations (RPO), these maneuvers are often benign and deliberate, such as a manned capsule docking with the International Space Station. This ability, however, suggests operators can intercept satellites situated in predictable orbits, especially in low-Earth orbit (LEO). Malign actions include satellite capture, signal intercept for

[32] Pekkanen, "Governing the New Space Race.", 95.
[33] Townsend, *Security and Stability in the New Space Age*, 8; Saadia M. Pekkanen, "Neoclassical Realism in Japan's Space Security," in *The Oxford Handbook of Japanese Politics*, ed. Robert J. Pekkanen and Saadia M. Pekkanen (Oxford Univ. Press, 2022), 769.
[34] Bowen, *War in Space*, 19; Pekkanen, "Neoclassical Realism in Japan's Space Security," 769.
[35] This is known as the Kessler Syndrome (or effect). Donald J. Kessler and Burton G. Cour-Palais, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt," *Journal of Geophysical Research: Space Physics* 83, no. A6 (1978): 2637–46.

espionage purposes, or in extreme circumstances ramming one satellite into another in a kinetically destructive maneuver.[36]

Since 2014, Russia has engaged in threatening behavior in orbit that reflects the weaponization trend of the "New Space Age." As early as 2015, the Russian satellite Luch (aka Olymp-K) conducted unusual orbital maneuvers after entering the geosynchronous orbital regime (GEO). Through 2019, Luch occupied at least 16 distinct orbital positions, which is unusual because most satellites maintain a stationary position relative to the Earth once in GEO.[37] Several commercial and state-level satellite operators criticized the Russians for what they viewed as inappropriate and concerning behavior in the fragile orbital regime, which extends over 35,000 km (~22,000 miles) above the Earth. Intelsat, a commercial satellite services provider, reported that Luch occupied a position between two operational Intelsat satellites for nearly three months.[38] In 2018, Parly accused Russia of maneuvering Luch dangerously close to the French-Italian military communications satellite Athéna-Fidus. Parly called this maneuver an "unfriendly act" of espionage.[39] Later, in 2019, Luch approached Intelsat 36 in GEO and closed to less than 1.8 km.[40] By comparison, the average distance between satellites occupying stationary positions in GEO is 207 km.[41]

[36] Joan Johnson-Freese, *Space Warfare in the 21st Century: Arming the Heavens* (New York, NY: Routledge, 2017), 143.
[37] Thomas G. Roberts, "Unusual Behavior in GEO: Luch (Olymp-K)," *Aerospace Security: A Project of the Center for Strategic and International Studies*, March 31, 2021, https://aerospace.csis.org/data/unusual-behavior-in-geo-olymp-k/.
[38] Brian Weeden, "Dancing in the Dark Redux: Recent Russian Rendezvous and Proximity Operations in Space," *The Space Review*, October 5, 2021, https://www.thespacereview.com/article/2839/1.
[39] "France Accuses Russia of Trying to Spy on Franco-Italian Military Satellite," *France24*, September 7, 2018, https://www.france24.com/en/20180907-france-accuses-russia-trying-spy-franco-italian-military-satellite-espionage-athena-fidus.
[40] Colin Clark, "US, China, Russia Test New Space War Tactics: Sats Buzzing, Spoofing, Spying," *Breaking Defense*, October 28, 2021, https://breakingdefense.sites.breakingmedia.com/2021/10/us-china-russia-test-new-space-war-tactics-sats-buzzing-spoofing-spying/.
[41] Roberts, "Unusual Behavior in GEO."

The Luch satellite maneuvers represent provocative rendezvous and proximity operations (RPO) and underscore the dual-use nature of space systems. There are, of course, legitimate uses for RPO, which all space actors undergo routinely. However, Russia appears to have been refining its RPO capabilities since at least 2013, when it launched several military satellites that conducted RPO with other Russian satellites. The military utility of Luch and Russia's other RPO-capable satellites appears to be surveillance, co-orbital inspection, and intelligence gathering.[42] RPO capability could also support targeting and tracking for other counterspace attacks, including direct-ascent ASAT.

Russian satellite maneuvers, such as those described above, are not illegal by any international standards. However, evidence suggests that Russia's behavior relative to other satellites increased the risk of collision. It also demonstrates sophisticated and precise space situational awareness capability that enables the Russian satellite to loiter for extended periods of time and collect uplink data from Alliance ground stations.[43] The Luch incidents exposed the vulnerability of civilian and NATO space infrastructure to RPO, which is inherently a dual-use capability that could be used in a counter-space capacity in the future. These developments suggest additional measures, including transparency, monitoring, and norms, may be necessary to mitigate the risks of such acts in the future.

Russia possesses one of the most prolific direct-ascent ASAT (DA-ASAT) capabilities globally, which it began testing in the Soviet era during the Cold War. As of 2021, Russia possesses three primary DA-ASAT systems: PL-19 Nudol, a ground-launched ballistic missile capable of intercepting targets in low-earth orbit (LEO); Burevestnik, an air-launched DA-ASAT

[42] Brian Weeden and Victoria Samson, "Global Counterspace Capabilities: An Open Source Assessment" (Washington, D.C.: Secure World Foundation, April 2021), 2-13.
[43] Clark, "US, China, Russia Test New Space War Tactics."

that can reach LEO to intercept targets or possibly deploy a hypersonic missile; S-500, a ballistic missile with a next-generation exoatmospheric kill vehicle that is still in development.[44] In November 2021, Russia successfully demonstrated the operational capability of its PL-19 Nudol DA-ASAT when it destroyed the Cosmos-1408 satellite in LEO at an altitude of approximately 485 Km.[45]

According to the U.S. Space Command (USSPACECOM), the Russian test produced over 1,500 pieces of trackable space debris and posed an immediate risk to the astronauts aboard the International Space Station (ISS), including two Russian Cosmonauts.[46] Shortly after Cosmos-1408 broke apart, NASA ground control notified the crew aboard the ISS to take emergency safety procedures when it became apparent the ISS would pass "through or near the vicinity of the debris cloud."[47] World leaders widely condemned the event, while Russia denied the test posed any risk to the ISS or other space activities.[48] The intensity of worldwide condemnation was similar to the criticism against China after its 2007 DA-ASAT test, which also produced large amounts of space debris.[49]

Russia launched the Nudol interceptor from the Plesetsk Cosmodrome, located about 800 Km north of Moscow.[50] Analysis of the PL-19 Nudol missile suggests Russia possesses an operational DA-ASAT capability to threaten any satellite or spacecraft in LEO credibly. The

[44] Weeden and Samson, "Global Counterspace Capabilities: An Open Source Assessment," 2-14 – 2-15.
[45] Foust, "Russia Destroys Satellite in ASAT Test."
[46] Theresa Hitchens, "Russian Suspected Ground-Launched ASAT Test Scatters Dangerous Debris through LEO," Breaking Defense, November 15, 2021, https://breakingdefense.sites.breakingmedia.com/2021/11/suspected-russian-ground-launched-asat-test-scatters-dangerous-debris-through-leo/.
[47] Bill Nelson, "NASA Administrator Statement on Russian ASAT Test," NASA, November 15, 2021, https://www.nasa.gov/press-release/nasa-administrator-statement-on-russian-asat-test.
[48] "Военные РФ подтвердили, что сбили советский спутник в ходе испытаний," Interfax.ru, November 16, 2021, https://www.interfax.ru/russia/803293.
[49] Broad and Sanger, "China Tests Anti-Satellite Weapon, Unnerving U.S."
[50] Hitchens, "Russian Suspected Ground-Launched ASAT Test Scatters Dangerous Debris through LEO."

amount of worldwide condemnation following the event suggests Russia was willing to bear reputational and material costs to signal the credibility of its coercive capacity in LEO.

When viewed as a coercive tool, Russia's DA-ASAT capability is thus another point of leverage to threaten objects of significant value to its adversaries. Russia knows that NATO forces, including France, depend on space-based capabilities for missions and operations. Possessing a credible capability to threaten satellites in LEO, Russia has armed itself with another tool to reinforce its bargaining power vis-à-vis NATO and the United States.[51] Given the peculiarities of the space environment and orbital mechanics, all space-faring actors share common interests in maintaining stable and safe access to space. However, uncertainty surrounding Russia's interests and intentions in space complicates the overall bargaining situation and reinforces the need for space reliant states in Europe to maintain their credible deterrent and coercive capabilities

Military Necessity and European Cooperation in Space

Modern spaceflight emerged from military necessity. German scientists and enthusiasts developed early rocket prototypes during the interwar period through the amateur organization VfR, or Verein für Raumschifffahrt (Association for Orbital Flight).[52] Through this organization, Wehrner von Braun, the father of modern rocketry who would later lead the American program in the 1960s, began experimenting with early prototypes. However, VfR struggled to acquire funding and materials to develop more capable rocket designs. In 1932, the German military was drawn into VfR after a successful rocket demonstration. Impressed at the military potential of

[51] For a discussion on coercion and credible threats as instruments of bargaining, see Thomas C. Schelling, *Arms and Influence* (New Haven, CT: Yale University Press, 1966), 2-8.
[52] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 4

rocketry, and because the Treaty of Versailles didn't specifically prohibit it, the German military began funding rocket research and development through their Army Weapons Department.[53]

The military hired von Braun and others, who worked on both rocket and jet propulsion for military applications. Their efforts culminated in the first successful rocket test in 1942 at Peenemünde, Germany's rocket facility on the Baltic Coast. Two years later, Germany deployed their rocket technology aboard the V-2 ballistic missile, the first military application of rocket technology in war. In late 1944, with its Luftwaffe depleted, Germany launched 4,320 V-2 missiles against allied targets, including over 1,120 strikes against London.[54] Despite its imminent defeat, Germany became the world's foremost missile power, and the technical expertise of rocket engineers became a lucrative prize for the Allies following the end of the war. Eager to regain its status as a great power, France hired over 70 engineers from Peenemünde to develop the French sub-sonic Véronique rockets that would form the technical basis for France's ballistic missile capability.[55]

Early European Space Cooperation

In 1963, French president Charles de Gaulle and West German Chancellor Konrad Adenauer signed the Élysée Treaty, signaling French-Germany reconciliation and a commitment to political reconciliation and European integration.[56] Thus began French-German collaboration on various political, economic, and strategic issues, including space. The first such space

[53] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 7.
[54] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 15.
[55] The *Véronique* rocket is shorthand for "Vernon électronique" which was the space program's initial site in France, in the Eure department. See also Jürgen Scheffran, "Space Policy and Missile Control in Europe," in *Space Power Interests*, ed. Peter Hayes (Boulder, CO: Westview Press, 1996), 91.
[56] Ministère de l'Europe et des Affaires étrangères, "Elysée Treaty," France Diplomacy - Ministry for Europe and Foreign Affairs, accessed July 27, 2021, https://www.diplomatie.gouv.fr/en/country-files/germany/france-and-germany/elysee-treaty/.

collaboration was developed under the aegis of CIFAS (Consortium Industriel France-Allemand pour Symphonie), which pooled French and German technical and financial resources to develop Europe's first telecommunication satellites for geostationary orbit called Symphonie 1 and 2.

France and Germany planned to launch the Symphonie satellites atop Europa-2 launch vehicles, a collaborative project between France, the United Kingdom, and Germany, among others, under the European Launcher Development Organisation (ELDO).[57] However, successive Europa-2 launch vehicle failures forced the French and Germans to seek assistance from the United States and NASA, which successfully delivered Symphonie 1 and 2 into orbit from Cape Canaveral in 1974 and 1975.[58]

ELDO and its sister entity European Space Research Organisation (ESRO) were the early mechanisms for Western European space collaboration under the auspices of the European Space Conference (ESC) and precursors to the European Space Agency (ESA). ELDO existed to develop European launch vehicles and reduce Europe's reliance on America for its access to space, while ESRO was created to manage European satellite and spacecraft development.[59] Launch vehicle development proved technically more challenging than satellite development, and the ESC sought cooperation with NASA to provide unconstrained launch services for its satellites. ELDO was eventually disbanded in 1974, and the ESC would incorporate Europa launch vehicle development into a single European space organization.

ESC delegates had talked of a single European space organization throughout various ESC meetings in the late 1960s. As the ESC debated the degree of cooperation with the United

[57] Scheffran, "Space Policy and Missile Control in Europe," 85; Harvey, *Europe's Space Programme: To Ariane and Beyond*, 47.
[58] "Symphonie 1, 2," Gunter's Space Page, accessed October 7, 2021, https://space.skyrocket.de/doc_sdat/symphonie-1.htm.
[59] "History of Europe in Space," The European Space Agency, accessed October 7, 2021, https://www.esa.int/About_Us/ESA_history/History_of_Europe_in_space.

States and NASA on the Post-Apollo space program, European ministers resolved at the Ministerial Conference in Brussels on December 20, 1972, to form a single European Space Agency. ESA would integrate ESRO and ELDO functions, be responsible for launch vehicle and satellite development, and manage European cooperation with NASA.[60]

In 1969 The United States invited European cooperation in the Post-Apollo space program to help develop and share the cost burden of what would become the Space Transport System (STS), or Space Shuttle. However, the Nixon administration's enthusiasm for inviting the Europeans to build major STS components declined as domestic considerations trumped U.S.-European cooperation on the Post-Apollo program.[61] Additionally, the Americans constrained their support for European launch requirements, citing the potential for commercial competition between emerging European communications satellites and the American-controlled INTELSAT Corporation.[62] The French delegation to the ESC considered European dependence on American launch services an obstacle to European autonomy in the evolving space age, thus emphasizing Europe's need to press forward with the Europa-3 launch vehicle development.[63]

[60] "European Space Conference - Ministerial Conference: Report by the Secretary General of the European Space Conference on the Status of European Space Programmes" (European Space Agency, October 12, 1972), Historical Archives of the European Union, https://archives.eui.eu/en/fonds/137663?item=ESC-116.
[61] Henry A. Kissinger, "282. Memorandum From the President's Assistant for National Security Affairs (Kissinger) to Secretary of State Rogers and the Administrator of the National Aeronautics and Space Administration (Fletcher)," June 1, 1972, Foreign Relations of the United States, 1969–1976, Volume E–1, Documents on Global Issues, 1969–1972 - Office of the Historian, https://history.state.gov/historicaldocuments/frus1969-76ve01/d282.
[62] Robert M. Behr, "240. Memorandum From Robert M. Behr of the National Security Council Staff to the President's Assistant for National Security Affairs (Kissinger)," September 21, 1970, Foreign Relations of the United States, 1969–1976, Volume E–1, Documents on Global Issues, 1969–1972 - Office of the Historian, https://history.state.gov/historicaldocuments/frus1969-76ve01/d240.
[63] "European Space Conference - Ministerial Conference: Report by the Secretary General of the European Space Conference on the Status of European Space Programmes," 1972. See also Walter John Stoessel Jr., "284. Information Memorandum From the Assistant Secretary of State for European Affairs (Stoessel) to Acting Secretary of State Irwin," October 5, 1972, Foreign Relations of the United States, 1969–1976, Volume E–1, Documents on Global Issues, 1969–1972 - Office of the Historian, https://history.state.gov/historicaldocuments/frus1969-76ve01/d284.

The French delegation's position on achieving a European space-launch capability suitable for the growing demands of spaceflight reflected the spirit of the Élysée Treaty that set conditions for European political integration and strategic autonomy. Charles de Gaulle's vision for French national independence and autonomy was initially rooted in the pursuit of nuclear weapons.[64] By the 1970s, however, advancements in satellite technology and the advent of human spaceflight became hallmarks of power and prestige, exemplified by the United States and the Soviet Union. France and Europe would need an autonomous launch capability to reap the commercial and scientific rewards of spaceflight and maintain their seat at the table with the great powers.[65] The European Space Agency, established by Convention of European Space Conference ministers on May 30, 1975, enabled Western Europeans to better coordinate their individual space efforts, optimize the resources devoted to space travel, and grant Europe equal footing in the rapidly evolving space age the 20th century.

European efforts to develop a launch vehicle finally succeeded with the launch of the Ariane 1 rocket from the Guiana Space Center near Kourou on December 24, 1979. Following the failure of the Europa-2 rocket, France lobbied the ESC and later ESA to continue the development of a European expendable launch system to service Europe's growing need for commercial satellite services. France partnered with Germany to develop the rocket, which would be based on a new design to place satellites into geosynchronous orbit, unlike previous European launch vehicles based on ballistic missile technology. French state-owned aerospace manufacturer Aerospatiale would serve as the prime contractor for the new rocket project, dubbed Ariane.[66] Other European manufacturers, including German aerospace companies, would

[64] Jean Lacouture, *De Gaulle: The Ruler 1945-1970*, translated by Alan Sheridan (W.W. Norton and Company, New York, NY: 1991), 413.
[65] Lacouture, *De Gaulle: The Ruler*, 415.
[66] ArianEspace history. https://www.arianespace.com/company-milestones/ (accessed July 28, 2021)

build major components and stages of the Ariane rocket. Although France provided most of the project's funding through CNES, even at the expense of other French space initiatives, the Ariane project was decidedly a European engineering and manufacturing collaboration. Nevertheless, French enthusiasm for a European launch system to compete with the American space shuttle reflected the French view that Europe needed independent access to space and autonomy from other world powers. A few months after Ariane's first flight, France created a state-backed venture through CNES and CSG called Arianespace to manage launch and business operations of the world's first commercial launch services provider.[67]

Since its inception in 1980, Arianespace has operated several launch vehicles, the latest of which is the Ariane 6 rocket, with an average of over a dozen launches per year from CSG. The success of the Ariane project epitomizes the advanced technology and industrial capacity of primarily the French and European aerospace industries. The European aerospace conglomerate ArianeGroup, which encompasses Ariane rocket production, among other projects, exemplifies this status. The nominally French commercial aerospace giant Airbus Group controls a 50% stake in ArianeGroup. Safran, a French aerospace component manufacturer that produces rocket engines, controls the other 50% of ArianeGroup. While Airbus Group and Safran are technically multinational corporations with business and manufacturing operations in Europe, Airbus Group and Safran were founded in France by Frenchmen and are headquartered in France, thus evoking a distinctly French identity. Although not an exclusively French company, ArianeGroup, and the entire Ariane project, are expressions of French aerospace industrial proficiency and interest. Of the thirteen ESA members involved with the *Ariane 5* rocket, Europe's most prolific space launch vehicle, France funds 52.7% of production and operating costs, more than double

[67] ArianEspace history. https://www.arianespace.com/company-milestones/ (accessed July 28, 2021)

Germany, the next highest contributor.[68] More importantly, French involvement in these ventures reflects an enduring French culture to maintain national independence and European strategic autonomy through a competent and competitive advantage in spaceflight for commercial, scientific and increasingly military purposes.

As of 2020, France has the third-largest space budget globally after the United States and China. The annual budget for CNES in 2020 was approximately €2.78 Billion (~3.37 billion USD), which included France's €1.4 Billion (~1.7 Billion USD) contribution to ESA.[69] France is ESA's largest contributor, accounting for over 26% of the 2020 budget, and hosts the Agency's headquarters in Paris.[70]

French Military Space Posture

Ever since Charles de Gaulle envisioned a "certain idea of France" to navigate between the United States and the Soviet Union, the notion of French strategic autonomy has driven material and technical capability advancements and military strategy and foreign policy developments in Paris. It is in this context that France has evolved its military space posture. Strategic autonomy for France and Europe requires independent access to space, the provision of space-based functions and capabilities for terrestrial operations and essential functions, and increasingly, the means to protect and defend those space-based functions.

[68] Anna Clementina Veclani and Jean Pierre Darnis, "European Space Launch Capabilities and Prospects," *Handbook of Space Security*, Kai-Uwe Schrogl et al, (eds.), (Springer Reference: New York, NY: 788
[69] CNES, "Un Budget Exceptionnel," https://cnes.fr/fr/budget-exceptionnel.
[70] ESA, "ESA Budget 2020," https://www.esa.int/ESA_Multimedia/Images/2020/01/ESA_budget_2020

French Military Space Systems

The advent of nuclear weapons necessitated France to develop its capabilities and ballistic missile programs to restore military and political parity with the other world powers. Charles de Gaulle, who envisioned France charting its own geostrategic path independent of the United States and the Soviet Union, directed the French military to develop an independent nuclear deterrent – the force de frappe. To support the development of land and sea-based ballistic missiles, the French government established the Comité d'Études Spatiales or CES (in English, Committee for Space Studies) in 1959. CES collaborated with the Société d'Étude et de Réalisation d'Engins Balistique, or SEREB (in English: Society for the Study and Development of Ballistic Missiles), to develop an indigenous launch system for France's nuclear program.[71]

In 1961 the government enacted its first établissement publique a caractère industriel et commercial concerning space, which also established the centre national d'études spatiales, or CNES – the French space agency.[72] Championed by de Gaulle, CNES assumed oversight of the various space programs and activities working to make France the world's third space power. By 1961, SEREB had developed a rocket capable of carrying a 50 kg payload. The Diamant-A rocket that eventually launched France's first satellite Asterix in 1965 was based on the V-2 ballistic missile developed at Peenemünde.[73]

The political situation in Algeria by 1962 rendered France's access to the Hammaguir launch facilities in the Sahara untenable. France needed access to launch facilities on French sovereign territory. CNES searched for potential sites among French territorial possession and

[71] Jacques Blamont interview https://www.spacelegalissues.com/space-law-an-interview-with-jacques-blamont/
[72] In France, an *établissement publique a caractère industriel et commercial* is a state-backed undertaking of commercial or industrial nature, which includes state-controlled institutions, research agencies, and manufacturing centers in pursuit of some public state interest.
[73] Scheffran, "Space Policy and Missile Control in Europe," 91.

former colonies and mainland France (i.e., France Métropole) suitable for a permanent launch facility.[74] Safety concerns of falling rocket debris eliminated sites in mainland France, and exposure to volatile tropical weather eliminated Guadeloupe, a French possession in the Caribbean. CNES ultimately decided on French Guiana as the future site of France's space launch facility.

In 1968, France launched the first rocket from French sovereign territory at a newly built launch facility near Kourou. A French department in South America near the equator, French Guiana, offered favorable launch conditions and enabled rockets to take advantage of Earth's rotational momentum to place satellites into orbit. In 1970, the Centre Spatiale Guyanais or CSG (in English: Guiana Space Center) became the exclusive French and ultimately European space launch facility for scientific, commercial, and military payloads.[75]

The French military had expressed interest in a domestic satellite reconnaissance capability to complement the French nuclear deterrent since the 1960s. As France and other European states worked to develop an independent launch capability and achieve a degree of autonomy in space for commercial and scientific purposes, the French military was eager to take advantage of space's military and security potential. In 1977, the French Armed Forces Ministry began developing an orbital reconnaissance satellite SAMRO ("SAtellite Militaire de Reconnaissance Optique"). Still, budgetary priorities placed military satellite development on the backburner until *SAMRO*.

[74] France *Métropole* refers to the French mainland territory in Europe. Jacques Blamont interview https://www.spacelegalissues.com/space-law-an-interview-with-jacques-blamont/

[75] "Histoire Du CSG," Centre Spatial Guyanais, August 20, 2019, https://centrespatialguyanais.cnes.fr/fr/centre-spatial-guyanais/histoire-du-spatial-en-guyane.

France was dependent on American satellite capabilities for imagery and intelligence to maintain French interests during the Chad-Libya war in the 1970s.[76] A domestic reconnaissance capability was necessary to fulfill de Gaulle's vision of strategic autonomy and decreased dependence on the United States. The French military planning budget for 1977-1982, known as the loi de programmation militaire, or LPM, was thus the first instance of French government funding for space-based military capabilities.[77] However, bureaucratic conflicts within the French Armed Forces Ministry ultimately scuttled SAMRO because the military services (i.e., the army, navy, and air force) felt the proposed satellite lacked the necessary capability to suit their needs, such as timely digital imagery to support their operations. It would take over a decade until the French deployed the HELIOS 1A military imaging satellite in 1995.[78]

France is the sole operator of 15 government-owned communications, research, and military satellites and is the co-operator of 14 such satellites with a range of European and international partners.[79] Although the relatively small number of satellites compared to the three great power, the United States (2,505), China (431), and Russia (168), France boasts the second most nationally owned satellites among European nations. It is the largest co-operator of satellites in Europe.[80] See Table 1.

[76] Interview with French Military Officer
[77] Interview with French Miliary Officer
[78] https://satelliteobservation.net/2016/11/06/history-of-the-french-reconnaissance-system/
[79] "Satellite Database," Union of Concerned Scientists, May 1, 2021, https://www.ucsusa.org/resources/satellite-database.
[80] ESA

Table 1. Nationally Operated Satellites (Government)			
Country	Single Operator	Co-Operator	Total
Germany	32	3	35
France	14	11	25
Italy	13	7	20
United Kingdom	8	1	9
Spain	6	2	8
Denmark	2	0	2
Luxembourg	1	0	1
SOURCE: "Satellite Database," Union of Concerned Scientists, May 1, 2021, https://www.ucsusa.org/resources/satellite-database.			

Although Germany operates the greatest number of satellites among European countries, France operates more military satellites than any other European country. In addition to the currently operational satellites, France was also a pioneer among European countries in orbital imaging capability for military purposes. In 1995, France became the first European and fourth country after the United States, Russia, and China, to possess an orbital military surveillance capability when it launched the HELIOS 1A photoreconnaissance satellite.[81] While Italy and Spain shared some of the production costs for access to the satellite's one-meter resolution images, HELIOS 1A was a French military initiative spearheaded by the country's defense procurement agency (direction générale de l'armement, DGA).[82]

France launched HELIOS 1A, Europe's first military imaging satellite, in 1995, followed by HELIOS 1B in 1999. Both HELIOS satellites utilized imaging technology developed for the SPOT (satellite pour l'observation de la terre) satellite series in the 1980s and early 1990s. Launched in 1986, SPOT-1 made high-resolution satellite images available to the public for the first time and was the first to provide overhead images of the Chernobyl nuclear disaster in the

[81] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 245.
[82] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 245.

Soviet Union.[83] The HELIOS 1 satellites also provided France and its European NATO partners overhead imaging during the Kosovo air campaign in 1999. According to then Armed Forces Minister Alain Richard, HELIOS 1 images were pivotal in French decision-making and operational planning during the conflict.[84]

Military satellites are an important indicator of a state's military power because they perform vital functions that enable terrestrial military operations, including communications, intelligence and imagery, precision navigation and timing, and missile warning. France's experience during the Gulf War demonstrated that modern military powers capable of independent decision-making and autonomous operations required their satellite-based intelligence, photoreconnaissance, and communications capabilities. French elites firmly believed that European political integration would be incomplete without a common security policy and the explicit capabilities to conduct independent military operations without relying on the United States.[85] France thus persuaded Italy and Spain to participate in the HELIOS 1 program, while Germany demurred. Nevertheless, as Table 2 shows, the Europeans continue to fall short of the great powers in the number of military satellites they operate.[86]

[83] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 71-72.
[84] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 245.
[85] Gordon, *A Certain Idea of France: French Security Policy and the Gaullist Legacy*, 176.
[86] Hugo Meijer and Stephen G. Brooks, "Illusions of Autonomy: Why Europe Cannot Provide for Its Security If the United States Pulls Back," *International Security* 45, no. 4 (April 20, 2021): 39.

Table 2. Military Satellites	
Country	Number of Military Satellites
United States	217
China	125
Russia	102
France	14
Germany	7
United Kingdom	6
SOURCE: "Satellite Database," Union of Concerned Scientists, May 1, 2021, https://www.ucsusa.org/resources/satellite-database.	

In addition to the military space support functions performed by French satellites, France also participates in the Galileo project, the European Commission's satellite navigation system, similar to the U.S. Global Positioning System (GPS). The Galileo project was envisioned as a joint venture between the European Union (EU) and ESA in the 1990s to reduce Europe's dependence on American GPS signals, which the Department of Defense controlled and degraded for civilian and non-U.S. use.[87] The Russian system, GLONASS, was also problematic and unreliable, while China, an initial partner in Galileo, eventually dropped out and created their own system, Beidou.[88] The French aerospace firm Alcatel (which later became Thales Alenia Space after a series of mergers and acquisitions) earned the first contracts to develop prototype navigation satellites for Galileo, whose total budget would exceed €3 billion.[89]

During early debates among EU members and the ESA Council, proponents of the Galileo project argued that the EU would have access to its own satellite-navigation capability while stimulating European industry and technology. Opponents, however, questioned the utility

[87] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 347.
[88] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 347.
[89] Harvey, *Europe's Space Programme: To Ariane and Beyond*, 347.

of spending huge sums on a system that they viewed as largely redundant given the existence of GPS and GLONASS. Adding to the debate was whether European military forces could utilize Galileo's Public Regulated Service (PRS) signal, which provides positioning, navigation, and timing (PNT) for authorized users. The EU initially envisioned the Galileo PRS signal to provide reliable, accurate, and encrypted PNT for European government users and sensitive purposes.[90] In 2006, the British government opposed PRS for military purposes by any EU members, while the French government expressed its intention to equip its forces with PRS-compatible equipment.[91]

Since Galileo was entirely a European project, no one country could dictate how Galileo or PRS signals could be utilized. However, French representatives to the European Interparliamentary Space Conference cautioned that European dependence on U.S. GPS signals left European militaries vulnerable should the U.S. decide to restrict GPS to some European users.[92] France also warned it might rethink its support and funding for the Galileo project should the EU impose a ban on PRS use by military forces.[93] The issue over PRS for military purposes reflected the broader debate over European autonomy versus dependence on the United States. Therefore, it is unsurprising that France pushed for the military uses of the Galileo project and the PRS signals specifically.

Space situational awareness (SSA) is a fundamental requirement of any country seeking to conduct operations, military or otherwise, in outer space. ESA describes SSA as "the knowledge of the space environment, including location and function of space objects,"

[90] "PRS," European Union Agency for the Space Programme, June 9, 2021, https://www.euspa.europa.eu/european-space/galileo/services/prs.
[91] Peter B. de Selding, "Britain, France At Odds Over Military Use of Galileo Service," SpaceNews, June 19, 2006, https://spacenews.com/britian-france-odds-over-military-use-galileo-service/.
[92] de Selding, "Britian, France At Odds Over Military Use of Galileo Service."
[93] de Selding, "Britian, France At Odds Over Military Use of Galileo Service."

consisting of three functions: space surveillance and tracking (SST); Space Weather monitoring and forecasting; and near-earth objects monitoring.[94] The French space strategy clarifies SSA is a foundational requirement for military space operations.[95] Therefore, any country seeking to achieve a degree of space dominance necessarily requires an independent SSA capability. Countries capable of SSA must accomplish four functional capabilities: detect/track/identify space objects; threat warning and assessment; characterization; data integration and exploitation.[96]

France is one of the few countries capable of tracking and cataloging objects in LEO, thanks to its GRAVES ground-based radar system. Managed by the armed forces ministry, the GRAVES (Grand Réseau Adapté à la VEille Spatiale) system enables the French military to develop a comprehensive picture of the LEO regime by autonomously assembling a catalog of objects in LEO, which is useful for collision avoidance, trajectory prediction, and other processes.[97] The system consists of three sites, a transmission and reception site corresponding to the bi-static radar and a data processing site located at the Air and Space Force's space object surveillance center COSMOS (Centre Opérationnel de Surveillance Militaire des Objets Spatiaux).[98] Since 2005, the ministry has committed to updating the system and extending its life-space through 2030, with a planned replacement SSA system to be developed by ONERA, the French aerospace research agency.[99] In addition to GRAVES, the Air and Space Force

[94] "Space Situational Awareness (SSA)," European Union Satellite Centre, Accessed August 30, 2021, https://www.satcen.europa.eu/page/ssa.
[95] Ministère des Armées, "Stratégie spatiale de défense," 37.
[96] U.S. Air Force, "Space Situational Awareness" (Curtis E. LeMay Center for Doctrine Development and Education, January 25, 2021), https://www.doctrine.af.mil/Portals/61/documents/AFDP_3-14/3-14-D04-SPACE-SSA.pdf.
[97] Florent Muller, "GRAVES Space Surveillance System: Life Extension and Upgrade Program," in *7th European Conference on Space Debris* (Darmstadt, Germany: ESA Space Debris Office, 2017), 4, https://conference.sdo.esoc.esa.int/proceedings/sdc7/paper/297.
[98] Muller, "GRAVES Space Surveillance System : Life Extension and Upgrade Program," 4.
[99] Ministère des Armées, "Stratégie spatiale de défense," 46.

operates three SATAM radars for air defense and early warning purposes, while the Navy operates the Monge, a missile range instrumentation vessel under the direction of DGA.[100] Combined with the forthcoming CERES satellite constellation that will detect electronic signals free from weather or atmospheric constraints, these capabilities will provide France, and Europe, with a comprehensive SSA picture to support space and military operations through 2030 and beyond. In addition to France, only the great powers the United States, Russia, and China possess the ability to track and catalog objects in low-earth orbit to the degree necessary to achieve SSA.[101]

In addition to its existing military space posture, France is also embarking on an ambitious program to expand its capabilities in orbit. In 2019 Florence Parly introduced a space armament program, which calls for the development of so-called "active defenses" in space.[102] During the presentation, Parly mentioned how French satellites are vulnerable to the demonstrated anti-satellite capabilities of the major space actors, specifically the United States, Russia, and China.[103] Therefore, France must be prepared to defend its interests and assets in space from any potential adversary. Parly declared France "reserve[s] the right and means to respond" should an adversary interfere with French satellites, indicating a range of possible responses, including the use of "powerful lasers" deployed on future satellites or nanosatellites patrolling the orbital regimes.[104]

[100] Lucia Marta, "The European Space Surveillance and Tracking Service at the Crossroad," *Defense & Industries*, no. 5 (October 2015): 11.
[101] "GRAVES, the 1st European space surveillance system," ONERA: The French Aerospace Lab, June 17, 2019, https://www.onera.fr/en/news/graves-the-1st-european-space-surveillance-system.
[102] "Florence Parly dévoile la stratégie spatiale française de défense," Ministère des Armées : Actualités, Septembre 1, 2020.
[103] Parly, "Discours de Florence Parly : Présentation de la stratégie spatiale de défense."
[104] Parly, "Discours de Florence Parly : Présentation de la stratégie spatiale de défense."

Parly's comments build on Macron's announcement earlier that year in which he described space as a new front that France must defend and declared that France would develop the necessary capabilities to defend its assets in space. France, Macron assured his audience, will be ready.[105] While Macron did not specifically describe how France would defend its space assets, he made it clear that France would rely on "active measures" to defend its satellites.[106] Macron's assurances, coupled with France's space armament program, suggest France may be seeking coercive counterspace capabilities to blind or disable adversary satellites. According to analysts, France's goal to develop active defenses in space will include both orbital and ground-based lasers that could be used against an adversary's spacecraft.[107] The space defense strategy supports analysts' assertions, stating that military space systems must adapt to evolving threats, including counter-space weapons capabilities demonstrated by other space actors.[108]

Aside from the offense-defense balance debate, distinctions about the nature of a weapon system fall apart in orbit. Macron and Parly have been surprisingly forthright on their intent to develop active measures to defend their assets in space. Notwithstanding the definitional difficulties of what, exactly, constitutes an anti-satellite (ASAT) or counter-space weapon, or the inherent dual-use nature of any satellite traveling at approximately 27,000 km/h (17,500 mph), France appears to embrace the willingness to use force in orbit. France will likely reserve the use of force for ostensibly defensive purposes, but such capabilities could easily be used for offensive purposes. Regardless of their stated purpose, France's forthcoming "active defense" measures reflect France's view of space and the threats contained therein.

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[105] Redaction, "Creation d'un grand commandement de l'espace vers l'Armée de l'air et de l'Espace."
[106] Emmanuel Macron, "Discours aux armées à l'Hôtel de Brienne," elysee.fr, July 13, 2019, https://www.elysee.fr/emmanuel-macron/2019/07/13/discours-aux-armees-a-lhotel-de-brienne.
[107] Taylor Dinerman, "The Space Review: Macron's Space Force: Why Now?" The Space Review, August 19, 2019, https://www.thespacereview.com/article/3778/1.
[108] Ministère des Armées, "Stratégie spatiale de défense," 48.

Reorganizing French Military Institutions

By the early 21st century, France, as with other space-faring nations, began to recognize the strategic significance of space for providing intelligence and imagery to the armed forces and as an operational and contestable domain. Not only did French military operations rely on space-based capabilities, but so too did the globalized economy. Additionally, China's 2007 anti-satellite (ASAT) weapons test demonstrated the high degree of vulnerability of space systems and satellites. Before discussing military space institutions, a discussion of the legal framework governing France's space activities is warranted.

In 2008 France enacted the loi sur les operations spatiale - the Space Operations Act (SOA), to govern French space activity per French international commitments. The Act, among various technical and legal mechanisms regulating space flight, grants the French government the authority to take necessary measures to safeguard French space systems and other "fundamental interests of the Nation."[109] The SOA defined a national legal regime that authorizes and regulates the conduct and control of space operations.[110] Specifically, under international law, SOA governs French space activities carried out by private entities, such as Arianespace. Given the partnership between CNES, a government agency, and Arianespace, the private contractor that provides launch services at CSG for France and ESA, France enacted a legal instrument to govern space activities performed by private entities on behalf of the French government. Under the existing legal framework outlined in the 1967 Outer Space Treaty (OST), the launching state is responsible for operating and maintaining the satellites or objects placed into orbit from its territory, whether a government or non-government entity carried it out.[111] The

[109] French Space Operations Act (slide show).
[110] Senat de la République Française, "LOI n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (1)," 2008-518 § (2008), https://www.legifrance.gouv.fr/loda/id/JORFTEXT000018931380/?isSuggest=true.
[111] United Nations, "The Outer Space Treaty," Office of Outer Space Affairs, accessed August 24, 2021,

SOA, however, provides a legal mechanism for the transfer of operational authority from the launching state to a third party once the satellite is in orbit.

This mechanism serves two important functions. First, it provides the legal framework to allow Arianespace to expand its services as a commercial launch operator for a range of customers, including other states and foreign companies. The mechanism ensures France, and CSG, remain the launch site of choice for commercial entities without France being liable for the objects launched from its territory. Second, this law secures France's role as the primary launch site for ESA and its satellites. While not a military function directly related to national space power, per se, SOA authorizes France, under international law, to remain the central element in providing for independent and secure European space access. Parly did acknowledge that France will need to update the legal mechanism to better link France's material capabilities to the emerging military institutions that govern military space activities.

Military institutions and organizations are important elements of spacepower because they house the planning and operational expertise of military space professionals and advocate for the military programs and budgets to develop and acquire space capabilities. A dedicated military space service and space command allow the state to retain the flexibility to concentrate space assets in support of joint military operations at the right time and place to achieve military end-states pursuant to the state's political objectives or national interest. Additionally, the military space service alleviates the budgetary infighting between competing programs in the other domain-centric services, such as the air force or navy.[112] France's traditionally civilian

https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html.

[112] Carl H. Builder, *The Masks of War: American Military Styles in Strategy and Analysis*, (Baltimore, MD: Johns Hopkins University Press, 1989), 198.

space institutions maintain a close relationship with the country's emerging military space institutions that underpin France's capacity as an independent space power.

Nominally a civilian agency, CNES is inextricably linked to France's armed forces. Following the Persian Gulf War and realization that space assets offered ground forces a marked advantage, the French government in 1993 granted the Ministry of Defense shared oversight of CNES, along with the Ministry of Higher Education and Research. The defense ministry funded much of the research into ballistic missiles led by CNES's precursor, CES. Part of the defense ministry's oversight mandate was to develop France's ISR capabilities in partnership with CNES. The defense ministry coordinated with CNES and aerospace firms to develop and operate France's surveillance and reconnaissance satellites, beginning with HELIOS 1A in 1995. In recent years, the defense ministry further delegated satellited capability development to the armament directorate (DGA) and CNES to include Syracuse, CSO, and CERES families of satellites.[113]

From its operational headquarters and monitoring station in Toulouse, CNES operates the military's ISR satellites in the LEO regime, specifically CSO, HELIOS, and ELISA. CNES engineers and technicians possess the necessary skills and attributes to maintain and operate these satellites, while the operations directorate coordinates mission planning and operational requirements with the military through France's new space command across a global network of ground tracking stations. Additionally, CNES monitors the orbital regimes for collision risks due to orbital debris and other hazards in collaboration with the Air and Space Force's COSMOS space surveillance and tracking center. CNES is also an important operational partner for the armed forces ministry.[114]

[113] "Space for Defence," *CNES MAG: Space, Innovation, Society*, February 2019, 9.
[114] "Space for Defence," *CNES MAG: Space, Innovation, Society*, February 2019, 21..

In 2010 the Armed Forces Ministry created the commandement interarmées de l'espace (i.e., Joint Space Command) to coordinate space operations among the military services and with CNES.[115] CIE was France's initial effort to integrate a variety of space functions resident within the ministry of defense.[116] CIE was responsible for identifying capability requirements to support military operations and provided operational control of military space capabilities to support the French armed forces.[117] Specifically, the CIE operated space-based intelligence capabilities, including photoreconnaissance and electronic surveillance (ELINT), satellite communications under the telecommunications directorate (DIRISI), and space surveillance, monitoring, tracking, and awareness functions performed under the auspices of the Air Force's air defense operational command (commandement de la défense aérienne et des opérations aériennes). The defense ministry recognized the need for more responsive space support functions to support terrestrial military operations, especially counterterrorism in Africa.

The 2013 French White Paper on Defense and National Security (Livre blanc de la Défense et sécurité nationales) acknowledged the crucial dependence on space to operate essential services.[118] More importantly, the 2013 white paper describes French forces' capabilities to conduct independent, out-of-area military operations in France's sphere of influence, including Africa. Specifically, French forces must understand the geographic theater of operations, the enemy situation, precise targeting and navigation, and command and control over vast distances.[119] France thus requires its own national military space capabilities to fulfill

[115] "Le Commandement Interarmées de l'espace," Dossier de la Ministère des Armées, March 26, 2012, https://www.defense.gouv.fr/portail/dossiers/archives-des-dossiers/l-espace-au-profit-des-operations-militaires/fiches-techniques/cie.
[116] The Ministry of Defense was renamed as the Armed Forces Ministry in 2017 (Ministère des Armées). Xavier Pasco, "Space Alert: A New French Space Command," Observer Research Foundation, October 5, 2019, https://www.orfonline.org/research/space-alert-volume-vii-issue-4-56195/.
[117] Ministère des Armées, "Stratégie spatiale de défense: Rapport du groupe de travail 'Espace,'" 41.
[118] France Defense White Paper 2013, 44.
[119] France Defense White Paper 2013, 44. See also Testé, "Future of French Space Security Programs," 3.

these tasks. The document also acknowledged the growing threat from orbital debris and the proliferation of counterspace weapons, such as the 2007 Chinese ASAT test, suggesting an increased possibility of aggression in space.[120] French space activities, and threats against them, thus underscore the French imperative to achieve and maintain strategic autonomy.

At Macron's direction, the Armed Forces Ministry conducted a military space review to assess France's ability to respond to emerging threats in outer space.[121] According to Michel Friedling, the air force general in charge of the CIE, the review found a degree of "fragmentation of responsibilities in the military space sector," characterized by a lack of coordination between various actors and stakeholders across the ministry and the absence of a unified chain of command to direct space operations.[122] The review found that France required a new organization to streamline planning and operational control to address emerging missions to protect French space assets from suspicious behavior, as Luch (Olymp-K) exhibited in 2017. Macron announced in 2019 that the new organization would be the grand commandment de l'espace (CDE), or major space command, and would report directly to the chef d'état-major des armées or chief of the defense staff.

The French space command is generally responsible for three areas relating to military space: developing and implementing military space policy, conducting military space operations, and organizing and training military space competencies. The first role encompasses the tasks and responsibilities previously carried out by the now-defunct CIE, including identifying the capabilities necessary to conduct and support military operations in, through, or from space,

[120] France Defense White Paper 2013, 44.
[121] Michel Friedling, "Interview du commandant du commandement interarmées de l'espace : 'écrire une page de l'histoire,'" *Air Actualités: le Magazine de l'Armée de l'Air*, Aout-Septembre 2019, 11.
[122] Friedling, "Interview du commandant du commandment interarmées de l'espace: 'écrire une page de l'histoire,'" 11.

including supporting the other armed services and working with France's European allies in space.[123] In the second role, CDE will provide the space support functions described in the space defense strategy: space service support, space situational awareness (SSA), operations support, and active space defense. In other words, the CDE will have operational control of military satellites and orbital platforms and work in tandem with CNES for launch services and space access. The third role encompasses the CDE's institutional responsibilities to cultivate space talent and expertise across the military services and space industry. Specifically, the CDE integrates military space professionals under one operational command to manage all aspects of their development, from initial training at a "space academy" to interactions with technical experts in academia and the space industry.[124] The CDE is an expression of the space defense strategy that recognizes space-based capabilities are critical for all French military operations, regardless of domain.[125] The CDE will thus assume overall responsibility for France's military space operations to help France grow as a military space power.

In his address establishing the CDE, Macron also reorganized the French air force in the air and space force (l'armée de l'air et de l'espace). The reorganization is the culmination of French strategic thinking on space that began with the 2008 and 2013 White Papers on Defense and National Security and was further emphasized in the 2017 Strategic Review. Each of these documents, to some degree, recognized the importance of outer space to French security, national independence, and strategic autonomy. Macron's decree did more than simply rename the French air force; it established a semi-independent military space service based on the

[123] Friedling, "Interview du commandant du commandement interarmées de l'espace : 'écrire une page de l'histoire,'" 11-12.
[124] Friedling, "Interview du commandant du commandement interarmées de l'espace : 'écrire une page de l'histoire,'" 12-13.
[125] Ministère des Armées, "Stratégie spatiale de défense : Rapport du groupe de travail 'Espace,'" 4.

strategic review conducted by the armed force ministry. It also reflects the prevailing sentiment among French space experts to distinguish themselves from the air force under a new identity.[126] Rather than adding to the air force's mission profile and competing for resources within an air force context, the reorganization enhances military governance for military space operations within the French context. The new service will centralize the military space experts and professionals under a dedicated armed force to help ensure France's capacity to act independently in space.[127]

This new pillar under the air and space force will develop military doctrine to support space operations in pursuit of military end-states. Doctrinal development requires an understanding of emerging threats to French space capabilities and the capabilities of potential adversaries, and their intent to affect French interest in outer space. Assessing the space environment thus requires a reorganization of the institutional and command relationships within the French military.[128] With the advent of the air and space force, France can now streamline the relationships between its military and civilian space institutions, i.e., CNES, to align its capabilities to attain political objectives in outer space.[129] However, the new service and space command possessed limited operational capabilities at their inception. Thus the operational control of France's existing satellites as of 2020 remained under the auspices of CNES while the air and space force and CDE worked to develop, in time, the ability to control satellites themselves.[130]

[126] Dinerman, "The Space Review: Macron's Space Force: Why Now?"
[127] Ministère des Armées, "Stratégie spatiale de défense : Rapport du groupe de travail 'Espace,'" 35.
[128] Ministère des Armées, "Stratégie spatiale de défense : Rapport du groupe de travail 'Espace,'" 40.
[129] Ministère des Armées, "Stratégie spatiale de défense : Rapport du groupe de travail 'Espace,'" 40.
[130] Ministère des Armées, "Stratégie spatiale de défense : Rapport du groupe de travail 'Espace,'" 42.

French National Spending on Military Space

The largely unregulated nature of space in the New Space Age suggests national military institutions are essential elements of national space power to preserve freedom of access and action. When it comes to outer space, France leads Europe largely due to its capacity to act independently and exercise spacepower to pursue political objectives. But France's capacity to act is further bolstered by the country's legal and institutional frameworks that provide the legal and financial authorities to act. France has the largest space program in Europe, underpinned by the largest space budget in Europe, and among NATO allies, second only to the United States. Increases in budgetary and programmatic outlays for space and the armed forces, including the loi de programmation militaire 2019-2025 (military budget law 2019-2025), reflect France's growing interest in space and space security across a range of administrations.

France has the largest civilian space budget in Europe and is the largest contributor to ESA. In 2020, the CNES budget exceeded €2.78 billion, of which over 50% or €1.401 billion was allocated to ESA.[131] The 2020 sum increased approximately 14% over the 2019 budget and reflected a years-long trend of increasing space budgets in France. Additionally, France appropriates deliberate funds through budget line 191 for CNES research and development focused on dual-use applications for the benefit of the armed forces ministry.[132]

France's military budget the defense spending plan are useful indicators of a state's national defense priorities. In July 2018, Macron signed the 2019-2025 military programming law entitled "revival of strength" (loi de programmation militaire 2019-2025 "remontée en puissance") to increase military funding to modernize the force and prioritize investment to

[131] Jean-Yves Le Gall, "Un budget exceptionnel," CNES, March 6, 2020, https://cnes.fr/fr/budget-exceptionnel.
[132] "Space for Defence," 9.

prepare the French military for future conflicts in key operational domains, including space.[133] The principal objective of the LPM 2019-2025 is to gradually increase defense spending until France reaches the NATO threshold of 2% of national GDP spent on defense, the first time France will meet this target since 2010.[134] The program, however, forecasts budgets through 2023, totaling €197.8 billion. The defense budgets for 2024 and 2025 will be adjusted based on the macroeconomic situation to ensure France meets its 2% of GDP target by 2025.[135]

LPM 2019-2025 seeks to modernize the French armed forces to meet the emerging threats and degraded strategic context described in the 2017 Defense and National Security Strategic Review. The LPM sets 2030 as its target for strengthening the armed forces to act independently, bilaterally, or as part of European, Allied, or international coalitions across the spectrum of operations.[136] In terms of space, one of the key operational domains prioritized in the LPM 2019-2025, the law programmed €4.3 billion for military space capabilities.[137] In response to emerging threats, most of those funds are allocated to modernize the country's fleet of ISR satellites and ground surveillance radars (e.g. GRAVES and SATAM).[138] Additionally, the law describes a need to improve threat detection, both on Earth and in space, as well as the capacity to respond to threats in space in particular. The LPM also directed the armed forces ministry to seek out willing and capable European partners to reduce France's vulnerability in space, a nod to Macron's commitment to European strategic autonomy.[139]

[133] Senat de la République Française, "LOI no 2018-607 du 13 juillet 2018 relative à la programmation militaire pour les années 2019 à 2025 et portant diverses dispositions intéressant la défense," Pub. L. No. 2018–607 (2018), https://www.defense.gouv.fr/content/download/537438/9236760/file/joe_20180714_0161_0001.pdf, 5.
[134] "SIPRI Military Expenditure Database," Stockholm International Peace Research Institute, accessed May 2, 2022, https://milex.sipri.org/sipri.
[135] Senat de la République Française, LOI no 2018-607 du 13 juillet 2018, 5.
[136] The LPF refers to this goal as Ambition 2030. Senat de la République Française, LOI no 2018-607 du 13 juillet 2018, 29.
[137] PLF Annee 2, 6.
[138] Senat de la République Française, LOI no 2018-607 du 13 juillet 2018, 49.
[139] Senat de la République Française, LOI no 2018-607 du 13 juillet 2018, 33.

The LPM describes five core strategic functions the French armed forces must accomplish to meet the strategic challenges of 2030. The LPM emphasizes emerging functions: "connaissance et anticipation" (knowledge and anticipation) and "prévention" (prevention) while consolidating existing ones: "dissuasion" (nuclear deterrence), "intervention" (defense of interests abroad), and "protection" (territorial defense).[140] The LPM highlights the importance of space capabilities to the ministry's ability to achieve "knowledge and anticipation." As threats and risks in space increase, The LPM directs France must possess the ability to detect aggressive or unfriendly acts from other actors through strengthened SSA and SST capabilities ("knowledge and anticipation"). At the same time, LPM acknowledges the need to improve satellite resilience and defensive capabilities ("prevention").[141] Additionally, LPM foresees space capabilities necessary for a range of military operations as drivers of future coalitions of capable European countries in which France will play a leading role.[142] ISR and active defense measures in space will benefit France and assure its national independence, but will also benefit partner nations and encourage them to increase their capabilities and participation in European defense efforts.[143]

In keeping with Macron's commitment, the military budget enacted for 2019, the first year of the LPM 2019-2025, increased defense spending by €1.7 billion to €35.9 billion, or 1.82% of GDP.[144] The 2019 budget authorizes €400 million to acquire "high value-added" satellite capabilities "for the defense of Europe and France," namely CSO, France's contribution to the collaborative European ISR program MUSIS, and CERES and the remaining Syracuse platforms.[145]

[140] Senat de la République Française, LOI no 2018-607 du 13 juillet 2018, 26.
[141] Senat de la République Française, LOI no 2018-607 du 13 juillet 2018, 56.
[142] Senat de la République Française, LOI no 2018-607 du 13 juillet 2018, 54.
[143] Senat de la République Française, LOI no 2018-607 du 13 juillet 2018, 54.
[144] Ministère des Armées, "Projet de Loi de Finances 2019 : LPM Année 1" (DICoD, Septembre 2018), 16.
[145] Ministère des Armées, "Projet de Loi de Finances 2019 : LPM Année 1" (DICoD, Septembre 2018), 16.

In 2020, the second budget year of the LPM 2019-2025 increased national defense spending by 4.5% to €37.5 billion, or 1.86% of French GDP, maintaining the country on track to meet Macron's commitment to spend 2% of GDP on defense by 2025.[146] The 2020 budget featured a 12% increase in military spending on space to €448 million, continuing the armed forces ministry's effort to modernize its satellites.[147] The ministry completed ground station and SATAM radar modernization and successfully launched the second of three CSO satellites.

The 2021 defense budget, the third enacted under LPM 2019-2021, once again raised national defense spending to €39.2 billion, a 22% increase since 2017.[148] Additionally, the ministry further emphasized the importance of space capability with an annual spending increase of nearly 40% to €624 million, with an additional €100 million allocated to modernizing space launch vehicles.[149] In 2021, the ministry was expected to further expand ground stations for the Syracuse family of satellites and will continue to modernize the SATAM radar.[150] The budget also allocates funds for the third CSO satellite, expected to launch in 2022 and complete France's MUSIS contribution, and the first of three CERES satellites, expected to launch in 2021.[151] CÉRÉS, or CapacitÉ de Renseignement Électromagnetique Spatiale is a military electronic intelligence (ELINT) family of satellites that will operate in LEO and replace the aging ELISA family of ELINT satellites.[152] CNES will operate CERES satellites on behalf of the armed force ministry, while DGA will operate the CSO family of satellites.

[146] Ministère des Armées, "Projet de Loi de Finances 2020 : LPM Année 2" (DICoD, Septembre 2019), 5.
[147] Ministère des Armées, "Projet de Loi de Finances 2019 : LPM Année 1" (DICoD, Septembre 2018), 6.
[148] Ministère des Armées, "Projet de Loi de Finances 2021 : LPM Année 3" (DICoD, Septembre 2020), 3.
[149] Ministère des Armées, "Projet de Loi de Finances 2019 : LPM Année 1" (DICoD, Septembre 2018), 4.
[150] Ministère des Armées, "Projet de Loi de Finances 2019 : LPM Année 1" (DICoD, Septembre 2018), 22.
[151] *MUSIS* (MUltinational Space-based Imaging System) refers to a European space-based ISR capability first proposed by France in 2006. Its original members include France, Germany, Italy, Belgium, and Spain. Ministère des Armées, "Projet de Loi de Finances 2019 : LPM Année 1" (DICoD, Septembre 2018), 23.
[152] "Ceres," CNES, March 5, 2019, https://ceres.cnes.fr/en/ceres-2.

As of 2022, the ministry expects to launch a pair of advanced X- and Ka-band secure SATCOM satellites, Syracuse-4A and -4B, to replace the aging Syracuse-3A and -3B satellites launched in the mid-2000s.[153] The latest family of Syracuse-4 satellites will feature secure communications payloads that are hardened against jamming and cyberattacks, a further tacit acknowledgment that unfriendly actors for espionage may target France's vital satellite communications, sabotage, or worse.

Conclusion

Although the great powers eclipse France's presence in orbit, the effort and resources applied to military space capabilities suggest France is pursuing an autonomous ability to achieve, at a minimum, episodic control of space. France's effort to modernize its satellites and an expressed willingness to defend satellites with "active measures" suggests France wants the ability to achieve military objectives in, through, or from space in support of political end-states, without interference from other actors. As CNES president Jean-Yves Le Gall attested in CNES's 2019 annual report, France's material capabilities and technologies enable France to attain a degree of space parity with the "big boys" - the United States, Russia, and China. France will arguably remain the strongest space actor in Europe and the second strongest space actor within the NATO alliance.[154]

However, France recognizes that it can only achieve parity through greater security integration with the European Union and the Common Security and Defence Policy (CSDP). The EU's "Strategic Compass for Security and Defense," a working document of the European External Action Service (EEAS), specifically mentions space security as a top priority for EU

[153] "Space for Defence," 8.
[154] Jean-Yves Le Gall, "Editorial," *CNES MAG: Space, Innovation, Society*, February 2019.

investment and directs the development of an EU Space Strategy for security and defense.[155] Although this paper briefly discussed European security cooperation, further study on the growing importance of space security for the EU and France's role in supporting the development of EU space capabilities. Other areas for further study include the military space postures of other European states, including Great Britain, and the decisions that lead to different outcomes among European states that face similar constraints.

Whatever military space capabilities and "active defense" measures France develops in the future, France's ability to achieve political ends in outer space is dependent on how those capabilities are fielded within a professional and institutionalized military space service. When states seek to exploit new technologies for security reasons, their development programs linger in military research and procurement agencies (e.g., DGA in France), where they enjoy dedicated budgets and resources. But countries can only effectively employ space-based capabilities and weapons in pursuit of political ends insofar as there is an institutionalized military service that plans for and sustains their use.[156] Institutions have core interests, and emerging capabilities and weapons must mesh, to some degree, with an institutionalized military service's core interest. For example, air forces have aircraft, missiles, and pilots as core interests, while navies favor ships, submarines, and aircraft carriers. These interests compete for limited budgets and resources within a country's overall defense budget priorities.[157] Emerging space-based capabilities, including counter-space weapons, are likely to achieve greater utility in a dedicated military space service or risk playing second fiddle to a legacy service's core interests in the never-ending battle for resources and budgetary priority.

[155] "A Strategic Compass for Security and Defence." European External Action Service, August 21, 2021.
[156] Builder, *The Masks of War*, 198.
[157] Builder, *The Masks of War*, 200.

The French armed forces recognize the institutional utility of a dedicated space service. Macron accepted Parly's recommendations, reorganized the French Air Force into the French Air and Space Force (l'armée de l'air et de l'espace), and established a stand-alone space command to develop space operations doctrine for the employment of French space assets.[158] Macron acknowledged Parly's recommendations in his speech on July 13, 2019, and likely did not determine on his own that France needed to institutionalize its space capabilities in new organizations. However, Macron's belief in the need for a space service and command stems from his unequivocal commitment to French and European strategic autonomy. As he clarifies in various speeches, documents, and interviews, Macron firmly believes that France and Europe must possess independent strategic capabilities to maintain their decision-making independence and independence of action. In today's modern and interconnected world, those strategic capabilities necessarily include those in outer space.

The armed forces ministry, tasked with fulfilling Macron's mandate, embarked on a major effort to modernize the armed forces and prepare them for future conflicts in a changing geostrategic context. The loi de programmation militaire 2019-2025, enacted in 2018, increased defense spending and set France on track to meet NATO's goal of spending 2% of GDP on defense. The budgetary increases reflect France's perception of the strategic environment and the acute threats facing France and Europe, as described in the 2017 Defense and National Security Strategic Review. Among these are terrorism, the rise of revisionist or revanchist great powers such as Russia, and the proliferation of new technologies. Parly recognized the degree to which France relies on space to address these threats and conduct out-of-area operations.[159] The contested nature of outer space, characterized by the proliferation of space launch capability and

[158] Parly, "Discours de Florence Parly : Présentation de la stratégie spatiale de défense."
[159] Parly, "Q & A: Florence Parly," 14.

technology, space weapons, and the lack of regulation, risks devolving into a domain of conflict. Compounded by the inherently dual-use nature of satellites and orbital debris, the risks in outer space demanded that France adapt to maintain its space-based capabilities, which underpin France's strategic independence.[160] France recognizes space assets as both a strategic advantage and necessity and thus needs to develop the means to preserve and defend those capabilities as risks and threats in outer space increase.[161]

[160] Ministère des Armées, "Revue Stratégique de Défense et de Sécurité Nationale 2017," 45.
[161] Parly, "Q & A: Florence Parly," 14.