# Counterspace Weapons

## Strategic Implications for Emerging Spacepower Nations

Bruno Martini, Brazilian Air Force University
Lt Col Luis Felipe Nohra, Brazilian Air Force
Maria Célia Barbosa Reis da Silva, Ph.D
Brazilian Air Force University

## Introduction

A new mantra has emerged for the increasingly congested, competitive, and contested space environment.[1] Since the launch 66 years ago of the first artificial satellite, the Soviet Sputnik, most nations continue to concentrate their national space assets around the Earth's orbit; to include, in addition to spacecraft, the necessary ground facilities to produce, test, launch, monitor and control them. This has been mainly due to the enormous and ever-growing dependence of space services for contemporary human life, such telecommunications, meteorology, environmental monitoring, navigation, disaster relief, resources management, digital utilities, agriculture, and defense.

With such important assets in orbit, nation-states have become more very interested in ensuring their security against threats such as natural near-Earth objects (asteroids and comets, for example), space climate extremes (cosmic radiation, solar wind, and solar coronal mass ejection, amongst others), orbital debris (both natural and artificial), and intentional threats posed by counterspace weapons. What's more, the orbital environment has become increasingly militarized, especially dangerous due to the possibility of being weaponized.

Over the last two or three decades, the importance of space in military operations has dramatically increased. No longer just a scientific concept, space now provides essential capabilities for the armed forces to gain an advantage over their enemies. Satellites are essentially force multipliers, as they allow the use of forces more efficiently and effectively. Many military operations are crucially dependent on communications provided by satellite (SATCOM), imagery acquired by sensors in orbit (IMINT), precise position information provided by satellite navigation systems (SATNAV), weather predictions for the battlefield and intelligence, and signals intelligence (SIGINT). At the same time, missiles have kept evolving, with increasing speed, maneuver capabilities, range, cargo, explosive capabilities, and accessibility; to the point that some missiles have planetary range, traveling as authentic space vehicles, at low-Earth orbit (LEO).

It is on Earth orbit where nations have their most distant strategic infrastructure. As such, these orbital platforms can become priority targets to their foes. Thus, according to international relations theory's realist school of thought and military history, the present development of anti-satellite (ASAT) weaponry by space superpowers was expected and almost inevitable.

Space Power (spelled in two words) was the term used in several seminal studies on the subject, such as David E. Lupton's 1988 book, *On Space Warfare: A Space Power Doctrine*.[2] In 2020, the US Department of Defense (DOD) "Defense Space Strategy Summary" established the single word spacepower for "The sum of a nation's capabilities to leverage space for diplomatic, information, military, and economic activities in peace or war in order to attain national objectives."[3] Furthermore, the US Space Force's (USSF) *Space Capstone Publication (SCP) - Spacepower - Doctrine for Space Forces* states "National spacepower is the totality of a nation's ability to exploit the space domain in pursuit of prosperity and security. National spacepower is comparatively assessed as the relative strength of a state's ability to leverage the space domain for diplomatic, informational, military, and economic purposes."[4] Nonetheless, countries like the United Kingdom (UK) and Australia have kept using the double-worded term "space power." Australia's *Defence Space Command* released the "Space Power eManual" in 2022 stating it as "the total strength of a nation's ability to conduct and influence activities to, in, through and from space to achieve its objectives."[5] The British *Ministry of Defence* (MoD) simply defined space power as "Exerting influence in, from or through space"[6] Following United States nomenclature, in this article, the term "spacepower (spelled as a single word) nation" is employed to express a nation-state with the capability to exert its own space power.

According to United States Air Force (USAF) doctrine, counterspace is a mission comprising Offensive Counterspace (OCS) and Defensive Counterspace (DCS) operations to control and protect space objectives in and through space, conducted from the multi-domains air, land, maritime, cyberspace and space.[7] Counterspace operations' targets may not be positioned just in space, but they may also be space infrastructure targets on the Earth's surface. The weapons used for OCS or DCS operations are generally called counterspace weapons and categorized as kinetic physical, non-kinetic physical, electronic, and cyber.[8] Present counterspace weapons may be classified as Earth-space/direct-ascent (launched from land, air, or sea), and space-space/co-orbital (placed and maneuvered in orbit, usually long before the strike).[9] The most common space-based targets are typically satellites, so a counterspace weapon directed to a satellite is called an ASAT weapon.

The Merriam-Webster English dictionary defines ASAT, either as anti-satellite or less commonly, antisatellite, as an adjective "of, relating to, or being a system designed for the destruction or incapacitation of satellites."[10] Adam Strauch defines the applications of ASAT weapons as 1) a strength multiplier which potentializes other military capabilities; 2) a countervalue, i.e. targeting of an opponent's assets that are of value but not actually a military threat; 3) a countermeasure to oppose an enemy's anti-missile defense systems; 4) an asymmetric countermeasure to thwart technologically superior enemies; 5) an effective measurement against potential space based weapons; and 6) an alternative weapon against ICBMs or other explosive carrying enemy vehicles traveling in orbit.[11]

Only a few spacepower nations presently possess ASAT capabilities as strategic or tactical weaponry. Kinetic attacks against their own satellites have been performed as ASAT tests by only four countries, the US, Russia, China, and India, and have served as a display of deterrent power. Moreover, other spacepowers are assumed to be developing considerable ASAT capabilities (Australia, France, Iran, Japan, South Korea, North Korea, and the UK), although they yet to perform in-orbit destructive tests.[12]

A limited, but increasing number of nations, 12 in total, plus the European Union (EU), have made their own space launches: Russia (1957), United States of America (1958), France (1965), Japan (1970), China (1970), UK (1971), EU (1979), India (1980), Israel (1988), Ukraine (1995), Iran (2009), North Korea (2012) and South Korea (2013). Ukraine is in danger of losing this capability due to its current armed conflict with Russia. Additionally, new private space enterprises are acquiring all types of space capabilities and are now able to launch their own space cargos. Soon, even more companies and countries are expected to join this space-faring club.

The strategic importance of counterspace weapons for spacepower nations is common knowledge for the USAF, DoD, and US civilian national security decisionmakers, yet not quite evident in other space-faring nations where the counterspace mission is still largely neglected or insufficiently addressed. So, how can nations possessing small satellite fleets plan space strategies to counteract the space threats imposed by counterspace systems and destructive ASAT weapons tests?

## Classifying Spacepower Nations using Brazil as a Case Study

One way to answer the previous question would be to inventory all nations with space assets and comparing their plans, strategies and identifiable behaviors related to the space domain. However, that would currently be nearly impossible as most countries do not publish them. Another way could be identifying a representative country as a proxy of others in somewhat analogous positions. Some imprecision remains for any kind of approximation/subjective analysis of how different each country would be from the original proxy country. Nonetheless, this would be much more realistic than a comparison to space superpowers' plans and strategies.

By almost any criteria, the US, Russia, and China are currently the top space superpower nations; followed by India, France, the UK, Japan, Israel, and South Korea, and multi-state organizations, whether political in nature, such as the EU, or military, such as the North Atlantic Treaty Organization (NATO), all established spacepowers that have demonstrated developed or distinctive space capabilities. Meanwhile, Iran, Ukraine and North Korea have yet to prove their *de facto* transition from emerging to established spacepowers, as they still must demonstrate their ability to access the orbital environment with their own organic capabilities. Other emerging spacepowers include the United Arab Emirates, individual EU countries, South Africa, Singapore, Australia, Canada, Pakistan, and some private space companies. Among emerging spacepowers, Brazil has stood out, establishing their presence in space by gaining advanced technical space power know-how and making a considerable impact in the global space economy.[13]

Almost every year a few more countries turn into developing spacepower nations by acquiring some kind of space capability, whether in orbit, on the ground, or by contributing with notable downlink or uplink services to the international community, such as Argentina, Luxemburg, and Switzerland. Nonetheless, the vast majority of nations do not dispose of any space capabilities on their own, solely using space services as clients, here classified as undeveloped spacepower nations.

In addition to nation-states and political/military organizations, corporations are emerging as spacepowers as well. Some private enterprises are proving capable of accessing Earth orbit by their own means, before most other countries worldwide, and thus may be classified as established spacepower corporates.

## Brazil as a Case Study

Although it would be desirable to deepen the discussion on spacepower classification methodology and establish more detailed and precise parameters in future studies, for the purposes of this article, the current Spacepower Classification Method is sufficient to consider Brazil as an appropriate representative of emerging spacepower nations.[14]

While Brazil does not possess its own autonomous means to access space yet, it already relies on services provided by its organically developed/imported satellites for both civilian and military operations. Thus, Brazil is an aspiring spacefaring nation, as many nations presently are, but still developing its capability to launch its own space assets.

Brazil is already capable of designing, building, operating, and maneuvering its own satellites, and taking considerable part in international efforts to ensure free access to space for any nation (for peaceful purposes). Thus, the way Brazil reacts to, and plans against, space threats may be considered representative of how other nations in similar space power positions would behave.

## Strategic Implications for an Emerging Spacepower Nation

Since the end of World War II, Brazil has not been an obvious military target for any other country, as it has not been directly involved in any diplomatic or military conflict, especially with its bordering neighbor countries. On the contrary, it has been an international promoter of peace, security, and sovereignty for all nations, and has firmly supported the United Nations (UN); currently serving as a non-permanent member in the UN Security Council (UNSC) since 2022.[15]

Thus, Brazil does not consider other nations' ASAT weapons arsenals as a direct threat. Even so, prudence does not allow Brazil or any other developing spacepower to rule out the possibility of becoming a target under a crisis scenario. Presently, the most likely scenario for an emerging spacepower nation would be having one or more of its satellites suffering indirect damage from a strike perpetrated by another country against a third country's space assets, or from debris caused by ASAT tests. Another probable scenario would be data or service interruption, as a collateral effect of an attack against another country's satellite(s). The most directly provocative scenario would be an attack, on one of its own government satellites, in which the identity of the aggressor is clearly identifiable. One of the worst scenarios for any spacepower nation would be an ASAT attack that escalates to a nuclear war. This could happen, for example, if an attack occurs against the strategic satellites (like those used for early-warning missile detection) of a spacepower with nuclear weapons, as such an attack could be perceived as the precursor to a nuclear strike. A nuclear ASAT strike, capable of destroying/deactivating hundreds or thousands of satellites, would be another worst-case scenario, probably causing the Kessler syndrome and leaving a huge orbital region hostile for new satellite placements and space travel.[16] To address these, amongst many other unforeseen, possible scenarios, Brazil, as well as other emerging spacepower nations, must hold discussions, both internally and internationally, to reach agreements on protocols to follow and steps to take in the event of such occurrences.

Just like in the cyberspace domain, there is no guarantee a response to an aggressive act in the space domain would be restricted to just the space domain; there is always a chance that it could escalate to air, land, or sea as well. Nonetheless, a spacepower nation may consider keeping such a conflict restricted to the space or cyberspace domains, to avoid a much deadlier and destructive outcome to all parties involved.

On 15 November 2021, the no longer operational Soviet Cosmos 1408 satellite, originally dedicated to Electronic and Signals Intelligence (ELINT) burst into pieces after a Russian Nudol ASAT missile struck it at an altitude of ~480 km, spreading a cloud of more than 1,700 "trackable" debris items. About 1,300 of those pieces were larger than 10 cm. The newly injected amount of space junk scattered in LEO at an altitude between ~200 km to ~1,500 km.[17] The next day, four NASA astronauts, a European Space Agency (ESA) astronaut, and two Russian cosmonauts onboard the International Space Station (ISS) had to find cover and prepare to evacuate in their emergency spaceships (SpaceX Crew Dragon and Soyuz) due to the risk of a destructive collision with the debris.[18] Months later, Dmitry Rogozin, then Director-General of Roscosmos, stated: "I confirm that at 2203 Moscow time, the engines of the Russian Progress MS-20 transport cargo spacecraft carried out an unscheduled maneuver to evade the International Space Station from a dangerous approach to a fragment of the Kosmos-1408 spacecraft."[19] This latest direct-ascent kinetic ASAT test highlighted the vulnerability of orbital assets in space (both targeted and untargeted), and space safety, i.e., the vulnerability of the lives and health of space crew members.

The dangerous orbital debris side-effects of kinetic ASAT weapons remain in orbit for years, accumulating faster than atmospheric drag can deorbit them, and consequently posing a long-term collision threat to other space assets. These debris may also collide with other debris, generating an even higher number of them in a cascade effect which enhances the chances of collisions and consequent new debris generation, i.e., the Kessler effect.

On 18 April 2022, US Vice President Kamala Harris pledged her country will no longer conduct further destructive ASAT tests and requested other nations to pledge the same.[20] Since then, at least another eleven nations declared they will not conduct direct-ascent ASAT destructive tests: Australia, Canada, France, Germany, Italy, Japan, New Zealand, Netherlands, South Korea, Switzerland, and the UK.[21] Furthermore, on 7 December 2022, the UN General Assembly, at the UN First Committee at the 77th session, passed a non-binding resolution to halt destructive testing of direct-ascent ASAT weapons. As many as 150 nation-states voted for the resolution with nine votes against it (Belarus, Bolivia, Central African Republic, China, Cuba, Iran, Nicaragua, Russia, and Syria) and nine abstentions (India, Lao People's Democratic Republic, Madagascar, Pakistan, Serbia, Sri Lanka, Sudan, Togo, Zimbabwe).[22]

Brazil, as any other orbital spacecraft operator, is forced to maneuver its satellites more often to avoid collisions with space junk, which increases fuel consumption and consequently decreases satellite lifespan. For example, on 25 June 2022, the Brazilian Air Force (FAB) launched two new radar remote sensing satellites as per its Strategic Space Systems Program (PESE) plan. The two new satellites, called Carcará I and Carcará II (named after the bold Brazilian bird of prey), are part of the Lessonia-1 Project, which aims to build a constellation of LEO satellites available to the Brazilian government for both civilian and military use. The imagery from these satellites allows for deforestation monitoring, cartographic updates, determination of river navigability, disaster relief, and the fight against drug trafficking, illegal mining and fires, among several other possibilities. As part of its space operations security mission, on 23 April 2023, the FAB's Aerospace Operations Command (COMAE) Space Operations Center (COPE) conducted a simulation to address the threat of collision between orbital debris from the old Cosmos 1408 and these new satellites due to the possibility of their altitude and paths coinciding. Figure 1 shows the path trajectory simulation for both Carcará I and II and their predicted intersection with the orbital debris, figure 2 represents the same, but in a Mercator projection map).

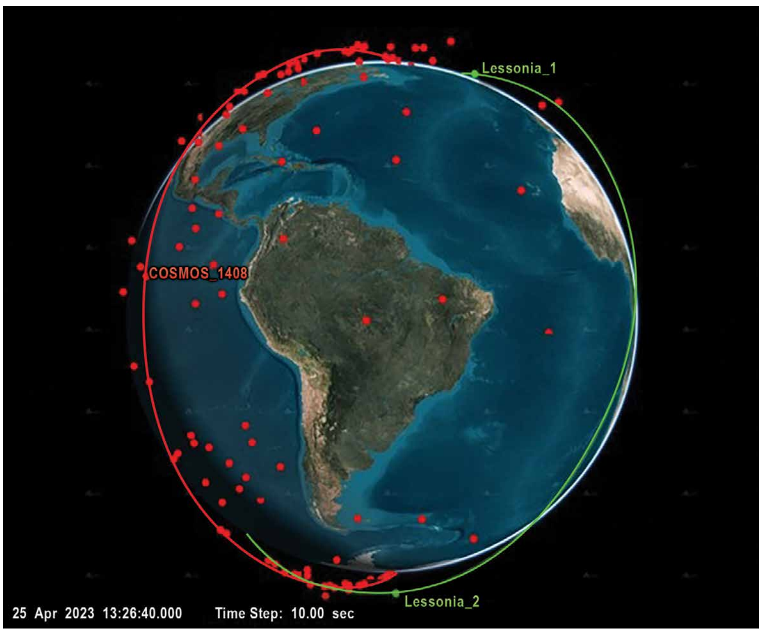


**Figure 1: Global view of the points of intersection between Carcará I and II (Lessonia_1 and Lessonia_2 respectively, in green) with the space debris from Cosmos 1408 (in red)**

*Source: FAB COPE*

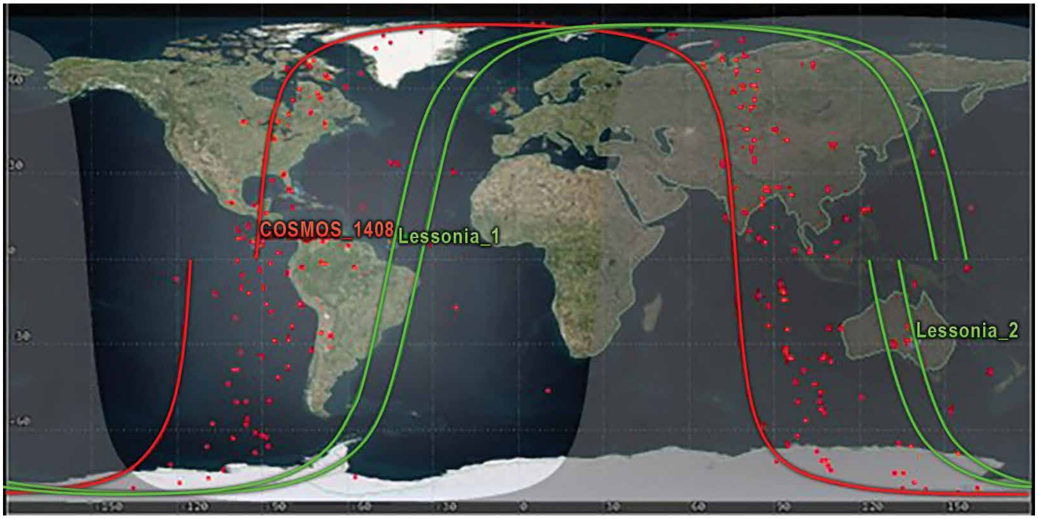


**Figure 2: World Mercator map view for the points of intersection among Carcará I and II satellites (respectively named Lessonia_1 and Lessonia_2, in green) with the space debris from Cosmos 1408 (in red)**

*Source: FAB COPE*

On average, the COPE´s simulation presents more than four hundred collision alerts per month for the Carcará I and II spacecraft. More importantly, it presents seven alerts for highly dangerous near misses of less than two kilometers. Additionally, based on this simulation, an average of two maneuvers per month (one per satellite) will be necessary to keep the satellites at more than 500 meters away from possible collision with debris. Thus, these destructive ASAT tests increase the operational dangers previously estimated for launched satellites, in turn demanding more maneuvers, consuming more non-rechargeable fuel, and consequently decreasing their originally predicted lifespan.

## Brazil as a Strategic Proxy for Other Emerging Spacepower Nations

One strategy that Brazil has adopted, which can serve as a proxy for other emerging spacepower nations, is the goal to acquire and wield what Brazilian space governmental institutions call "the entire space cycle," i.e., the capability to independently produce its own space launching vehicles and payloads, the wherewithal to launch and operate them in space, and then receive, process and distribute their data.[23] To do so, partnerships with other countries and private enterprises are desirable and should be incentivized, as the space enterprise is an extremely costly one. Brazil has recently signed agreements with four foreign private companies (Innospace, C6 Launch Systems, Virgin Orbit, and Orion Applied Science & Technology) to launch space cargo from its national space center, the Alcântara Launch Site (CLA), opening itself to the new commercial orbital launch space market. The CLA is optimally geolocated for space launches: 1) it is near the equator line, 2) has good and stable climate conditions, 3) has its main launching trajectory directed into open and sparsely navigated sea, and 4) has an unpopulated forest buffer zone. This effort culminated with CLA's inaugural launch of the Astrolábio Operation on 19 March 2023, when the South Korean company Innospace launched a hybrid propulsion rocket HANBIT-TLV with a 100% Brazilian payload.[24]

Another strategy that Brazil can adopt, which can serve as a proxy for other emerging spacepower nations, is to join a like-minded block of political interests to enhance the UN's non-binding resolution to halt destructive testing of direct-ascent ASAT weapons with further practical steps to increase space security, limit space weaponization, and to seek a peaceful and sustainable orbital environment for present and future generations. As the current resolution only applies to direct-ascent ASAT weapons, perhaps one of outcomes of this strategy can be its expansion to include banning of all the destructive counterspace weapon tests in Earth's orbit.

Brazil has already publicly declared its peaceful nature, recognizing the UN as an international forum to resolve disagreements among nations, while preserving each nation's sovereignty, self-determination, and territorial integrity. Thus, the country wagers on strengthening international agreements such as the five treaties on outer space from the United Nations Office for Outer Space Affairs (UNOOSA).[25] It also intends to become a relevant actor on further discussions on International Space Law and its legal instruments, as it still demands much content to be addressed, discussed, developed, and established. Brazil supports space sustainability to explore the Earth's orbital environment and beyond, and reach consensus to satisfy domestic and global societal demands, and the indefinite continuity of present space services to future generations.

As a recent example, in June of 2021 the country signed the Artemis Accords proposed by US National Aeronautics and Space Administration (NASA), which includes more than a dozen other countries. These accords seek a shared vision of principles among nations to facilitate new space endeavors with benefits to all humankind.[26] Another area in which Brazil could work on to serve as a proxy to other emerging spacepower nations would be to support and join ongoing academic law discussions, like the Manual on International Law Applicable to Military Uses of Outer Space (MILAMOS) by the McGill University from Canada.[27]

The newly established FAB COPE should improve its capabilities in Space Domain Awareness (SDA) as to better contribute to its international partnerships (including the US), reduce dependence from partner countries, function as a redundancy/backup to partner countries, and even increase those partners' orbital awareness. On 10 April 2023, FAB announced it was taking part in USSF's Joint Commercial Operations (JCO), and COPE would become the host for the JCO Brazil operational cell. Besides helping to track orbital debris, Brazil can use this opportunity to monitor possible space weaponization, as an effort to advocate for the peaceful uses of space by all nations. And through the Joint Commercial Operations – Space Defense (JCO-SD), coordinated by US Space Command (USSPACECOM), Brazil may also be able to support space launches, detect space objects, identify in-orbit abnormal behaviors, develop orbital mechanics instruction, and provide unclassified information for commercial organizations.[28]

Brazil has built redundancy into COPE operations, having its main facility located at its federal capital in Brasilia, and a Secondary Space Operations Center (COPE-S) located in Rio de Janeiro, about 725 miles away. This redundancy increases its space operations security and reliability, especially in case of any emergency or malfunction. Additionally, to further support its SDA mission and its role in JCO, the COPE should be further improved by installing optical telescopes in geostrategic sites such as the Brazilian cities of Sinopi (state of Mato Grosso), Urubici (state of Santa Catarina), Santiago (state of Rio Grande do Sul), and Novo Progresso (state of Pará), as appropriate, in addition to the telescope recently installed in Brasília (Federal District).

To enhance its military and civil space operations, Brazil still needs to develop a comprehensive General Space Law with adequate legislation and exact roles for each of its space institutions, such as FAB from the Ministry of Defense (MD), the Brazilian Space Agency (AEB), its National Institute for Space Research (INPE) from the Ministry of Science, Technology and Innovations (MCTI), and private actors, such as the South Korean Innospace, which just took part of CLA's inaugural launch. Internally, Brazil also needs to document a new kind of Space Usage Military Doctrine, through FAB, to better deal with potential space threats, including, but not restricted to counterspace weapons. As any other nation with space assets, Brazil must be ready to respond to any space hostility, and such retaliation should not be restricted to just the space domain, as any conflict in space can realistically escalate to the other air, land, maritime, and cyber domains, and even a total war.

With its ever increasing reliance on orbital services and satellite fleets, Brazil must reconsider FAB´s role outside the atmosphere, and perhaps rename it to Brazilian Aeroespace Force (FAEB – *Força Aeroespacial Brasileira*) as many of its military terms and unit names have been expanding from aerial to aerospace, such as the previously mentioned COMAE, theBrazilian Aerospace Defense

Command (COMDABRA), the Aerospace Science and Technology Department (DCTA), and the Aerospace Sciences Graduation Programme (PPGCA) at the Brazilian Air Force University (UNIFA).

Another option would be to establish a new Armed Forces branch with the creation of a Brazilian Space Force (FEsB - *Força Espacial Brasileira*), with its own doctrine, strategy, tactics, training, facilities and equipment. CLA, in addition to the Barreira do Inferno Launch Center (CLBI) and COPE bases in Brasília and Rio de Janeiro would be ideal facilities to harbor FEsB.*

Future technological and strategic considerations push Brazil and other emerging spacepower nations to not only think about the possible weaponization of Earth's orbit, but also other deeper space environments, such as cislunar, lunar orbit, or even the Moon's surface; followed by Mars and beyond. The current practical use of space for Brazil is restricted to Earth orbit, but as the Artemis Program progresses it can soon include the Moon.[29] It is also logical to assume it will eventually expand all the way to Mars as the country's development advances. As it rises as a spacepower nation, just like it was colonized and founded by the Portuguese explorers who threw themselves into the deep blue ocean looking for new lands and opportunities during the era of great navigations between the 15th and the 17th centuries, so must Brazil embrace its own history and explore and make use of deep space. ❑

*The advanatage of turning the FAB into FAEB or establishing FEsB as the fourth Brazilian Armed Force at some time in the short/long term future has been the Ph.D. dissertation topic from one of the article's authors and has received consideration by the FAB and the MD.

**Notes**

1. Maj Gen Shawn N. Bratton, USAF, *Space Doctrine Publication (SDP) 4-0, Sustainment, Doctrine for Space Forces*, Space Training and Readiness Command (STARCOM), (United States Space Force Dec 2022), https://www.starcom.spaceforce.mil/Portals/2/SDP%204-0%20Sustainment%20(Signed).pdf?.

2. David E. Lupton, *On Space Warfare: A Space Power Doctrine* (Maxwell AFB, AL: Air University Press, 1998), https://apps.dtic.mil/sti/pdfs/ADA421942.pdf.

3. US Department of Defense, "Defense Space Strategy Summary," US Department of Defense, (June 2020), https://media.defense.gov/2020/Jun/17/2002317391/-1/-1/1/2020_DEFENSE_SPACE_STRATEGY_SUMMARY.PDF.

4. Gen John W. Raymond, USSF, *Space Capstone Publication (SCP) – Spacepower – Doctrine for Space Forces* (Colorado: Headquarters United States Space Force, Jun 2020), https://www.spaceforce.mil/Portals/1/Space%20Capstone%20Publication_10%20Aug%202020.pdf.

5. Air Marshal Rob Chipman, AM, CSC, "The 'Lightspeed' Space Power eManual," Air and Space Power Centre, (Australia, Department of Defence, Mar 2022), https://airpower.airforce.gov.au/publications/SPMLink.

6. Joint Task Force-Space Defense, "Joint Doctrine Publication (JDP) 0-01.1," *Joint Task Force-Space Defense*, (Feb 2023), https://www.jtf-spacedefense.mil/.

7. Air University, Air Force Doctrine Publication (AFDP), *Counterspace Operations* 3-14 (Alabama: Curtis E. Lemay Center, 25 Jan 2021), https://www.doctrine.af.mil/Portals/61/documents/AFDP_3-14/3-14-D05-SPACE-Counterspace-Ops.pdf.

8. Tyler Way, "Counterspace Weapons 101," *Aerospace Security,* (28 October 2019), https://aerospace.csis.org/aerospace101/counterspace-weapons-101/#:~:text=There%20are%20four%20distinct%20categories,may%20be%20preferred%20over%20another.

9. Brian Weeden and Victoria Samson, "Global Counterspace Capabilities: an open source assessment," Secure World Foundation, (2023), https://swfound-staging.azurewebsites.net/media/206957/swf_global_counterspace_april2020_es.pdf.

10. Merriam-Webster, "Anti-satellite," English dictionary, (12 January 2022), https://www.merriam-webster.com/dictionary/anti-satellite.

11. Adam Strauch, "Still all quiet on the orbital front? The slow proliferation of anti-satellite weapons," *Obrana a Strategie* (Defence & Strategy), 14, no. 2, (2014), 61-72.

12. Brian Weeden and Victoria Samson, "Global Counterspace Capabilities: an open source assessment," Secure World Foundation, (2023), https://swfound-staging.azurewebsites.net/media/206957/swf_global_counterspace_april2020_es.pdf.

13. Caleb Henry, "Emerging Space Powers: the leaders of tomorrow," Lockheed Martin, (23 January 2022), https://www.satellitetoday.com/long-form-stories/emerging-space-powers-the-leaders-of-tomorrow/.

14. Joseph Soeters, Patricia M. Shields, and Sebastiaan J. H. Rietjens, (Ed.), *Routledge handbook of research methods in military studies,* (London: Routledge, 2014); Delphine Deschaux-Dutard, *Research Methods in Defence Studies: A Multidisciplinary Overview*, (London: Routledge, 2020).

15. Ministério das Relações Exteriores (MRE), "Brazil's 7 priorities in the Security Council – 2022-2023," MRE, (27 September 2021), https://www.gov.br/mre/en/Brazil-UNSC/the-2022-2023-mandate/braziils-7-priorities-in-the-security-council-2022-2023.

16. Donald J. Kessler, Nicholas L. Johnson, J.-C. Liou, and Mark Matney, "The Kessler Syndrome: Implications to Future Space operations," *American Astronomical Society – Rocky Mountain Section,* (6-10 February 2010), https://aquarid.physics.uwo.ca/kessler/Kessler%20Syndrome-AAS%20Paper.pdf'

17. NASA, "The intentional destruction of Cosmos 1408," *Orbital Debris Quarterly News*, 26–1, (March 2022), 1-5; NASA, "Effective number of cataloged objects per 10-km altitude bin," *Orbital Debris Quarterly News,* 26–2 (June 2022), 9.

18. Carmen Pardini and Luciano Anselmo, "The short-term effects of the Cosmos 1408 fragmentation on neighboring inhabited space stations and large constellations," *Acta Astronautica,* Vol. 10, (September 2023), https://www.sciencedirect.com/.

19. Telegram, "Dmitry Rogozin," (16 June 2022), https://t.me/rogozin_do/3072.

20. The White House, "Vice President Harris Advances National Security Norms in Space," Fact Sheet, (18 April 2022),

https://www.whitehouse.gov/briefing-room/statements-releases/2022/04/18/fact-sheet-vice-president-harris-advances-national-security-norms-in-space/.

21. Secure World Foundation, "Netherlands, Austria, and Italy add momentum to growing international commitment not to conduct direct-ascent anti-satellite missile tests," *SWF*, (6 April 2023), https://swfound.org/news/all-news/.

22. Report of the First Committee, "Prevention of an arms race in outer space," United Nations General Assembly, Seventy-seventh session, agenda item 97, (14 November 2022), https://documents-dds-ny.un.org/doc/UNDOC/GEN/N22/690/30/PDF/N2269030.pdf?.

23. Agência Espacial Brasileira, *PNAE: Programa Nacional de Atividades Espaciais: 2022-2031* (Brasília: AEB, 2022), https://www.gov.br/aeb/pt-br/programa-espacial-brasileiro/politica-organizacoes-programa-e-projetos/programa-nacional-de-atividades-espaciais; Bruno Martini and Maria Célia Barbosa Reis da Silva, "A Inteligência Geoespacial por Satélites de Interesse Nacional do Brasil," *Revista da Escola Superior de Guerra*, 32, no. 64 (January/April 2017), https://revista.esg.br/index.php/revistadaesg/article/view/945/826.

24. Ministério da Ciência, Tecnologia e Inovações, "Operação Astrolábio: saiba mais sobre o lançamento experimental do foguete HANBIT-TLV," Agência Espacial Brasileira, (Ministry of Science, Technology and Innovation, "Operation Astrolabe: learn more about the experimental rocket launch," Brazilian Space Agency), https://www.gov.br/aeb/pt-br/assuntos/noticias/operacao-astrolabio-saiba-mais-sobre-o-lancamento-experimental-do-foguete-hanbit-tvl.

25. United Nations Office for Outer Space Affairs (UNOOSA), "International Space Law: United Nations Instruments," (2017), https://www.unoosa.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-ENGLISH.pdf.

26. The Artemis Accords, "Principles for a Safe, Peaceful, and Prosperous Future," NASA, (22 January 2023), https://www.nasa.gov/specials/artemis-accords/index.html.

27. Dale Stephens and Melissa De Zwart, "The Manual of International Law Applicable to Military Uses of Outer Space (MILAMOS)," *RUMLAE Research Paper*, no. 17-12, (7 November 2017), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3065704.

28. United States Space Command, *Joint Task Force-Space Defense (JTF-SD),* https://www.jtf-spacedefense.mil.

29. The Artemis Accords, (22 January 2023).

**Bruno Martini, Brazilian Air Force University**

Degree in Oceanography in 2004, and a Master's degree in Coastal and Oceanic Systems Dynamics in 2011, from the Federal University of Paraná (Brazil). Trained in ocean optics observation satellites at the US Naval Research Laboratory (NRL), National Aeronautics and Space Administration (NASA) John C. Stennis Space Center (SSC), Mississippi, US in 2011. English and Spanish teacher at the Rockfeller Language Center since 2017 and 2020, respectively. Since 2022 he has been studying "Space Force or Aerospace Force, Does Brazil Need Them? When and Why?" as a Ph.D. student in the Aerospace Sciences Graduation Programme (PPGCA) at the Brazilian Air Force University (UNIFA).

**Lt Col Luis Felipe Nohra, Brazilian Air Force**

Undergraduate from the Brazilian Air Force Academy (AFA) in 1999, and Master's Degree in Electronic Warfare from the Aeronautics Institute of Technology (ITA), in 2009. He participated in the Space Technology Transfer Program of the Geostationary Defense and Strategic Communications Satellite (SGDC) in Thales Alenia Space, in France. He is currently the Team Leader of the Satellite Controllers Division, at the Brazilian Space Operations Center (COPE), in the Brazilian Air Force (FAB). Lt Col Nohra attended the Coalition Space Course (CSpC), from the National Security Space Institute (NSSI), US Space Force, in Colorado Springs, US, in 2022. His previous operational assignments include P-95 aircraft commander, in Salvador Air Force Base, instructor pilot and chief of Electronic Warfare Section.

**Maria Célia Barbosa Reis da Silva, Ph.D., Brazilian Air Force University**

Professor at the Brazilian Air Force University (UNIFA) and at the Higher War School (ESG), consultant and advisor for the Research Support Foundation of the State of Rio de Janeiro (FAPERJ). Bachelor's Degree and Undergraduate in Portuguese and English from the Pedro II Humanities School (1976). Master's Degree in Vernacular Literature from the Federal University of Rio de Janeiro (1989). Post-doctorate in Literature, Culture and Contemporaneity from the Pontifical Catholic University of Rio de Janeiro and PhD (1998) in Literature from the Pontifical Catholic University of Rio de Janeiro. Member of the CAPES Project "Incorporation of Aerospace Technology for Defense: organizational, doctrinal and strategic autonomy impacts."