APRIL 2024

A REPORT OF
THE CSIS
AEROSPACE
SECURITY
PROJECT

SPACE THREAT ASSESSMENT 2024

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CLAYTON SWOPE
KARI A. BINGEN
MAKENA YOUNG
MADELEINE CHANG
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Foreword
ERIC FANNING

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

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Center for Strategic & International Studies
1616 Rhode Island Avenue, NW
Washington, DC 20036
202-887-0200 | www.csis.org

ACKNOWLEDGMENTS

This report is made possible by general support to CSIS. No direct sponsorship contributed to this report. The Aerospace Security Project would like to thank BlackSky, COMSPOC, ExoAnalytic Solutions, HEO Robotics, LeoLabs, Planet, and Slingshot Aerospace for their contribution of data, images, and analysis. Finally, many thanks to Audrey Schaffer, Steve Jordan Tomaszewski, Jeeah Lee, Phillip Meylan, Katherine Stark, Julia Huh, and Louis Gleason for their support in the research, review, and publication process.

CONTENTS

1 FOREWORD

2 INTRODUCTION

3 OVERVIEW OF COUNTERSPACE CAPABILITIES

7 CHINA

13 RUSSIA

16 FEATURED ANALYSIS: NORMALIZATION OF DEVIANCE

20 INDIA

23 IRAN

26 NORTH KOREA

28 OTHER COUNTRIES
- 27 Australia
- 28 France
- 28 Israel
- 28 Japan
- 28 South Korea
- 29 United Kingdom
- 29 Non-state Actors

31 FEATURED ANALYSIS: COALITIONS OF CONVENIENCE

35 WHAT TO WATCH

40 CONCLUSION

41 ABOUT THE AUTHORS

43 ENDNOTES

FOREWORD

IN AN ERA MARKED BY TECHNOLOGICAL ADVANCEMENT AND global interconnectedness, space has become increasingly vital to economic prosperity and national defense worldwide. This edition of the *Space Threat Assessment* by the Aerospace Security Project at the Center for Strategic and International Studies (CSIS) provides accessible insights into the evolving global space landscape, outlining key developments and resulting threats.

Today, the United States, with its pioneering spirit and innovative capabilities, stands at the forefront of leveraging space and its limitless potential for the good of humankind. From satellite communications and navigation systems to intelligence gathering and missile defense, space assets have become ingrained in the fabric of modern life and our nation's security. This position is not assured.

While the U.S. increasingly focuses on space, foreign nations are also reaching new milestones. As the space domain becomes more congested and contested, collaboration between government agencies and private industry becomes imperative. Synergy between governmental oversight, regulatory frameworks, and private sector innovation is essential for maximizing the potential of space while mitigating risks and safeguarding national interests.

A strong and resilient aerospace and defense workforce is a vital part of this challenge. Trained professionals in government and industry underpin a thriving space sector and are essential to overcome attacks. Our people are a strategic asset and a key advantage.

Technology and innovation, especially from the private sector, are also primary strengths. We must continue to mature and integrate new technologies like artificial intelligence into space systems and find better ways for governments to take advantage of new cutting-edge capabilities. We can accelerate change by incentivizing the private sector to invest in the research and development of new technologies.

Through insightful analysis that comes at a crucial time, this report underscores the critical need for proactive cooperation between government and industry to harness the full spectrum of opportunities offered by space. By working together, we can unlock the vast potential of space exploration and utilization, drive economic growth, strengthen national security, and ensure America's continued leadership in the final frontier.

ERIC FANNING

President and CEO, Aerospace Industries Association

INTRODUCTION

WELCOME TO THE SEVENTH EDITION of the *Space Threat Assessment* by the Aerospace Security Project at the Center for Strategic and International Studies (CSIS). For the last seven years, CSIS has used open-source information to produce an annual assessment of threats to U.S. national security space systems, referred to as counterspace threats, and trends in counterspace capabilities. Each report in this series catalogs yearly developments, uses, and advancements of counterspace weapons and enablers to provide policymakers and the public with accessible insights into the global space threat landscape.

Today, there are more satellites and systems in space providing services, information, and capabilities to people on Earth than ever before.[1] While many of these systems have a civilian mission and are built and run by companies instead of governments, they also support U.S. national security. As noted in past assessments, these civilian and commercial space systems face expanding threats from foreign adversaries, which increasingly include cyber and espionage threats.[2]

Given the criticality of services and capabilities provided by space systems to U.S. national and economic security, the authors believe that policymakers should think in terms of threats and risk as they resource and prioritize mitigation measures. In addition to threats, a risk assessment includes analysis of vulnerabilities as well as the likelihood of and impacts from undesired events.

Continuing past trends, 2023 saw foreign nations reach new milestones in space: record-setting launches, deployments of satellites, and missions to the Moon and other parts of the solar system.[3] While not strictly advancing in counterspace weapons, foreign countries have shown progress in building and expanding the foundational capabilities needed to support both space and counterspace systems. China broke its national record for launches in one year and, for the third time, sent its reusable spaceplane into orbit.[4] North Korea successfully launched a satellite into space, while Iran placed its third surveillance satellite into orbit.[5] Over the last year, both India and Japan landed missions on the Moon.[6] In February 2024, the world learned that Russia is developing a space-based counterspace weapon involving nuclear technology, bringing more public awareness and policymaker attention to space security.

As in the prior two years, space-based capabilities, especially commercial space services, played a publicly visible role in conflict zones. Information from commercial remote-sensing space systems and connectivity from satellites continued to help Ukraine resist Russian aggression.[7] Space also influenced the conflict in Israel and Gaza, with media organizations using commercial satellite imagery to share information about the conflict's impacts.[8] These examples demonstrate the accessibility and utility of space-based services offered by U.S. companies to parties involved in conflicts, putting space business leaders in the middle of geopolitics, global security questions, and, in some cases, military conflict.

The information cut-off date for this report is March 30, 2024. For more detail on past counterspace weapons activities, please review the prior *Space Threat Assessments* (editions 2018–2023) or visit the project's interactive timeline at **https://aerospace.csis.org/counterspace-timeline/**.

OVERVIEW OF COUNTERSPACE CAPABILITIES

This chapter provides an overview of different types of counterspace weapons and a useful taxonomy to classify and differentiate them. Counterspace weapons vary significantly in the technical methods used to create effects against space systems, in how they are deployed, and in the level of technology and resources needed for their development and fielding. For the purposes of this report, counterspace capabilities are organized into four main categories: kinetic weapons, non-kinetic weapons, electronic weapons, and cyber operations. This report also discusses unfriendly behaviors in space and the potential implications of such behaviors on space security. Capabilities intended to conduct espionage only are not considered weapons but are discussed in this report.

Kinetic attacks are defined here as those taken through physical, material means such as bombs, bullets, missiles, and other munitions. All kinetic attacks are considered as meant to destroy or damage. This category includes weapons that target spacecraft, such as direct-ascent (DA) anti-satellite (ASAT) missiles outfitted with conventional warheads, and projectile attacks launched from one on-orbit satellite to another. It also includes attacks using bombs, missiles, or other physical means on terrestrial space infrastructure, such as ground stations, launch sites, rocket and satellite factories, and space monitoring infrastructure. Orbital grappling satellites are another form of kinetic attack. Such a grappler physically handles a target spacecraft to do it harm or attaches itself to a spacecraft and maneuvers it to another location. In the latter case, such "kidnapping" would not destroy the target satellite, but could effectively disable it without generating any debris.

Illustration
A ballistic missile can be used as a kinetic counterspace weapon.

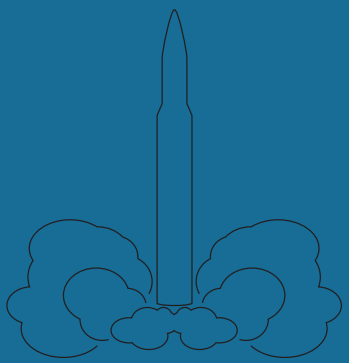
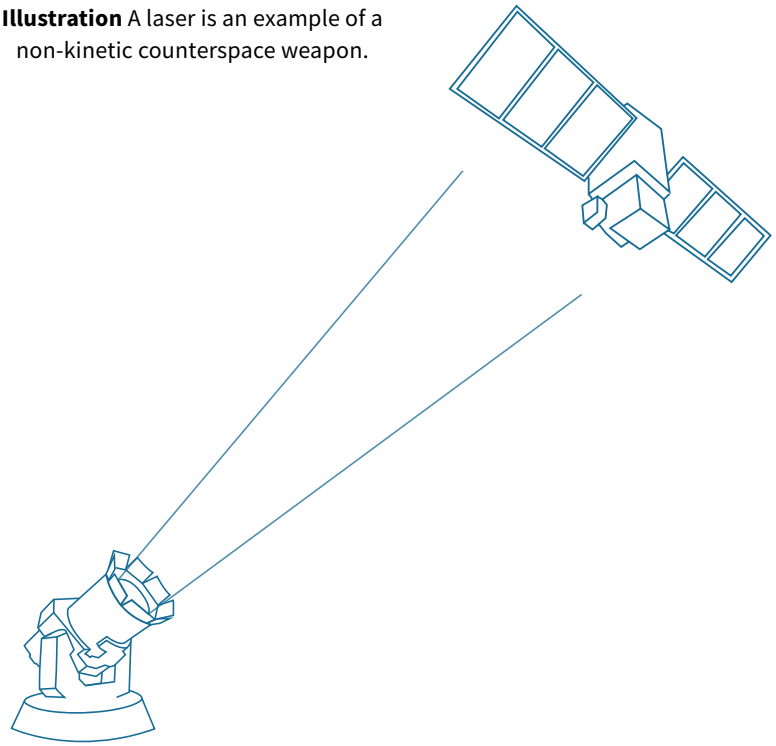


Illustration A laser is an example of a non-kinetic counterspace weapon.



Non-kinetic attacks are defined as those that use radiated energy to destroy, damage, or interfere with space systems. This energy can be directed, such as with laser or microwave energy, or distributed through nuclear detonations or electromagnetic pulse (EMP) events. High-powered lasers and dazzlers and high-powered microwave ASAT systems are included in this category. Dazzlers are intended to temporarily blind an optical satellite, although they may also unintentionally damage targeted satellites. Nuclear detonations in near space or space are included in this category because these attacks primarily damage electronics through the resulting EMP and lingering radiation that gets trapped in orbit by Earth's magnetic field. Other non-nuclear weapons that create EMP events in space would also be included in this category.

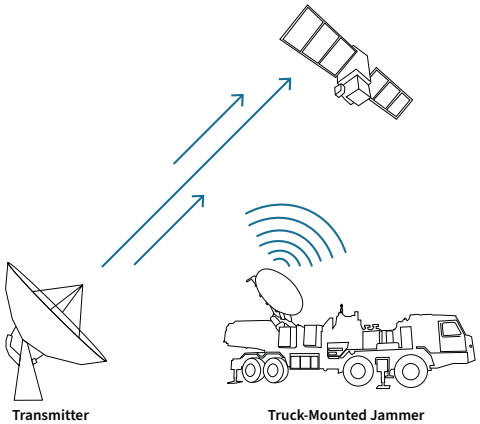
To date, no country has used a kinetic or non-kinetic weapon to destroy or permanently disable another country's satellite, but four countries—the United States, Russia, China, and India—have successfully tested DA ASAT missiles against their own satellites.[9] These types of attacks risk the creation of orbital debris, which can indiscriminately affect other satellites and human-crewed systems, such as the International Space Station (ISS) and China's Tiangong space station.[10] Depending on altitude, orbital debris can persist for decades, if not centuries, and pose a long-term risk to the space environment. According to one industry expert, over half of all low Earth orbit (LEO) fragments today comes from just six breakup events, with more than a quarter of LEO debris fragments produced by one event: China's DA ASAT test that destroyed its Fengyun 1C weather satellite in 2007.[11]

Electronic weapons use the electromagnetic spectrum to deny or interfere with a target's ability to use space services and capabilities. These weapons cannot destroy; they only impart temporary effects as long as the electronic system engages its target. This category includes jamming and spoofing of global navigation satellite system (GNSS) and satellite communications (SATCOM) signals. Spoofing is a form of electronic attack where an attacker tricks a receiver into believing a fake signal produced by the attacker is the real signal it is trying to receive. It can affect GNSS signals from the Global Positioning System (GPS), Galileo, BeiDou, and GLONASS systems, in addition to non-encrypted satellite downlinks.[12] Use of GNSS jamming and spoofing has become commonplace, with GNSS interference observed around the world, often by commercial airline pilots.[13] Also included are any electronic attacks to jam space-based radar and the reception of radio frequency (RF) signals by the user of a satellite service on Earth, the satellite itself, or the ground station of a space system.

The final category, cyber operations, includes any offensive activity in cyberspace that targets space systems, including ground infrastructure, satellite terminals, spaceports, and spacecraft. Cyber operations can destroy or permanently disable a targeted system, although they can also be used to temporarily disrupt or to conduct espionage, including gaining access to proprietary or sensitive technical information on a target network. A network exploitation can be a beachhead for any of these purposes, as a cyber operation's intent is often ambiguous.[14]

The same ambiguity also clouds efforts to understand and accurately classify most unfriendly satellite behaviors conducted by Russian and Chinese satellites, including close approaches. It is generally difficult to neatly categorize these capabilities. For example, Russia's second Luch/Olymp satellite, launched in 2023, probably positions itself near other satellites in geostationary orbit (GEO) to conduct intelligence activities.[15] But it might also be validating a concept of operations for future orbital kinetic attacks,

Illustration
Uplink and downlink jamming are two forms of electronic counterspace attack.



OVERVIEW OF COUNTERSPACE CAPABILITIES

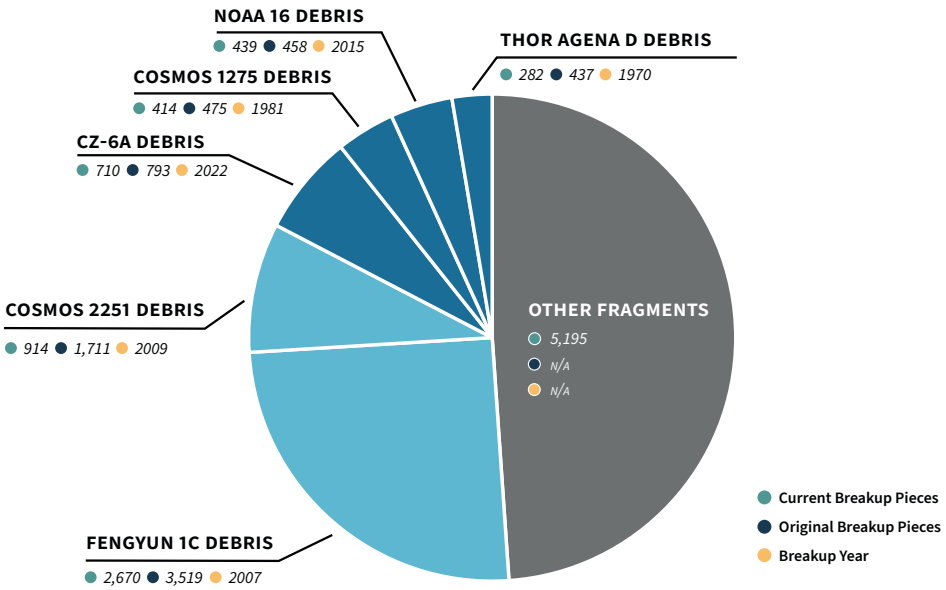


Figure 1 The Long-Lasting Effects of Space Debris from Six Major Events

LEOLABS: RECREATED WITH PERMISSION

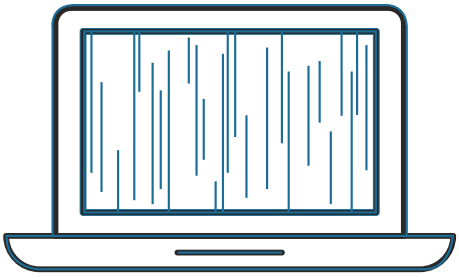
SOURCE: DARREN MCKNIGHT, "ENABLING ENDURING SPACE SAFETY BY MANAGING ORBITAL DEBRIS," LEOLABS, MARCH 2024, HTTPS://LEOLABS.SPACE/WP-CONTENT/UPLOADS/2024/03/MANAGING-ORBITAL-DEBRIS-DR-DARREN-MCKNIGHT-MARCH-2024.PDF.

or as some speculate, it may be carrying an electronic attack satellite-jamming payload.[16] With limited open-source information available, it is difficult to draw a definitive conclusion.

A grappler satellite—defined in this report as a satellite that can attach itself to a target spacecraft and maneuver both into other orbits—is an example of a counterspace capability enabled by unfriendly close approaches. While a grappler satellite may not destroy its target, it could effectively disable a satellite without generating any debris.

Not every nation possesses the full breadth of counterspace capabilities described here, as the level of technological sophistication and ground and space infrastructure required for counterspace weapons dramatically varies. For example, A satellite lasing system requires high beam quality, adaptive optics (if being used through the atmosphere), and advanced pointing control to steer the laser beam precisely—all technology that is costly and sophisticated. A high-altitude nuclear detonation requires not only the capability to build a nuclear weapon but also the capability to place that weapon into the right location in space to affect targeted satellites.

On the other hand, the technology needed to jam and spoof many types of satellite signals is commercially available and inexpensive, making it relatively easy to proliferate among state and non-state actors.[17] The same is true for cyber operations. Like jamming and spoofing, there is a low barrier to entry for the acquisition and use of cyber capabilities to target space systems. A nation's proficiency in cyber operations does not necessarily relate to its space capabilities, as a country without space launch capabilities may have mature offensive cyber capabilities.



Illustration

Cyberattacks can be used to take control of a satellite and damage or destroy it.

Table 1

TYPES OF COUNTERSPACE CAPABILITIES

	Kinetic Weapons			Non-kinetic Weapons		Electronic Weapons		Cyber Operations
	Terrestrial Infrastructure Attack	Direct-Ascent ASAT	Orbital ASAT	Nuclear Detonations	Directed Energy	Jamming	Spoofing	
Origin to Destination	Ground-to-Ground	Ground-to-Space	Space-to-Space	Ground-to-Ground; Ground-to-Space; Space-to-Space	Ground-to-Ground; Ground-to-Space; Space-to-Space	Ground-to-Ground; Ground-to-Space; Space-to-Space	Ground-to-Ground; Ground-to-Space; Space-to-Space	N/A
Permanence of Attack	Permanent	Permanent	Permanent	Permanent	Varies, dependent on mode of attack	Not Permanent	Not Permanent	Varies, dependent on mode of attack
Scale of Attack Effects	Widespread, if node supports multiple satellites	Widespread, if orbital debris creation	Limited to Widespread, dependent on mode of attack	Widespread	Limited and Regional, dependent on mode of attack	Limited and Regional, dependent on mode of attack	Limited and Regional, dependent on mode of attack	Limited to Widespread, dependent on mode of attack
Attributability of Attack	Variable attribution, depending on mode of attack	Launch site can be attributed	Can be attributed by tracking previously known orbit	Launch site can be attributed	Limited attribution	Modest attribution depending on mode of attack	Modest attribution depending on mode of attack	Limited or uncertain attribution
Requires Space Launch Capability	No	Yes	Yes	No	No	No	No	No
Requires Space Domain Awareness	No	Yes	Yes	No	Yes	No	No	No

CSIS AEROSPACE SECURITY PROJECT RESEARCH AND ANALYSIS

CHINA

President Xi Jinping has said that to "develop the space industry and build China into a space power is our eternal dream."[18] Over the last decade, China has solidified itself as a space power, maintaining its status as the second-most-capable space nation after the United States. Beijing relies on a suite of growing space and counterspace capabilities to support national goals, including using space as an extension of its soft-power Belt and Road Initiative to strengthen its economic and diplomatic ties with other countries.[19] On the diplomatic front, China is working with Russia to create an international coalition oriented around lunar missions, a direct competitor to the U.S.-led Artemis program, while also pursuing strategic space cooperation with African, Latin American, and Asian countries.[20]

For China's space program, 2023 was another record-setting year. It conducted 67 space launches, resulting in over 200 satellites successfully placed into orbit and one launch failure.[21] China's counterspace activities in 2023 appear largely to be an extension of activities conducted in previous years, including the launch of another spaceplane, operation of GEO-based satellites that conduct rendezvous and proximity operations, and use of electronic jamming and cyber operations against ground networks. As space and counterspace capabilities play an essential role in China's national security strategy, China will likely continue to emphasize the modernization and development of its space technologies in the coming years.[22]

CHINA'S COUNTERSPACE ACTIVITIES IN 2023 APPEAR LARGELY TO BE AN EXTENSION OF ACTIVITIES CONDUCTED IN PREVIOUS YEARS.

China's growing commercial space sector also achieved new milestones in 2023. This sector may be viewed as a way to foster innovation in an ecosystem dominated by the government and state-owned enterprises (SOEs), despite many of these private entities being SOE subsidiaries or spin-offs. According to a 2023 U.S. space investment report, China is second to the United States in terms of the amount of private capital channeled to space companies.[23]

SPACE POLICY, DOCTRINE, AND ORGANIZATIONS

Beijing's space ambitions align with its overall national strategic interests. Space capabilities are seen as key to a modern military and modern warfare, advancing economic and diplomatic interests globally, and elevating the national prestige of China and the Chinese Communist Party (CCP). In seeking the mantle of global space leadership, Beijing designated aerospace a top priority in its Made in China 2025 strategic initiative, aimed at achieving technological breakthroughs and boosting its innovation base, and has allocated large state and private investments to the expansion of its space sector.[24]

Beijing is pursuing a broad range of space exploration and human spaceflight activities, as outlined in its 2022 five-year plan, "China's Space Program: A 2021 Perspective." It plans to upgrade and expand its space launch vehicle (SLV) capabilities; expand its space station, Tiangong, which became fully operational in 2022; research key technologies for exploring and developing cislunar space, including establishing a human presence on the Moon; and pursue more robotic exploration of deep space, including Mars.[25]

Similar to the United States, Chinese military leaders aim to secure the full use of space for China, while at the same time preventing adversaries from using their own space capabilities.[26] Chinese military theory stresses the importance of joint operations, emphasizing the key role that space capabilities, information warfare, and networked systems play in modern combat operations.[27] At the same time, investments in counterspace weapons would allow the People's Liberation Army (PLA) to hold at risk their adversaries' space assets, especially those that would enable command, control, communications, and intelligence in the region.[28]

Separate organizations are responsible for military and civil space activities. Established in 2015, the PLA Strategic Support Force (PLASSF) centralizes the development, operations, and integration of space, cyber, and electronic warfare capabilities. This includes development and management of SLVs and government launch sites; intelligence, surveillance, and reconnaissance (ISR) satellites; navigation and communication satellites; satellite control centers; and cyberspace operations, electronic warfare, and many counterspace capabilities.[29] The China National Space Administration (CNSA) is responsible for civil space activities and international space cooperation, while the China Manned Space Agency (CMSA) manages China's human spaceflight program, which includes the Tiangong space station and Shenzhou crewed spacecraft.[30] Notably, the CNSA works closely with the PLA, while the CMSA falls under an equipment development division within the Central Military Commission.[31]

Although these organizations maintain separate priorities, the same SOEs produce much of the technology for both. Further, Beijing's military-civilian fusion policy blurs the line between civil and commercial activities and military endeavors, encouraging the acquisition of cutting-edge technologies, including space technologies, to achieve both economic and military dominance.[32]

SPACE CAPABILITIES

China maintains an extensive suite of space capabilities, including space launch with its family of Long March rockets, GNSS through its Beidou system, satellite communications, ISR, missile warning, and space situational awareness (SSA).

In space launch, 2023 was a breakthrough year, especially for commercial SLV providers. Enabled by a 2014 government policy change that opened select space sectors to private investment, seven Chinese commercial companies—including some subsidiaries or spin-offs from Chinese SOEs—conducted space launches in 2023 and early 2024. April 2023 saw China's first successful satellite launch by a private company using a liquid propellant rocket, built by Beijing Tianbing Technology (also called Space Pioneer).[33] In July 2023, a private Chinese company, LandSpace, launched the world's first methane-liquid oxygen SLV, technology that promises to enhance rocket performance, and in January 2024, space start-up iSpace tested a reusable SLV.[34] Also in January 2024, start-up Orienspace launched its new Gravity-1 rocket from a sea-based platform, successfully delivering three satellites to LEO and making it the most powerful launch vehicle developed by China's private space sector.[35] Additionally, component-level testing continued in 2023 by a Chinese SOE developing the Long March 9, a super heavy-lift reusable rocket rivaling SpaceX's Starship that could enable China's deep space exploration plans.[36]

Beijing is also expanding its space launch sites to accommodate this commercial growth. The December 2023 opening of a commercial spaceport on the island of Hainan will increase China's ability to support more commercial launches, which are often deprioritized at the four main government launch sites.[37]

Another significant development in 2023 is China's growing space-based remote-sensing capabilities and their implications for the PLA's ability to track forces and assets across the Indo-Pacific. Over 400 satellites have been launched by China over the last two years, over half of which are remote-sensing satellites.[38] Further, according to U.S. Space Command, as of January 2024, China had approximately 360 ISR satellites on orbit, more than triple the number in 2018.[39] Notably, in August 2023, Beijing launched the world's first GEO-based synthetic-aperture radar (SAR) satellite, Ludi Tance-4, and in December 2023, it launched an optical imagery satellite to GEO, Yaogan-41. Some analysts estimate resolutions of 20 meters for Ludi Tance-4 and possibly 2.5 meters for Yaogan-41.[40] When paired with other Chinese ISR satellites, artificial intelligence to quickly identify objects, and networked communications systems, the PLA could possess near-real-time situational awareness of the vast Indo-Pacific theater.

In 2019, China's first commercial rocket placed satellites into orbit.

PHOTO BY STR/GETTY IMAGES

China is also courting foreign customers for its remote-sensing capabilities. In early 2023, the United States sanctioned Chinese companies Spacety and China HEAD Aerospace for providing imagery of Ukraine to Russia's Wagner Group.[41] Though China has espoused neutrality in the Ukrainian conflict, this arrangement is an example of a Chinese entity providing direct support to Russian combat operations in Ukraine.[42]

Last year also witnessed progress by Chinese SOEs in the mass production and deployment of large satellite constellations in LEO. In November 2023, China is believed to have launched its first batch of satellites to test internet connectivity from space as part of a planned 13,000-satellite national LEO broadband constellation, GuoWang. Another 12,000-satellite constellation, G60 Starlink, saw its first satellites roll off the production line in December 2023. Deployments of both constellations are anticipated to start in 2024 and will provide broadband internet services akin to Starlink once operational.[43]

China maintains significant global SSA capabilities, which are required to maintain constant connectivity with its assets for basic on-orbit safety and collision avoidance, as well as to target satellites and employ counterspace weapons effectively. These capabilities include a fleet of ships equipped with radar tracking antennae, ground stations for satellite telemetry and tracking in China and more than a dozen other countries, and advanced communications equipment that assists in tracking SLV and intercontinental ballistic missile (ICBM) launches and satellites.[44]

In 2023, a U.S. research institute reported that the PLASSF had established a new base focused on military SSA, called Base 37. This development suggests improvements to the PLA's ability to integrate data from ground- and space-based sensors, and units at this base will likely improve the PLA's ability to identify, track, and analyze foreign space

Rendezvous and Proximity Operations

Previous iterations of CSIS's *Space Threat Assessment* have reported on unusual rendezvous and proximity operations (RPOs) by Chinese satellites in GEO, last year highlighting the Shijian-21 (SJ-21) satellite, an experimental space debris mitigation satellite that latched onto and rapidly moved a defunct GNSS satellite.[47] SJ-23, believed to be another experimental satellite, was launched into GEO in January 2023. It was reported to have released an object, later identified as an apogee kick motor, which is typically used to help move a satellite into GEO before being jettisoned.[48]

Over the course of 2023 and into early 2024, SJ-23 and other Chinese spacecraft exhibited unusual behaviors in GEO, particularly in proximity to certain U.S. government and commercial satellites. For example, over several weeks in February 2023, SJ-23 and a U.S. Geosynchronous Space Situational Awareness Program (GSSAP) satellite appeared to move westward in GEO coincident with each other, covering about 100 degrees in longitude.[49] Elsewhere, in late 2023, a pair of Chinese satellites—Shiyan (SY) 12-01 and 12-02—appeared to move in synchronized yet opposite directions, apparently similar to maneuvers they did in 2022 after being approached by a U.S. government satellite.[50]

Such capabilities, with demonstrations of greater proficiency in RPOs and docking, can contribute to space sustainability through orbital debris removal, but they can also serve as intelligence collectors and latent counterspace weapons. These RPOs continue to enable China to mature operational concepts and technical skills necessary for orbital ASAT weapons.

objects and ballistic missile launches.[45]

The PLA also appears to be conducting training regarding how to evade collection by other countries' ISR satellites. Various reports from 2022 to 2024 in the *PLA Daily*, the official newspaper of the PLA, describe various branches of the PLA—including the army, air force, and rocket forces—conducting drills to "retract equipment and quickly maneuver" and "maintain radio silence" when "'enemy' satellites are conducting reconnaissance."[46] There appears to be a clear appreciation across the PLA that their adversaries will use space-based ISR assets to monitor and target their forces and activities.

COUNTERSPACE ASSESSMENT

China has demonstrated nearly every counterspace capability covered in this report, having fielded jamming and directed energy systems, demonstrated DA ASAT capabilities, and tested technologies relevant to on-orbit counterspace weapons systems. Additionally, China can conduct sophisticated cyber operations that target space and other important infrastructure.[55] According to the U.S. Department of Defense, Beijing views counterspace systems as a way to deter and counter foreign intervention in a regional conflict.[56]

Electronic Weapons

The PLA maintains a range of both fixed and mobile electronic warfare systems that can interfere with satellite communications links, GNSS signals, and SAR intelligence-gathering satellites.

China was likely responsible for GPS interference in the Indo-Pacific region noted by commercial pilots last year. In March 2023, Australian airline group Qantas and the International Federation of Air Line Pilots' Associations issued warnings to pilots about Chinese warships engaged in radio signal and GPS jamming over the South China Sea, Philippine Sea, eastern Indian Ocean, and northwest of Australia.[57] GPS spoofing has also affected maritime transportation in recent years, with research from 2019 showing hundreds of ships affected by GPS spoofing near Shanghai, although responsibility for such spoofing remains uncertain.[58]

As the Qantas case in 2023 shows, the employment of such jamming and spoofing capabilities in peacetime has had effects well beyond the military sphere, risking harm to civil and commercial transportation and public safety.

Image of a Qantas commercial airliner.

PHOTO BY PHIL WALTER/GETTY IMAGES

Spaceplane

Last year's assessment described the launch of two different Chinese reusable spaceplanes in 2022: an orbital version, named Shenlong, and a suborbital version that immediately returned to Earth. The Shenlong spaceplane, conducting its second orbital mission, remained in LEO from August 2022 through May 2023 (276 days).[51] U.S. commercial firm LeoLabs observed Shenlong release an object into orbit and perform multiple maneuvers with it, including formation flying, docking, and recapture operations.[52]

On December 14, 2023, China launched the Shenlong spaceplane on a Long March 2F into LEO for a third mission. Coincidentally, this occurred just days after a planned launch of a similar U.S. spaceplane, the U.S. Air Force X-37, although it ended up launching on December 28, 2023.[53] At the time of publication, Shenlong remains in orbit and shrouded in secrecy, but does not appear to have conducted unusual activity.[54]

There are no indications that China's spaceplanes would act as counterspace weapons. However, Beijing's growing proficiency in complex RPOs, object releases, docking, and capture operations between spacecraft showcases the fundamentals necessary for an orbital ASAT capability.

Cyber Operations

As discussed in past iterations of this report, China has been implicated or suspected in several cyberattacks against foreign satellite networks, including U.S. National Oceanic and Atmospheric Administration (NOAA) remote-sensing and weather satellites and an Indian satellite communications network.[59] China also seeks to burrow into government and defense contractor networks to conduct espionage, steal data and technology, and implant damaging malware.[60] These trends led the U.S. intelligence community in August 2023 to issue a bulletin warning the U.S. space industry of cyber targeting, among other threats to space companies' intellectual property.[61]

A notable Chinese cyber operation uncovered in 2023 was Volt Typhoon, a campaign that targeted critical infrastructure in Guam and elsewhere in the United States. Microsoft, which unveiled the cyber campaign, assessed that it is part of China's efforts to be able to disrupt critical communications infrastructure between the United States and Asia.[62] Targeted sectors included transportation such as ports and rail, utilities, and telecommunications infrastructure, with satellite communications systems specifically mentioned by Microsoft.[63]

Non-kinetic Weapons

According to the U.S. Defense Intelligence Agency, "China has multiple ground-based laser weapons of varying power levels" that can temporarily blind optical sensors or degrade and damage satellites.[64] In May 2023, a U.S. company operating imagery satellites observed laser infrastructure at the Korla test site in western China, capturing a pattern of activity that appears consistent with a laser ASAT capability.[65] The PLA is also believed to have fielded ground-based mobile laser weapons and is conducting research and development (R&D) on mobile high-powered microwave (HPM) weapons, but it is unclear whether the latter have counterspace applications, according to a U.S. researcher.[66]

As the United States and others deploy proliferated satellite constellations as a means to build greater resiliency against space threats, the authors anticipate that China will seek ways to hold those proliferated architectures at risk because of the advantages they provide, or the threat Beijing believes they pose. In a January 2024 commentary, an author affiliated with the PLA Academy of Military Sciences assessed that SpaceX's Starlink has "a clear military focus," can "carry weapon payloads for space strike missions," and "threatens space security."[67] One such way to counter proliferated constellations is through high-altitude nuclear detonations (HAND), the effects of which have been researched by a PLA-affiliated institute, as noted in last year's assessment.[68] While this remains a worrisome development, the authors did not identify further Chinese HAND or space-based nuclear weapons research in the past year.

Kinetic Weapons

While China possesses ground-based DA ASAT missile systems, it has abstained from further destructive testing of those systems against satellites since its 2007 intercept of a defunct Chinese weather satellite in LEO. However, Beijing is believed to have continued development and non-destructive testing of a range of DA ASAT weapons that can reach higher orbits, including in GEO.[69]

Korla test site with possible laser facilities (right side).

BLACKSKY: REPRINTED WITH PERMISSION

RUSSIA

Russia has had both successes and failures in space over the past year. A Russian attempt to land on the Moon failed in August 2023, with Luna-25 crashing into the lunar surface.[70] Three Russian spacecraft supporting the ISS suffered coolant leaks in the last year.[71] However, Russia successfully launched several civilian and military satellites.[72] Additionally, Russia picked up new foreign launch customers, including the United Arab Emirates (UAE) and Malaysia, despite U.S. and European sanctions.[73] Arguably, the biggest revelation since the last report involves allegations that Russia is developing a nuclear-capable ASAT weapon that the United States says would violate the 1967 Outer Space Treaty.[74]

While Russian officials have outlined an ambitious space agenda, sanctions continue to block access to Western technology critical to Russia's ability to build modern satellites. In these circumstances, Russia will have a difficult time executing its vision. The bedrock of Russian strength in space, including its counterspace capabilities, is Soviet-era technology and infrastructure. It remains to be seen how long it can lean on what are foundationally 1980s systems and designs to keep up in space.[75]

SPACE POLICY, DOCTRINE, AND ORGANIZATION

Space plays a critical role in Russian military thinking, which has long emphasized a concept designed to counter U.S. air power called "strategic aerospace operations."[76] Degrading U.S. space capabilities is an important element of this strategy, as Russia understands the importance the United States places on space capabilities to enable air and missile strikes as well as joint operations.[77] A focus on space and counterspace operations also fits within Russia's active defense framework, which is about impairing an adversary's ability to bring its full force to bear and limiting the length of any hostilities. Russia would likely seek to degrade or destroy an adversary's space capabilities at the start of a conflict, even before military hostilities begin.[78]

Public rhetoric over the past year also provides insight into Russia's military thinking regarding space and counterspace responses, particularly how it might attempt to degrade commercial space capabilities. In October 2023, Russia warned that Western "quasi-civilian" satellites could be legitimate targets.[79] Russia did not mention specific space systems, although they were probably referring to U.S. satellite communications and remote-sensing providers. In September 2022, a Russian official taking part in a UN working group on space made a similar threat, warning that Russia could retaliate against Starlink for its role in Ukraine.[80]

Roscosmos, a state corporation, is the Russian space agency responsible for human and uncrewed space programs and aerospace research activities.[81] Russian military space activities are led by the Russian Space Forces, one of three branches of the Russian Aerospace Forces, which itself is one of three arms of the Armed Forces of the Russian Federation. The Russian Space Forces, established in 2015, is responsible for missile warning, ballistic missile defense, and military spacecraft and satellites, including the GLONASS global navigation system.[82]

THE BEDROCK OF RUSSIAN STRENGTH IN SPACE, INCLUDING ITS COUNTERSPACE CAPABILITIES, IS SOVIET-ERA TECHNOLOGY AND INFRASTRUCTURE.

SPACE CAPABILITIES

Since the dissolution of the Soviet Union, Russia has developed only one new launcher, the Angara rocket, whose maiden launch was in 2014. First designed in 1966, the Soyuz rocket has flown more missions than any other rocket in the world. Russia had 20 space launches in 2023, similar to the totals for 2021 and 2022.[83] Russia depends on imported Western technology and components to build satellites, and these components have become harder to obtain due to sanctions.[84] Russia's ability to manufacture communications satellites has effectively ground to a halt since the imposition of sanctions in 2022.[85] Russia satellite manufacturing processes are slow and labor intensive, with the head of Roscosmos admitting it takes 18 months to build one satellite.[86] By contrast, SpaceX alone is producing six satellites per day.[87]

Yet despite these shortcomings, Russia today remains a force to be reckoned with in space, particularly in counterspace and space launch capabilities. Throughout 2023, Russia continued launching people and supplies to the ISS. While Russia lost foreign launch contracts in 2022, there was renewed interest from foreign customers, including for satellites with Western ties, specifically the United Kingdom and Luxembourg, by late 2023.[88] Russia deployed several notable military surveillance satellites in 2023. Russia launched its second Luch/Olymp inspector satellite in March 2023.[89] In December 2023, Russia launched two remote-sensing military satellites and the second of two weather satellites, Arktika, designed primarily for monitoring the Arctic and demonstrating Russia interest in the Arctic region.[90]

Although the Roscosmos annual budget will hover between $2.6 billion and $2.8 billion over the next three years, a tenth of the National Aeronautics and Space Administration (NASA) annual budget, Russia outlined an ambitious space agenda in October 2023.[91] It articulated plans for a new space station, a nuclear space tug, and two new launch vehicles, the Amur-LNG and Korona. Publicly, Russia has also committed to building a constellation of 264 satellites that would provide broadband access.[92] Additionally, Russia announced plans to land cosmonauts on the Moon by 2040.[93]

Many of these proposals, such as the new space station and Amur rocket, are not new and have been stalled for years due to lack of funding.[94] But Russia has demonstrated a willingness to make significant investments in space. Other than the Crimea Bridge, the construction of Russia's third launch site, the Vostochny Cosmodrome, was Russia's largest infrastructure project in the last 20 years.[95] Russia also brought online a new radar-based SSA system, Razvyazka, in the middle of 2023.[96] The Razvyazka system, located near Moscow, will be used to catalog space objects, replacing a long-range radar station that was in operation from 1978 into the 2000s. In July 2023, Russia inaugurated a new optical-electronic monitoring station in South Africa for tracking space objects, potentially paving the way for future Russian-South African space cooperation, according to the head of Roscosmos.[97]

COUNTERSPACE ASSESSMENT

In February 2024, the U.S. government confirmed that Russia is developing a new ASAT capability. According to a U.S. White House spokesman, the capability is not deployed and poses no immediate threat. It can neither attack humans nor cause physical destruction on Earth, but it would violate the Outer Space Treaty of 1967.[98] Some theorize that Russia is considering a nuclear weapon in space, while others suggest that Russia is developing a nuclear-powered electronic warfare satellite. U.S. officials have been concerned enough about the threat to approach China and India, asking for help to convince Russia to halt this work.[99] Such a weapon, in either case, would be an effective way to threaten large numbers of satellites—such as proliferated satellite constellations—which the United States and others are deploying as a means to build greater resiliency against space threats. In addition to developing new ASAT capabilities, Russia maintains DA ASAT systems, last testing such a system in 2021.

As noted earlier, Russia launched a second Luch/Olymp inspector satellite in March 2023, which, like the original Luch/Olymp satellite, is making stops near Western satellites in GEO.[100] Since launch, the second Luch/Olymp has parked near a U.S. Wideband Global SATCOM satellite and Eutelsat satellites. The first Luch/Olymp remained near Western commercial communications satellites for most of the last year.[101]

Past reports have chronicled concerning counterspace announcements and developments, such as the Peresvet ASAT laser dazzling weapon, which has yet to prove its worth in combat.[102] There are also reports that Russia has repeatedly tried and failed to effectively jam and prevent users in Ukraine from accessing Starlink.[103] In April 2022, a U.S. defense official described how Starlink was able to upgrade its terminals to fend off jamming attempts at the start of the conflict.[104] Russia has also been blamed for GPS interference reported in Poland, Scandinavia, and the Baltic States and continues to interfere with GPS reception in Ukraine.[105]

In November 2023, the European Space Agency's Sentinel-1 SAR satellite experienced interference while imaging Sevastapol, Ukraine.[106] Sentinel-1 experienced similar interferences in July 2021 while imaging the Rostov region in Russia.[107] Unlike other SAR satellites, which mostly use X-band frequencies, Sentinel-1 uses the C-band, which is also used for other purposes, such as communications, radar, and weather applications. Rather than indicative of a counterspace attack on an SAR satellite, some experts speculate that the observed interference could be attributed to powerful electronic warfare systems used by Russia to disrupt drones.[108]

During the past year, Russian satellites have conducted unfriendly behaviors in space, although it is difficult to say conclusively whether these activities were meant to support or test orbital ASAT weapons or merely to conduct espionage—or to do both. In November 2023, the Russian satellite Cosmos 2570 released a daughter satellite that then released its own daughter satellite. All three satellites then performed close approach activities around each other.[109] The same month, a presumed-defunct Russian remote-sensing satellite, Resurs-P3, came to life and approached another Russian satellite, Cosmos 2562, for an unknown purpose.[110] This activity suggests a need to reassess satellites that are no longer operational, as they may be acting as sleeper cells in space.

Russian satellites with a record of unfriendly behaviors can pose hazards even after the end of their missions. Between 2013 and 2014, two Russian satellites, Cosmos 2491 and Cosmos 2499, were observed conducting very close approaches with other Russian satellites, possibly testing orbital weapons technologies.[111] Although observers concluded that their missions probably ended around 2017, Cosmos 2491 made news in 2020 when its propulsion tank unexpectedly exploded.[112] In 2023, Cosmos 2499 also suddenly exploded, with observers speculating that the explosion was caused by the same propulsion tank issue that affected its sister satellite.[113] The explosion created a cloud of debris that will likely remain in orbit for decades, if not centuries.[114]

With these Luch/Olymp and Cosmos satellites, Russia could be testing and validating tactics, capabilities, and operational procedures that it could use to enable future orbital counterspace weapons. Russia is probably assessing what kinds of space activities and operations it can conduct without risking a response by or escalation with the United States. Russia is also likely searching for and learning how to exploit its adversaries' weaknesses in space, assembling its operational plans for how it would use its full arsenal of counterspace tools in any direct conflict with the United States.

FEATURED ANALYSIS

NORMALIZATION OF DEVIANCE

COINED BY AMERICAN SOCIOLOGIST DIANE VAUGHN IN HER analysis of the Space Shuttle Challenger disaster, normalization of deviance refers to an environment in which people grow accustomed to and tolerant of what had previously been considered unacceptable behavior.[115] In the case of the Space Shuttle Challenger, Vaughan concluded that unsafe practices, which individually did not lead to immediate disaster, became acceptable and commonplace, increasing risks and eventually leading to catastrophe.

In each edition of this assessment, the authors have documented the use of counterspace weapons meant to destroy or disrupt access to space-based capabilities. A pattern has emerged that suggests the normalization of certain counterspace activities that had heretofore been uncommon. While the use and testing of weapons that could generate space debris remains rare, cyberattacks, jamming and spoofing activities, and unfriendly behaviors in space have now become commonplace and rarely trigger an escalatory or retaliatory response. These activities have become normalized.

CYBER OPERATIONS

Discoveries of nation-state cyber exploitations targeting U.S. and allied networks have become routine.[116] The U.S. government regularly condemns malicious nation-state cyber activities and often imposes economic sanctions on the attacking nation. There is little evidence to show that this approach deters future cyberattacks, as cyber operations targeting U.S. national security or commercial interests have continued. Although destructive cyberattacks decreased in 2023, cyber espionage operations increased.[117] While Russia's cyber focus continues to remain on Ukraine, China is targeting the U.S. defense industrial base and critical infrastructure and nations around the South China Sea. Meanwhile, Iranian and North Korean cyber operators are developing more sophisticated attacks and techniques.[118]

This past year pointed to new and increased attention by cyber threat actors on space systems and technologies, as well as the companies responsible for their development and operations. In August 2023, the U.S. National Counterintelligence and Security Center issued public guidance warning of the cyber threats to U.S. space systems.[119] That same month, Viasat and U.S. National Security Agency leaders publicly discussed an analysis that concluded that Russian hackers only needed 45 minutes to deploy malware that took 45,000 satellite modems offline before the start of Russia's invasion of Ukraine in 2022.[120] In June 2023, a nonstate organization claiming an affiliation with the Wagner Group hacked a Russian teleport, disrupting satellite communications to Russian government users.[121] In June 2018, a hacking group with ties to China was found to have compromised the computers of an undisclosed satellite operator that were used to monitor and control satellites.[122]

Although some cyber operations likely aim to disable a space capability, others are intended for intelligence collection or economic espionage. From 2021 to 2023, a cyber threat actor attributed to China focused on aerospace and R&D organizations, among other targets, throughout North America, Asia, and Europe.[123] Interestingly, U.S. and allied space interests are not the only targets. In March 2023, North Korean cyber threat actors conducted operations aimed at collecting information from a Russian aerospace research institute.[124]

A PATTERN HAS EMERGED THAT SUGGESTS THE NORMALIZATION OF CERTAIN COUNTERSPACE ACTIVITIES THAT HAD HERETOFORE BEEN UNCOMMON.

Other than for espionage aimed at acquiring information on space and aerospace technologies, cyber threat actors are probably targeting space systems not because they have a specific interest in space, but because space capabilities support critical national capabilities, such as telecommunications. Attacks on space systems fit within the context of increased interest, particularly by China, in finding ways to disrupt critical U.S. and allied infrastructure.[125]

Discovered in March 2023, malicious cyber activity tied to a Chinese threat actor, called Volt Typhoon, targeted U.S. critical infrastructure in Guam and other parts of the United States. While Volt Typhoon had previously focused on intelligence-gathering operations, experts concluded that in this instance hackers were looking for ways to disrupt communications infrastructure, including satellite communications, between the United States and Asia during a conflict with China.[126]

UNFRIENDLY BEHAVIORS IN SPACE

It is admittedly difficult to define unfriendly behaviors in space when there are not generally recognized best practices for normal space behaviors. However, uncoordinated intentional close approach operations between satellites from two or more nations are included in this report's definition of unfriendly behaviors. Close approach operations between satellites from the same nation may also be considered unfriendly if those operations suggest the development of technologies or procedures that could be used for orbital weapons systems. Some unfriendly behaviors combine both of these characteristics, including close approaches between satellites from two nations and testing of systems that could enable a future orbital weapon.

While it is difficult to fully ascertain the purpose of a Chinese or Russian military satellite, especially using open-source information alone, some satellites exhibiting unfriendly behaviors are probably conducting espionage. Certain Russian and Chinese satellites that routinely exhibit these behaviors in LEO and GEO, often referred to as inspector satellites, are probably collecting RF, optical, and thermal data of other satellites. The two Russian Luch/Olymp satellites in GEO—the first launched in 2014 and the second in 2023—routinely maneuver near Western government and commercial communications satellites and remain there for extended periods. The Chinese satellites Shiyan-12-01 and Shiyan-12-02, launched in 2021, appear to have inspected U.S. government satellites in GEO, probably performing satellite characterization activities. Satellites can perform multiple roles, however, and satellites that appear to conduct espionage could also carry orbital weapons.

In past years, this report has documented unfriendly behaviors of several satellites in Russia's Cosmos series that might indicate development of orbital ASAT projectile weapons. In 2017, Cosmos 2521 released a subsatellite, Cosmos 2523, at a high velocity, possibly testing an orbital projectile weapon.[127] Launched in 2019, Cosmos 2542 potentially performed similar projectile weapons testing, launching an object with a relative velocity of between 140 and 186 meters per second.[128] In addition to the presumed weapons

test, Cosmos 2542 also released a satellite, Cosmos 2543, in 2019.[129] Both Cosmos 2543 and Cosmos 2558, launched in 2022, have a history of shadowing U.S. satellites.[130]

This and other assessments have also chronicled the behaviors of China's SJ-17 and SJ-21 satellites, which have both conducted frequent unusual maneuvers in GEO.[131] Specifically, SJ-21 demonstrated the ability to grapple and move a defunct Chinese satellite from GEO to a graveyard orbit, potentially testing techniques and technologies for a grappler ASAT weapon.

All of these unfriendly behaviors in space have become commonplace. Both Russia and China routinely maneuver their satellites near Western government and commercial satellites, sometimes remaining close by for months at a time. Since the United States, Russia, and China do not usually share details about the capabilities of sensitive government satellites, most public assessments rely primarily on satellite position information derived from SSA data sources, which is not enough to conduct a full threat assessment. Information about satellite capabilities and observations about behaviors should be assessed together with other data, such as the timing of suspicious maneuvers.

The authors of this report, therefore, have an incomplete picture, but several trends are clear and should be summarized. China and Russia are both operating satellites that attempt to better understand high-value U.S. government satellites. Russia is operating at least two satellites Russia is operating at least two satellites in GEO that probably have an espionage mission but may also perform other functions. Several Russian satellites over the last 10 years have probably tested orbital projectile weapons for use in LEO. China has tested technologies and procedures for using grappler satellites in GEO. These developments are concerning and will likely continue in the coming years.

Figure 2: Cosmos 2558

HEO ROBOTICS: REPRINTED WITH PERMISSION

Table 3

LUCH/OLYMP AND LUCH/OLYMP 2 ACTIVITIES

Luch/Olymp and Luch/Olymp 2 close approaches with each satellite approached represented by a three letter national abbreviation of the satellite's country of origin.

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
						UAE			
				USA	USA	USA			
				LUX	USA	NOR			
			PAK	IND	USA	NOR	USA		
	USA		USA	IND	USA	NOR	USA	USA	
	USA		CHN	FRA	USA	FRA	UAE	USA	**FRA**
	UAE		FRA	FRA	USA	FRA	AZE	USA	**MUS**
UAE	GBR	CHN	FRA	NIG	USA	FRA	LUX	USA	**USA**
GBR	GBR	USA	FRA	TUR	LUX	FRA	GBR	USA	USA
FRA	FRA	FRA	FRA	TUR	FRA	FRA	FRA	GBR	GBR

NOTE: THREE CLOSE APPROACHES IN 2023 NOTED IN BOLD ARE LUCH/OLYMP 2 WHILE THE OTHER NOTED HERE ARE LUCH/OLYMP.

SOURCE: SLINGSHOT AEROSPACE, HTTPS://WWW.SLINGSHOTAEROSPACE.COM/.

JAMMING AND SPOOFING

Efforts to interfere with GNSS around the world have become ubiquitous, with many regions experiencing the effects of GNSS jamming and spoofing. GNSS interference has proliferated, particularly due to the ease with which GNSS jammers, albeit small ones, can be purchased on the internet.[132] Interference with GNSS signals has been regularly observed across the South China Sea; in the Middle East, including in Iraq, Syria, and Armenia; and across the Eastern Mediterranean, in Lebanon, Cyprus, Turkey, and Israel. Countries in Europe, including Finland, Latvia, Lithuania, Poland, and Romania, also experience occasional GNSS interference.[133]

Jamming and spoofing activities seek to deny GNSS access within a certain area on Earth rather than aiming to disable a whole constellation or any space-based component of the system. However, these jamming and spoofing efforts can put at risk public safety, causing collateral damage and impacting civilian and commercial activities in the vicinity of conflict zones.[134] Once such example from September 2023 involved a private aircraft crew reporting that they almost strayed into Iranian airspace—where Iranian units have reportedly issued threats to shoot down aircraft without a clearance—due to GPS spoofing.[135] The activities violate international spectrum rules, as the UN International Telecommunications Union specifically prohibits any transmission of false or misleading signals.[136]

Other than condemnation and harsh words, there have been no retaliatory responses by the United States or any other nation to GNSS jamming or spoofing to date. As evidence that jamming and spoofing is becoming a normal part of military operations, Israel even publicly acknowledged its efforts to interfere with GNSS at the start of its campaign in Gaza.[137] That the United States itself has been accused of causing interference to the reception of GPS signals might complicate the U.S. response calculus.[138] Further complicating U.S. decisionmaking on how to respond to GNSS jamming is the fact that most observed instances of jamming and spoofing occur outside of U.S. territory and target non-U.S. users of space.

INDIA

India continues to expand its space activities, taking a historic leap forward this past year by landing its Chandrayaan-3 robotic vehicle on the Moon's surface in August 2023.[139] While significantly behind the United States and China in the number of rockets launched in 2023, India had more launches than Europe and Japan combined.[140] Over the next few years, India plans to become the fourth nation capable of sending astronauts into space. India is also strengthening its international space cooperation, signing the U.S.-led Artemis Accords in June 2023 and partnering with Japan on another lunar mission.[141] India is also placing greater emphasis on using its growing space capabilities for military purposes.[142]

SPACE POLICY, DOCTRINE, AND ORGANIZATION

Although India has never articulated a formal military space doctrine, the Indian military has begun to emphasize space power for Indian national security.[143] In 2017, the Indian military service chiefs released an updated joint doctrine for the Indian Armed Forces, which noted that the "emergence of space power is analogous to conventional land, sea, or air power that will mark it out as a 'Revolution in Military Affairs'."[144] According to India's most senior military officer, India needs to develop more indigenous ISR satellites with optical and hyperspectral sensors, its own global positioning, navigation, and timing constellation, and new counterspace capabilities, which would be used for deterrence and to protect Indian space systems.[145] To meet these goals, India has plans to launch and operate over 100 military satellites in the next seven to eight years.[146]

Currently, India's military space activities are managed within the Ministry of Defence by the Defence Space Agency (DSA) and Defence Space Research Agency (DSRO).[147] As a collaboration between India's air force, army, and navy, the DSA operates India's space warfare and satellite intelligence assets.[148] As India's military space R&D organization, the DSRO produces space warfare systems and related technologies, including electronic warfare, missiles, and radars, among others.[149] The DSRO developed the interceptor used for India's DA ASAT demonstration in 2019.[150] The Indian Air Force, currently being renamed the Indian Air and Space Force, also plays a significant role in India's military space activities.[151]

Internationally, India expanded its space partnerships through new bilateral and multilateral agreements, public statements, and working groups.[152] On the civil space front, India signed the Artemis Accords in June 2023, affirming New Delhi's commitment to a set of principles for cooperation in civil space exploration.[153] On the military front, the United States reportedly shared satellite imagery of Chinese troops along the contested India-China border in 2022, potentially signaling interest in increasing intelligence ties with India, including in space, probably as a counterbalance to China.[154] In January 2024, India signed an agreement with France to jointly develop and launch military satellites.[155]

India's Department of Space (DoS) administers all civilian space activities in the country.[156] The most significant organization in the DoS is the Indian Space Research Organization (ISRO), which is focused on space exploration and space technology development.[157] Several other smaller space-focused government organizations fall under the DoS, including the Indian National Space Promotion and Authorization Centre (IN-SPACe) and NewSpace India Limited (NSIL), both of which foster the growth of the nation's private space sector.[158]

Last year, India released Indian Space Policy 2023, the nation's first official space policy, which outlines the peaceful, prosperous, and sustainable use of space by government and non-government entities.[159] It complements India's ongoing Mission DefSpace initiative that challenges private companies to produce space and other defense equipment domestically.[160] In November 2023, Prime Minister Narendra Modi also unveiled Space Vision 2047, outlining India's long-term goals for space, including launching humans into space, establishing a space station, and building a lunar base.[161]

SPACE CAPABILITIES

India launched its first satellite on a domestically produced rocket in 1980. Although India only conducted about one space launch per year for most of the last two decades, it has recently ramped up its launches, with five launches in 2022 and seven launches in 2023.[162] Currently, the Small Satellite Launch Vehicle, Polar Satellite Launch Vehicle, and Geosynchronous Satellite Launch Vehicle (GSLV) are India's primary SLVs. The GSLV has two configurations, the Mark-II and Mark-III, the latter of which is also referred to as Launch Vehicle Mark-3 (LVM3).[163] In addition to launching Indian payloads, these rockets serve international customers such as OneWeb, which launched its satellites on the LVM3 in 2023.[164] In April 2023, India conducted tests of a reusable spaceplane, dropping the spacecraft from a helicopter and then successfully landing it autonomously.[165]

INDIA HAS PLANS TO LAUNCH AND OPERATE OVER 100 MILITARY SATELLITES IN THE NEXT SEVEN TO EIGHT YEARS.

In 2023, India spent about $1.5 billion on its civil space efforts.[166] According to Indian officials, the Chandrayaan-3 mission cost only $75 million, a remarkably low amount for a successful space mission to another celestial body.[167] In September 2023, India launched Aditya-L1, a spacecraft designed to study the Sun from the L1 Lagrange point. India is planning to send Indian astronauts to space in 2025.[168] Currently, India has about 60 active satellites performing communications, remote-sensing, and positioning, timing, and navigation functions.[169] Three of those satellites are dedicated to providing military communications.[170] In April 2024, SpaceX plans to launch a new Indian SAR satellite with 0.5-meter resolution, which will reportedly be used to monitor the Indian-Chinese border.[171]

Although India continues to expand its space activities, it has not yet made a significant impact on the global space market, accounting for less than one percent of the international launch services market.[172] To increase its share of the global space econ-

Modi congratulating ISRO for India's successful lunar landing.

PHOTO BY PUNIT PARANJPE/GETTY IMAGES

omy, boost the domestic technology and industrial sectors, and improve its international standing, India continues to encourage developments in the commercial industry that could enable new future space security capabilities. India has also encouraged the development of domestic space start-ups.[173]

COUNTERSPACE ASSESSMENT

Increasingly focused on the military uses of space, India tested a DA ASAT missile in March 2019, destroying a defunct Indian satellite in LEO and becoming only the fourth country to successfully demonstrate this capability.[174] Prime Minister Modi said the test was, "not against anyone," although a retired Indian air marshal claimed it was intended "to send a message to the rest of the world, particularly to China, because they did it in 2007."[175] In April 2019, the head of the DSRO stated that India is developing directed energy, laser, EMP, and orbital weapons.[176] Since then, there have been no public announcements or indications of India's progress to develop these capabilities.

IRAN

Despite long-standing international concern that Iran's space developments serve to advance its missile technology, Iran continued to advance its space capabilities and demonstrated notable space milestones over the last year. Although Tehran saw previous setbacks with its Simorgh SLV, it most recently conducted two successful space launches in January 2024—one via a Simorgh SLV and another with a Qaem 100 rocket—that placed four separate satellites into orbit.[177] In September 2023, Iran launched its third military satellite, Noor-3, which is believed to perform Earth remote sensing, like its two predecessor Noor satellites.[178] Iran also launched a biocapsule in December 2023 that may be part of Tehran's ambitions for a domestic human spaceflight capability.[179]

SPACE POLICY, DOCTRINE, AND ORGANIZATION

Since taking office in 2021, Iranian president Ebrahim Raisi has prioritized strengthening the country's nuclear, missile, and space programs. Raisi has recognized space as a "power-creating" industry, with Iran aiming to achieve "first place in the region" for its space capabilities.[180] Iranian officials have alluded to a "space club" of technologically capable nations, which Iran aims to join.[181] In addition, advancements related to Iran's space program also advance Iran's policy goals around missile development, as SLVs and ICBMs use similar technologies.[182]

In 2023, Iran outlined space goals in a 10-year strategic plan created by the Supreme Space Council.[183] In response to the 10-year plan, Raisi underscored the importance of investing in domestic space capabilities, including space launch, and completing the goal of placing an Iranian communications satellite in GEO.[184] Another goal is the development and launch of at least eight new satellites, plus a telecommunication constellation of 10 small satellites named the General Soleimani Satellite System.[185] Furthermore, Iran aims to send a human into space in the next five years.[186]

Due to Russia's procurement of Iranian missiles and drones for use in Ukraine and sanctions that have disrupted Russian space launch sales to the West, Iran is now one of Russia's few remaining space customers and has used that to its advantage in negotiations with Moscow. In 2022, Russia built and launched Iran's Khayyam Earth observation satellite.[187] In October 2023, Iran announced plans to seek additional aid from Russia on a new Khayyam-2 satellite. It also plans to discuss developing with Russia a remote-sensing satellite, a small GEO satellite, and a telecommunications satellite.[188] Furthermore, in September 2023, universities in Iran and Russia agreed to jointly develop a research spacecraft in the next two years.[189]

Although viewed skeptically by the United States and other nations, Iran claims that its civilian space activities, led by the Iranian Space Agency (ISA) and Iranian Space Research Center (ISRC), are dedicated to peaceful purposes.[190] The Supreme Space Council, chaired by the Iranian president, develops the policies of the ISA and ISRC.[191] While the ISA is organized under Iran's Ministry of Information and Communications Technology, its activities are influenced by the Ministry of Defense and Armed Forces Logistics (MODAFL).[192] Specifically, the ISA has worked closely with MODAFL-affiliated organizations on Iran's liquid-fueled ballistic missile program.[193] The Islamic Revolutionary Guard Corps (IRGC) Aerospace Force also conducts space launches.[194]

Over the last several years, the IRGC has become more active in space and expanded its efforts at the Shahroud missile test site, one of two main Iranian spaceports, including in the construction and launching of the Noor satellites.[195]

IRAN IS NOW ONE OF RUSSIA'S FEW REMAINING SPACE CUSTOMERS AND HAS USED THAT TO ITS ADVANTAGE IN NEGOTIATIONS WITH MOSCOW.

SPACE CAPABILITIES

Iran's recent launches of IRGC satellites demonstrate its intent to advance its space program for military purposes. After two failed launch attempts in 2019, Iran launched its first satellite, Noor-1, in 2020, followed by Noor-2 in 2022.[196] Noor-1 decayed from orbit in 2022, but Noor-2 remains operational. In September 2023, the IRGC placed its third military satellite, Noor-3, into orbit.[197] All three Noor satellites reportedly perform Earth remote-sensing missions. The Noor-3, launched on a three-stage Qased rocket, is alleged to have 2.5 times better image accuracy than its predecessor, Noor-2, although its actual imaging capabilities are unknown.[198]

In early January 2024, the IRGC launched the domestically made Soraya satellite on the Qaem 100 rocket, a three-stage solid-fuel launch vehicle. Soraya was placed in a 750 km orbit, Iran's highest orbit yet, and is reportedly for scientific and defense research.[199] Iran's telecommunications minister stated that the launch affirms Iran's rights in space.[200] Weeks later, Iran launched a Simorgh rocket that placed three separate satellites into orbit, marking the first time Iran has deployed multiple satellites from one launch.[201] Furthermore, as part of its plan to send a human into space in the next five years, Iran launched a biocapsule in December 2023.[202]

Iran continues work on space systems that have yet to launch but are in different stages of production or delivery. In September 2023, the ISA received the Tolou-3 remote-sensing satellite from a subsidiary of MODAFL.[203] Iran claims that the satellite will focus on agriculture, disaster management, and water resource management. In February 2024, Russia launched Iran's remote-sensing satellite, Pars-1.[204] Pars-2 and Pars-3, also remote-sensing satellites, are reportedly in development.[205]

In addition to maturing its ability to manufacture satellites, Iran continues to develop and build SLVs, with four current vehicles, all optimized for LEO.[206] In December 2023, Iran said that it was working on a new rocket, Sarir, that would be able to place satellites into GEO.[207] In addition to the Imam Khomeini spaceport near Semnan and the Shahroud

missile test site, Iran is now building the non-military Chabahar space center, a new launch site that Iran intends to open in 2025.[208]

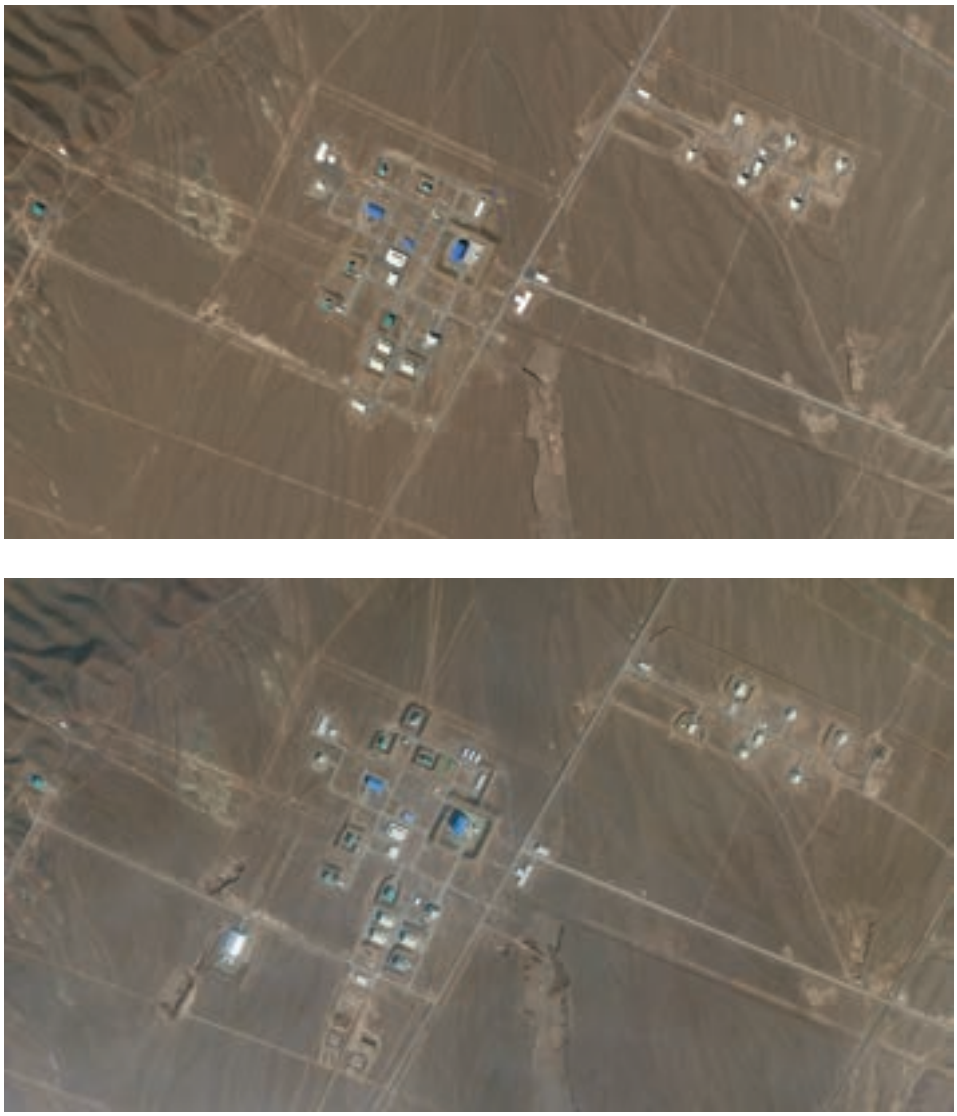
COUNTERSPACE ASSESSMENT

In October 2023, the Iranian minister of defense declared that, amid the tensions in the Middle East, Iran must support national defense beyond its borders by harnessing space and cyberspace capabilities.[209] Iran has continued its use of cyberattacks, which have grown increasingly sophisticated and aggressive in recent years, with attempted hacks into the foreign defense, civil society, and private systems of adversaries.[210] In September 2023, cyber threat actors linked to Iran targeted defense, satellite, and pharmaceutical companies in the United States and around the world to gather intelligence and trade secrets.[211] Iran's cyber efforts are a relatively low-barrier method for the nation to retaliate even when its capabilities in other domains may not compare. Furthermore, even if cyberattacks do not directly target space assets, access to them can be impacted by attacks on terrestrial infrastructure.[212]

In addition to its cyber capabilities, Iran can use jamming and spoofing to deny its adversaries the use of space capabilities, which some consider possible amid rising tensions with Iranian proxy groups in Iraq and Yemen.[213] Already, Iran has demonstrated its ability and willingness to jam satellite communications, interrupting the reception of foreign satellite-based television and audio channels.[214] Beginning in 2023, Iran also operates the Cobra V8 electronic warfare system, believed to be based on the Russian Krasukha-4, which its manufacturer has claimed can hide objects on the ground and in the air from space-based SAR systems.[215]

Iran has claimed that its GNSS spoofing capabilities led to the downing of a U.S. drone in 2011.[216] Separately, over a two-week period in September 2023, over 20 commercial and private aircraft reportedly strayed off course when flying near Iran as a result of GNSS signal spoofing.[217] By November 2023, more than 50 such incidents had occurred, mostly near Baghdad, Cairo, and Tel Aviv.[218] Some experts tracked the source of the spoofing to an area east of Tehran, although Israel has also been identified as a source of spoofing in the Middle East since the Hamas attacks in October 2023.[219]

There is no open-source indication that Iran possesses DA ASAT or orbital counterspace weapons.



Shahroud missile test showing site expansion from 2020 (top) to 2024 (bottom).

PLANET: REPRINTED WITH PERMISSION

NORTH KOREA

Since its first attempt to launch a satellite in 1998, North Korea has made eight more launch attempts, successfully put three satellites into orbit, and renamed or reorganized its space agency three times. Last year saw its first successful space launch since 2016, with the launch of the Malligyong-1 military reconnaissance satellite, which was discussed in last year's report. Pyongyang also completed significant upgrades to the Sohae satellite launching station. Additionally, North Korea strengthened its cooperation with Russia in various areas, including space technology.

SPACE POLICY, DOCTRINE, AND ORGANIZATION

North Korea's Law on Space Development, enacted in 2013 and revised in 2022, provides the legal foundation for the nation's space activities and explains how North Korean space development adheres to the principles of *Juche*, the state ideology.[220] It further declares the aim to use space for peaceful purposes and calls for international cooperation on space projects.[221] Additionally, the Workers' Party of Korea Congress adopted a five year plan in 2021 focused on advancing civil and military space, setting a goal to launch the nation's first spy satellites, produce solid-fuel ICBMs, and develop hypersonic and multi-warhead missiles.[222]

The National Aerospace Technology Agency (NATA) oversees North Korea's space activities, including developing and operating SLVs and satellites. NATA was established by the 2013 Law on Space Development and then reorganized in 2023.[223] A high-ranking North Korean source claimed that NATA's reorganization was mainly to facilitate ongoing technological cooperation with Russia.[224]

North Korean and Russian ties related to space technologies may also be increasing. Since the imposition of sanctions on Russia following its invasion of Ukraine, experts believe that Russia has provided missile technology and components, food and fuel shipments, and spare parts for its Soviet-era military equipment to North Korea.[225] In exchange, Russia has received North Korean-manufactured munitions.[226]

SPACE CAPABILITIES

In November 2023, North Korea successfully launched a military surveillance satellite, the Malligyong-1, into orbit on the solid-fueled Chŏllima-1, the first successful launch of this rocket.[227] While North Korea's satellite reconnaissance capabilities are rudimentary compared to those of China and the United States, the successful launch is a political and symbolic achievement.[228]

North Korea also tested a solid-fuel ICBM in 2023, which could be used for space launch.[229] Solid-fuel propellant is more portable and energy-dense than liquid fuel, potentially providing North Korea the ability to build rockets that can launch heavier satellites or place satellites in higher orbits. In December 2023, state media reported on 2024 plans to launch three more reconnaissance satellites.[230]

In May 2023, satellite imagery revealed that North Korea is working on significant upgrades to the Sohae satellite launching station that include additional on-site storage, easier transportation around Sohae, and expanded port access and support for large SLVs.[231]

COUNTERSPACE ASSESSMENT

During the last year, there were no indications in open-source reporting of advances in North Korean counterspace capabilities. To date, North Korea has not demonstrated or announced plans to develop DA ASAT or orbital counterspace capabilities.[232] The nation remains skilled in electronic warfare and cyberattacks, including a March 2023 cyber operation targeting a Russian aerospace research institute and another in April 2023 targeting defense industry firms in Eastern Europe and Africa.[233] Additionally, North Korea's cyber operations are used to gather information on aerospace technologies and commit financial crimes that provide revenue for the country's missile development programs.[234] In March 2024, North Korea attempted to jam GPS signals during South Korean military exercises, the first reported use of GPS jamming by North Korea in eight years.[235]

IN NOVEMBER, NORTH KOREA SUCCESSFULLY LAUNCHED A MILITARY SURVEILLANCE SATELLITE . . . [WHICH] IS A POLITICAL AND SYMBOLIC ACHIEVEMENT.

OTHER COUNTRIES

AUSTRALIA

Australia continues to become more forward leaning in its space policy and partnerships. In December 2023, Australia, the United States, and the United Kingdom announced the Deep Space Advanced Radar Capability (DARC), a joint space domain awareness program to provide advanced monitoring of satellites in GEO.[236] This announcement was accelerated by AUKUS—the trilateral security partnership between Australia, the United Kingdom, and the United States—and is complemented by an October 2023 Technology Safeguard Agreement between Australia and the United States that allows U.S. commercial SLVs to launch from and land in Australia.[237]

In March 2024, Australia's largest commercial satellite was launched on a Falcon 9 rocket. This orbiting service vehicle will demonstrate a capability to provide life extension services to satellites already on orbit and will be able to physically move other satellites.[238]

FRANCE

France continues to be a major player in space, although the country only had three launches in 2023 (down from five in 2022). The Ariane 5's last flight occurred on July 5, 2023, creating a gap in European heavy-lift capability until the planned first launch of the Ariane 6 in mid-2024.[239] France launched one defense payload in 2023, a military communications satellite.[240]

Of the Western nations, France is perhaps the most vocal in stating its plans for counterspace weapons development and fielding. In April 2023, the Ministry of the Armed Forces of France released its 2024–2030 Military Programming Law, which includes plans for orbital counterspace capabilities.[241] These include a project for "lasers in orbit" called FLAMHE and a ground-based laser counterspace system called BLOOMLASE, both of which aim to be operational by the end of the decade.[242]

An article published by the ministry in October 2023 mentions plans for a GEO-based active defense constellation.[243] YODA, a demonstrator satellite for the constellation, is planned to be launched in 2025.[244]

ISRAEL

Israel continues to expand its national security space capabilities and its space exploration program. In March 2023, Israel launched a new SAR satellite on its Shavit-2 rocket, joining a family of on-orbit reconnaissance satellites.[245] On the civil side, it announced in February 2023 that NASA, working with the Israel Space Agency, will launch Israel's first space telescope mission, the Ultraviolet Transient Astronomy Satellite (ULTRASAT), to investigate short-duration phenomena in the universe, such as supernova explosions.[246]

With Israel at war against Hamas, it has deployed electronic warfare capabilities that have interfered with satellite services. In mid-October 2023, as it began military operations in Gaza, Israel said it was restricting GPS use in active combat areas and warned the public to expect glitches in location-based applications that use GPS.[247] Israel also acknowledged the use of GPS spoofing, observed to originate in northern Israel, stating that it was a required defensive measure, likely to confuse guided missiles, drones, and rockets used by Hezbollah.[248] These efforts to disrupt and confuse GPS signals have also impacted civilian aircraft, with multiple instances of GPS interference reported by pilots in the area.[249] The readiness of Israel to interfere with and disrupt the reception of GPS signals, even its willingness to officially acknowledge that interference, reinforces this report's observations that GPS jamming and spoofing risk becoming commonplace counterspace activities.

Although there is no information that the system will or could target satellites, Israel's Iron Beam is a short-range directed energy air defense system that could possibly be employed against satellites in the future. While it was not expected to enter operational use for several years, Israel announced in October 2023 that it would be deployed soon to enhance Israel's defenses during the ongoing conflict with Hamas.[250]

Also of note was Israel's November 2023 use of its Arrow missile defense system to intercept a medium-range ballistic missile (MRBM) fired by Houthi rebels from Yemen.[251] While the intercept was reported at an altitude of about 100 km, MRBMs can reach an altitude of over 300 km at their peak, solidly within very low Earth orbit (VLEO), making the Israeli Arrow system and similar missile defense systems capable of being DA ASAT weapons.[252]

JAPAN

Japan has maintained momentum after its 2022 release of three strategic defense documents that all integrated space. In June 2023, Japan released a Space Security Initiative, serving as the country's first space security policy. The initiative will be based on three basic policies: expanding the use of space for national security, ensuring the safe and sustainable use of space, and creating a positive cycle of space security and space industrial development.[253] In November 2023, Tokyo announced that the Japan Aerospace Exploration Agency (JAXA) would be allocated ¥1 trillion ($6.7 billion) over a 10-year period to support the nation's commercial sector and technology development in the space industry.[254]

Japan and the United States have also maintained momentum in their space relationship. In January 2023, the two nations signed an agreement to collaborate on space science, space exploration, technology, and mission assurance and safety. Notably, the January 2023 U.S.-Japan Security Consultative Committee meeting between Japanese and U.S. foreign and defense ministers led to the joint statement that "attacks to, from, or within space . . . in certain circumstances, could lead to the invocation of Article V of the Japan-U.S. Security Treaty," which commits that the United States would defend Japan if any of its territory was attacked by a third party.[255] In March 2023, the two nations held the eighth U.S.-Japan Comprehensive Dialogue on Space, during which policymakers from both countries discussed national security as well as commercial and civil space cooperation.[256]

SOUTH KOREA

South Korea continues to place increasing emphasis on space and space technology, seen through myriad strategy, program, budget, and organizational initiatives. At the end of 2022, South Korea's defense ministry announced a new military space strategy to build and organize space capabilities.[257] In December 2022, the Ministry of Science and Information and Communication Technology released the 4th Space Development Promotion Basic Plan, which outlines the nation's military, civil, and commercial space goals for the next five years. These include new launch vehicles, manned space vehicles, on-orbit services, and early warning satellites.[258] South Korea's new space budget follows this plan, allocating ₩874 billion ($674 million) for space across all offices and programs, a 20 percent increase from the previous year.[259] The largest portion of the budget is earmarked for developing a sovereign GNSS, the Korean Positioning System (KPS), a priority in the space development plan. The KSLV-3 rocket and space defense are the second- and third-largest categories of spending, respectively.[260]

Noteworthy achievements in 2023 include the successful first launch of South Korea's KSLV-2 (Nuri) rocket in May 2023 and the launch of South Korea's first spy satellite from the U.S. Vandenberg Space Force Base in November 2023.[261] In January 2024, Minister of Science Lee Jong-ho announced that South Korea's space agency, the Korea AeroSpace Administration (KASA), would be launched in May and would lead aerospace research and space missions, such as Moon and Mars exploration projects.[262] KASA will also facilitate the domestic aerospace industry, including "plans to foster more than 2,000 space-related companies and create about 500,000 new jobs."[263] This is in addition to the already established Korean Aerospace Research Institute (KARI), which will focus on technology R&D in support of KASA, which will now lead "space industry and space security."[264]

South Korea is also expanding its partnerships in space with the United States. In 2023, the two countries held their first space policy consultative group meeting, the first Technical Working Group meeting on GPS-KPS cooperation, the second U.S.-South Korea space cooperation tabletop exercise, a U.S.-Japan-South Korea trilateral summit on space security cooperation, the 21st U.S.-South Korea space cooperation working group, and the South Korea-U.S. space forum. They also signed a joint statement on cooperation in space exploration and space science.[265]

UNITED KINGDOM

The United Kingdom established its Space Command as well as its first National Space Strategy in 2021.[266] In 2023, the United Kingdom released two space plans: the National Space Strategy in Action and the Science and Technology Framework. These set the framework for a March 2024 document, the Space Industrial Plan. Together, the three plans outline UK space strategy until 2030 and a roadmap for delivering 22 national space capability goals by the end of the decade.[267] UK Space Command confirmed that its ongoing priorities were operationalizing its activities, including the Ministry of Defence's SKYNET military communication satellite program.[268] The United Kingdom is also focused on international cooperation and joined the United States and Australia for the DARC network of space-tracking radars.[269] In 2023, the UK government announced that it would fund £10 billion ($12.7 billion) over the next decade to meet the goals outlined in the National Space Strategy.[270]

NON-STATE ACTORS

This year continued a pattern of non-state actor activity associated with large-scale conflicts, including Russia's war on Ukraine and Iran-backed groups in the Middle East. GhostSec, an Anonymous-affiliated cyber hacktivist group, targeted GNSS receivers related to Russian and Israeli infrastructure.[271] In June 2023, hackers claiming affiliation with the Wagner Group reported disrupting Russian satellite communications networks, resulting in internet provider Dozor-Teleport, which supplies Russia's military and Federal Security Service, showing drops in connectivity later that same month.[272]

Regional indiscriminate jamming has become the new normal in conflicts. Jamming devices, which are fairly cheap and effective, have become a popular tool for state and non-state actors alike. Hamas reportedly used jamming to support its October 7 attack on Israel.[273] In the months prior, commercial airliners and business jets near Syria, Lebanon, and the Gaza strip reported spoofing attacks, which experts suspect were aimed at "denial of service rather than actual deception" and were unable to be attributed.[274] Notably, interference spiked during periods of heightened conflict involving drone attacks and rocket launches.[275]

FEATURED ANALYSIS:

COALITIONS OF CONVENIENCE

Since the beginning of the space age, activities in space have reflected—and shaped—larger geopolitical dynamics. For reasons specific to each country, China, Russia, Iran, and North Korea face heightened tensions with the United States and its allies in Europe and Asia. As a result, these four nations, each to a greater or lesser degree, are becoming more isolated from Western supply chains, technologies, and scientific communities. Each nation also has ambitions in space. Although each country may not entirely trust the intentions of the other, each country has sought some type of coalition of convenience on space cooperation to fulfill their national ambitions. The one exception to this trend may be Chinese cooperation with Iran and North Korea on space. Based on open-source information, this report's authors could not find indications of space cooperation between these three countries.

RUSSIAN AND CHINESE SPACE COLLABORATION

Russia's 2014 annexation of Crimea led to a precipitous decline in U.S.-Russian space cooperation, a decline that accelerated following Russia's 2022 invasion of Ukraine, creating an opportunity for increased partnerships between Russia and China on space issues.[276] While China may be an attractive trading partner for Russia to counter the impacts of Western sanctions, it is unclear whether space technology transfer between the two countries has increased, even though Russia and China have announced several partnerships on space technologies and capabilities over the last few years. Both Russia and China remain suspicious of each other, with Russia accusing China of conducting espionage cyber campaigns on its telecommunications and government services in November 2023.[277]

In 2017 and 2019, Moscow and Beijing signed agreements related to space and missile defense technology transfer, leading to joint efforts to facilitate compatibility between GLONASS and BeiDou, the two countries' respective GNSS systems.[278] In 2022, the two countries agreed to further develop joint GNSS capabilities, agreeing to place GLONASS ground stations in six Chinese cities and BeiDou ground stations in six Russian cities.[279] Furthermore, Russia has reportedly aided China in developing a space-based missile warning system.[280]

More recently, Chinese firms provided Russia's Wagner Group with satellite imagery of Ukraine in 2023, causing the United States to place sanctions on those firms and serving as a clear example of Chinese support to Russia's military activities in Ukraine.[281] Also in 2023, Russian president Vladimir Putin called for expanding cooperation on military satellites and high-orbit assets to "ensure strategic security of both Russia and the People's Republic of China."[282] In November 2023, Russia and China agreed to a four-year plan for jointly building and developing the International Lunar Research Station (ILRS) and exploring the Moon's surface.[283] The head of Roscosmos announced in March 2024 that China and Russia are exploring the possibility of constructing a nuclear power station on the Moon to support future lunar settlements.[284]

Additionally, Russia and China use their space programs and partnership to recruit diplomatic allies.[285] Together, Beijing and Moscow collaborate on space issues with a number of countries, including Argentina, Brazil, Egypt, Ethiopia, India, Iran, Saudi Arabia, South Africa, and the UAE. In 2023, six more countries joined China and Russia as part of the ILRS coalition: Azerbaijan, Belarus, Egypt, Pakistan, South Africa, and Venezuela.[286]

Additionally, China and Russia partner in the United Nations on space issues, for example, pursuing a treaty, first introduced in 2008, on the non-weaponization of space. At odds with their development of counterspace capabilities, advocacy for this initiative likely reflects diplomatic maneuvers to blame the United States, as it has opposed this treaty. On the other hand, China and Russia have joined forces to oppose efforts of the UN Open Ended Working Group (OEWG) to develop a set of recommendations on responsible behaviors and norms in space.[287]

For now, Beijing and Moscow appear to use their global space partnerships, including with one another, for political posturing against the United States. Their relationship is built on mutual suspicion, with neither side interested in being eclipsed by the other in space. While pursuing a friendship with "no limits," both China and Russia appear to accept transactional relationships, capitalizing on the other's weaknesses.

RUSSIAN COLLABORATION WITH IRAN AND NORTH KOREA

Western sanctions and broken cooperation agreements have limited Russia's ability to find customers for its space services and technology and have impacted its ability to acquire Western-produced components historically used in the domestic production of advanced space systems, particularly communication satellites. Since its 2022 invasion of Ukraine, Russia has sought customers for its space technology and knowledge, while at the same time seeking strategic partnerships and weapons for its war. Iran and North Korea are offering Russia all of these, with their bilateral partnerships growing stronger over the past year. In return, Iran and North Korea receive Russian aid for their space programs. Ultimately, the development of events on Earth, especially the war in Ukraine, will determine the future pace of these countries' space cooperation.

WHILE PURSUING A FRIENDSHIP WITH "NO LIMITS," BOTH CHINA AND RUSSIA APPEAR TO ACCEPT TRANSACTIONAL RELATIONSHIPS, CAPITALIZING ON THE OTHER'S WEAKNESSES.

Iran

As Iran has worked to develop a space program in recent years, it has turned to Russia for support on space launch and satellite systems. In return, Russia has obtained drones from Iran for use in Ukraine.[288] Russia launched Iran's Khayyam Earth observation satellite, which was constructed by Russian companies, on a Soyuz rocket in 2022, marking the first time

Russia built and launched a satellite for Iran.[289] In October 2023, Iran announced plans to seek additional aid from Russia on a new Khayyam-2 satellite.[290] Reportedly, Iran also plans to discuss developing a remote-sensing satellite, a small GEO satellite, and a telecommunications satellite with Russia.[291] Furthermore, in September 2023, universities in Iran and Russia agreed to jointly develop a research spacecraft in the next two years.[292] In February 2024, Russia launched Iran's Pars-1 remote-sensing satellite.[293]

In return for Iran's continued supply of weapons to Russia for its war in Ukraine, Western analysts worry that Russian space launch technology and components will be transferred to Tehran for its ballistic missile programs under the cover of space cooperation. As of January 2024, Iran is in talks with Russia and China to procure solid rocket fuel that is used for its SLVs and ballistic missiles. If the agreement goes through, Iran may also use the fuel to supply more weapons to Russia for use in Ukraine. Some analysts believe that providing Iran with fuel is a way for China to subtly support Russia without provoking the West.[294]

Like the Sino-Russian partnership, Iran's space partnerships follow two motives: strategic cooperation and commercial transactions. Iran and Russia have likely bonded over their mutual need to cope with sanctions and a shared opposition to Western dominance and have announced their partnership in several public statements.[295] Iran has been one of Russia's only customers for space since its invasion of Ukraine, securing Russia much-needed funding for its struggling space program.[296]

Overall, Russia and Iran have signaled their intent to continue cooperating closely on space and other technological matters, which should raise alarms among U.S. policymakers.[297] If Russia continues to drain its resources in Ukraine, it will lean even more heavily on Iran for aid, potentially offering more elaborate space capabilities in return.

Putin and Kim touring the Vostochny Cosmodrome satellite launch center in September 2023.

PHOTO BY MIKHAIL METZEL/GETTY IMAGES

North Korea

As with Iran and Russia, North Korea has struggled to circumvent Western-imposed sanctions that impact its space sector.[298] By cooperating with Russia, North Korea probably receives help with nuclear and space technologies, parts for its aging Soviet-era military equipment, and food and fuel to alleviate the country's shortages.[299] Russia, in exchange, receives artillery shells, rockets, and other munitions that help the country in its extended war against Ukraine.[300]

As background, Russian defense minister Sergei Shoigu visited North Korea in July 2023 to discuss military cooperation.[301] In September 2023, Putin and Kim Jong-un met at the Russian Vostochny Cosmodrome satellite launch center, their first meeting since 2019.[302] As the two viewed Russia's air defense technologies and military factories, Kim pledged his support for Putin's war against Ukraine, while Putin committed to helping North Korea build and launch satellites.[303]

The following month, satellite imagery captured an unprecedented number of freight railcars at the Tumangang-Khasan rail crossing between North Korea and Russia, with analysts suggesting that North Korea was supplying weapons to Russia.[304] In the same period, Russia may have used the transit route to send weapons to North Korea.[305] Both of these presumed trading episodes violate multiple UN Security Council resolutions and sanctions placed on the countries by the United States and its partners.[306]

Soon after these events, in November 2023, Russia and North Korea signed a protocol to expand cooperation in trade, science, and technology.[307] Their deepening partnership was further confirmed in January 2024 when Russia used North Korean ballistic missiles in Ukraine. What is not apparent in open-source information is the extent to which Russia is sharing technology and expertise with North Korea that would allow it to improve its own space launch and satellite manufacturing capabilities.

WHAT TO WATCH

The 2023 edition of CSIS's *Space Threat Assessment* made several prescient predictions. Over the last year, the United States energetically pursued international support through the United Nations for a destructive DA ASAT testing ban.[308] Although nations may frown on using debris-generating counterspace weapons, as predicted in last year's report, they are using other capabilities against space systems, such as cyberattacks and GNSS and SATCOM jamming. More cyber operations and efforts to disrupt space capabilities, including jamming, and spoofing are likely to be seen in the future.

Finally, as noted last year, countries continue to exhibit growing interest in space, particularly as an essential element of their national and economic security. Many countries continue to develop space surveillance capabilities that not only facilitate safe space operations but also support counterspace activities. China will likely continue to focus on space, potentially ramping up its efforts to place its own LEO broadband constellations in orbit during the next year.

Although Russia retains formidable space capabilities and may be developing a space-based nuclear ASAT weapon, Russia is on the decline, with a significantly slower launch cadence than in the past and an inability to produce space systems using the most modern technologies. India will likely continue making strides in space. France, Germany, Japan, and South Korea updated or introduced space security strategies this past year. These and other nations are likely to further increase their focus on space security over the coming years.

IMPACTS TO PUBLIC SAFETY FROM GNSS INTERFERENCE

As this report has noted, interference with space-based services, such as satellite communications and GNSS signals, has become ubiquitous and will likely pose an increasing risk to public safety going forward. Reports of GNSS spoofing attributed to countries and non-state actors around the world have significantly increased over the past year. For example, spoofing of GPS signals in 2023 was reported in Eastern Europe, Scandinavia, Russia, Gaza and southern Israel, Iran, Turkey, China, and Pakistan, with GNSS jamming reported in Ukraine, over the Baltics, in the South China Sea, Philippine Sea, eastern Indian Ocean, northwest of Australia, and near South Korea.

Many of these reports come from commercial airline pilots and crews of maritime shipping vessels who rely on GNSS positioning data to transport their passengers and cargo to and from their destinations around the globe.[309] Efforts to interfere with the reception of GNSS signals, particularly spoofing, which might convince an airline pilot or ship captain that they are somewhere they are not, are dangerous and pose a significant public safety risk. There is no reason to suspect anything but an increase in these jamming and spoofing activities in 2024.

PERVASIVENESS OF CYBER

Cyber operations will likely play an increasingly dominant role in efforts to deny the use of space, not necessarily because of a specific interest by cyber threat actors in space, but because space capabilities play an important role in global critical infrastructure, especially telecommunications. China, in particular, has ramped up malicious cyber activity aimed at U.S. critical infrastructure, with a goal of setting in place capabilities to disable or disrupt communications and transportation infrastructure in the Indo-Pacific region during any U.S.-China conflict.

With cyber operations, there is also a low bar for entry. Nations with no space capabilities or specific space infrastructure can conduct cyber operations. It is reasonable to expect the continuation of the same trend over the next year, with China continuing to target U.S. critical infrastructure and other cyber threat actors finding more reasons to target space systems and networks based on the important role space plays across a variety of functions critical to daily life.

MORE UNFRIENDLY BEHAVIORS

In addition to government satellites engaging in unfriendly behaviors in space, over the next year, commercial satellites with mission profiles that might be categorized as unfriendly will begin operations. More and more commercial satellites aimed at conducting in-space satellite imaging and satellite characterization activities, equipped with high maneuverability, will likely go into operation in the future. Does more transparency about satellite capabilities increase or decrease space security? If more transparency enhances space security, it is worth evaluating whether in-space satellite characterization activities should continue being considered unfriendly behaviors. Greater awareness of satellite capabilities, such as which satellites have grappling arms, paired with information about satellite behaviors and positioning may help operators identify possible destructive or disabling threats to their systems.

EVOLUTION OF COALITIONS OF CONVENIENCE

In the coming year, growing space engagement between Russia and Iran is likely, as both sides have something clear to gain from the partnership. Russia has gained a customer for its launch services and satellite manufacturers, as well as access to Iranian drone and missile production capabilities. Iran has gained a reliable, scalable space launch capability and can use Russian satellite manufacturers. It will be worth watching to see if Russia, rather than just selling launches and satellites, works with Iranian scientists and engineers to increase their own technical proficiencies and domestic space capabilities.

The future of Russian and North Korean space cooperation is slightly less clear and is likely dependent on what Russia thinks it will get from the relationship. It may depend on whether North Korea can continue producing and supplying Russia with munitions and weapons for use in Ukraine.

How the China-Russia space cooperation will evolve is even murkier. As noted in this report, there is little public information, beyond statements and announcements about collaborative projects, that sheds light on specific activities and technology exchanges. Due to China's progress in space, especially its increased launch cadence and deployment of dozens of remote-sensing satellites in the last year, it remains to be seen what Russia has to offer China. Russia may not have anything space-related that China cannot do on its own, meaning that China may not see a reason to deepen its space collaboration in the coming year.

IMPORTANCE OF SPACE SURVEILLANCE

Government and commercial ground- and space-based SSA systems provide space operators with timely, accurate, and precise information on the locations of objects in space to conduct safe space operations. As this report noted last year, many counterspace capabilities, such as DA ASAT and orbital systems, also require robust SSA data for tracking and targeting. Space systems designed for espionage also depend on SSA data because these systems need to know the location of their targets. As unfriendly behaviors in space increase, so will demand for more and higher-quality SSA information, especially in terms of accuracy and precision, which will likely necessitate the deployment of additional terrestrial and space-based SSA sensors. China and Russia will likely seek to continue enhancing their own space surveillance systems to maintain sovereign capabilities.

As China and Russia enhance their own tracking systems, they may try to better understand the limitations and constraints of U.S. and allied space surveillance capabilities, particularly any gaps in coverage and time. Such an understanding could help China and Russia execute activities in space during those gap periods. To mitigate this risk, the United States should consider improving its own space surveillance capabilities, with a goal to not only track smaller objects but also reduce coverage and timing gaps for LEO and GEO objects.

COMMERCIAL OPERATORS FACE EVOLVING THREATS

Over the last two years, Ukraine has served as a proving ground for many space capabilities, demonstrating the value of commercial space services in the crucible of war and testing the abilities of commercial operators to maintain service in spite of Russia electronic warfare and cyberattacks. Commercial operators have had to innovate and adapt to counter Russian counterspace efforts as well as, in one case, Russian efforts to co-opt commercial service for their own use. Starlink has shown the value of LEO broadband capabilities, so much so that Russian forces have apparently decided to use Starlink themselves in Ukraine.[310] Today and in future conflicts, this poses a twofold challenge for a commercial operator: the need to maintain service for the "good" users despite signal jamming while also identifying and denying service to the "bad" users.

Based on lessons from Ukraine, commercial remote-sensing operators should also prepare for future efforts to disrupt or interfere with their services. As noted earlier in this report, ground-based electronic warfare jammers not designed to target space systems can be used to create interference in SAR collection. Commercial SAR operators may want to plan for the future use of such systems to disrupt their services. Commercial electro-optical satellite operators should remain concerned too about systems designed to temporarily blind or disable their systems. Given growing concerns about the use of deepfake imagery, both SAR and electro-optical remote-sensing operators will also likely need to develop methods that allow customers to verify the authenticity of their data.[311]

Commercial operators, particularly ones with business models oriented around consumers, should not be expected to tackle these security and operational challenges alone. The U.S. government should consider ways to partner with space companies to better understand and develop ways to address these current challenges, which will likely increase in the future.

THE GEOPOLITICAL IMPACTS FROM COMMERCIAL SPACE

Satellite imagery has played an important role in providing near-real-time data about the situation on the ground in Israel and Gaza following the Hamas terrorist attacks in October 2023 and subsequent Israeli

Image of a Starlink terminal deployed in Ukraine.

PHOTO BY YASUYOSHI CHIBA/GETTY IMAGES

military actions.[312] Throughout the conflict, satellite imagery obtained from commercial space operators has been used to document the impacts of Israel's military operations on Gazan infrastructure, including using artificial intelligence algorithms to identify bomb craters.[313]

Satellite imagery has been used in a similar way by media outlets in Ukraine to document the human toll of the conflict. In Ukraine, beyond providing satellite imagery to hold the antagonists accountable for their actions, U.S. satellite imagery companies have provided data directly to Ukraine to assist in its defensive efforts. To illustrate the ability of U.S. space companies to contribute valuable commercial services, these companies have routinely cited their contributions in Ukraine. Companies have been less visible in provisioning satellite imagery for the Israel-Gaza conflict, with at least one U.S. company modifying its business processes, including access and safeguards, to minimize misuse of its data.[314] However, U.S. companies have offered satellite imagery for humanitarian organizations operating in Gaza.

Satellite communications companies will also make decisions with geopolitical impacts. Israel's communications minister, responsible for regulating spectrum use in Israel, strongly condemned an offer in October 2023 from Elon Musk to provide Starlink service for humanitarian work in Gaza, threatening to suspend work with Starlink.[315] Additionally, Starlink denied a request by Ukraine to turn on service in Crimea to support Ukrainian military operations, citing U.S. sanctions against Russia.[316] In 2022, in an effort to promote internet freedom, Starlink activated service in Iran, a country also facing U.S. sanctions.[317]

Looking ahead, services provided by commercial space operators will play a growing role in conflict zones. There are already concerns that Starlink is withholding service from Taiwan, although it is unclear whether that is due to the lack of regulatory approval from Taiwan's spectrum regulator or for some other reason.[318] It remains to be seen whether U.S. companies will be able to develop a consistent framework to determine to whom they sell their products, beyond adherence to U.S. sanctions. For example, would a U.S. company doing in-space refueling refuse to service an Israeli communications satellite that might be supporting Israeli military activity in Gaza? Since U.S. regulations and export controls are not designed to provide a moral compass, companies have the latitude to decide on their own with whom they want to do business, potentially wading into turbulent and uncharted geopolitical waters for space companies.

Image of Gaza from space.

PHOTO BY MAPS4MEDIA/GETTY IMAGES

CHINESE PROGRESS AND RUSSIAN DECLINE IN SPACE POWER

This year's assessment continues to chronicle China's launch and satellite technology advancements. China may look at space as a numbers game, meaning that China's goal is to exceed the United States by any metric related to space, such as more launches, more satellites, or more missions to the Moon. This approach does not ensure quality but instead emphasizes quantity and speed. In some ways, this is the same approach taken by the Soviet Union in the early days of the space race. If this analogy holds, there are lessons in store for China, namely that sacrificing quality for speed and quantity carries risk. This approach also has benefits for China, as emphasizing quantity and speed may allow it to quickly build a robust space architecture that can sustain losses and still provide service.

In any case, China has significantly increased the number of remote-sensing and surveillance satellites in orbit over the last year, posing new risks for U.S. military operations in the Indo-Pacific region. The ubiquity of Chinese space surveillance may necessitate new ways of warfighting, assuming that military forces are under constant surveillance from space. Additionally, 2024 is important to watch as the two Chinese companies planning LEO broadband constellations to rival Starlink begin putting sizable numbers of satellites into orbit.

It remains to be seen if China's economic headwinds will impact its spending on space or its ability to help finance and grow private space companies, which are viewed as incubators of innovation and new ideas, in contrast to China's state-run enterprises.

Meanwhile, there are signs, including the failure of the Russian Moon lander, that Russian space activity may be on the decline.[319] The number of Russian satellites in space has been declining for years. Since the end of the Cold War, Russia has depended on Western technology to build advanced satellites. Sanctions imposed after Russia's invasion of Ukraine have made access to those technologies much more difficult and will likely hinder Russia's ambitious space plans. Additionally, the lack of evidence that Russia

LOOKING AHEAD, SERVICES PROVIDED BY COMMERCIAL SPACE OPERATORS WILL PLAY A GROWING ROLE IN CONFLICT ZONES.

has used more technologically advanced counterspace hardware, such as laser weapons, to influence outcomes in Ukraine during the last two years may be another sign of that decline or speak to difficulties in operationalizing these technologies.

In response to Russian counterspace braggadocio, the West may have overestimated Russian counterspace weapons and capabilities—arguably, the West has a history of overestimating Russian capabilities since the time of the presumed 1960s missile gap. Alternatively, the Russians may have decided not to use counterspace capabilities beyond cyber operations and jamming for other reasons. Use of such weapons, which would almost certainly have targeted U.S. commercial space systems, could have raised serious escalation risks. Perhaps there is no way to know, particularly in open-source reporting.

Last year's assessment suggested that U.S. adversaries might shift their targeting strategies toward ASAT capabilities designed to counter proliferated satellite constellations such as Starlink and the U.S. Space Development Agency's missile warning and tracking architecture. Given its alleged efforts to develop a new space-based nuclear ASAT weapon, Russia appears to be doing just that and looking for new counterspace tools to disrupt and degrade its adversaries' proliferated space systems.

CONCLUSION

There has not been a DA ASAT test since 2021, but countries are still considering how to deny their adversaries the use of space. It also does not mean that threats to space systems are decreasing. This past year, revelations that Russia is seeking to develop a nuclear space-based ASAT capability focused more attention on space security issues. Likewise, China continues to use aggressive cyber targeting of U.S. infrastructure, including satellite networks, in order to conduct espionage and establish footholds that might help it deny the United States use of critical capabilities in the event of a conflict in the Indo-Pacific region. Such activities are a reminder of the breadth of ways that space capabilities are being threatened.

More and more nation-states and threat actors are regularly conducting GNSS jamming and spoofing as defensive measures to protect against missile and air strikes. Meanwhile, China and Russia continue to conduct operations in space that suggest either espionage or the development and testing of future orbital counterspace weapons. What can be discerned through open-source reporting is possibly only the tip of the iceberg. Many counterspace threats are likely becoming harder to overtly see and track—they are moving into the shadows, both in the cyber domain and in space systems that conceal their ability to destroy behind a facade of other purposes.

ABOUT THE AUTHORS

Clayton Swope is the deputy director of the Aerospace Security Project and a senior fellow in the International Security Program at the Center for Strategic and International Studies (CSIS). Before joining CSIS, Swope led national security and cybersecurity public policy for Amazon's Project Kuiper, an initiative to increase global broadband access through a constellation of satellites in low Earth orbit. While at Amazon, he also worked on cloud policy issues. Prior to his time at Amazon, Swope served as a senior adviser on national security, space, foreign affairs, and technology policy issues for a member of the U.S. House of Representatives. He also worked for more than 14 years at the Central Intelligence Agency, serving largely in the Directorate of Science and Technology. He holds a Bachelor of Science in mechanical engineering from the University of Notre Dame.

Kari A. Bingen is the director of the Aerospace Security Project and a senior fellow in the International Security Program at CSIS. She joined CSIS from HawkEye 360, an innovative space technology company creating a new class of RF data and analytics, where she was the chief strategy officer. Prior to the private sector, Kari served as the deputy undersecretary of defense for intelligence and security, overseeing the defense intelligence and security enterprises, comprising more than 120,000 personnel and an annual budget of over $54 billion. Before that, Kari served as the policy director on the House Armed Services Committee and staff lead for its Strategic Forces Subcommittee, advising members of Congress on defense policy, program, and budget matters. Prior to entering government, Kari specialized in national security space issues, working with U.S. defense and intelligence community clients, first as a space systems analyst at SRA International's Adroit C4ISR Center, and then as a senior space policy analyst at the Aerospace Corporation.

In addition to her work at CSIS, Kari is an adjunct assistant professor at Georgetown University. She is a member of the U.S. Strategic Command Strategic Advisory Group, was a commissioner on the CSIS Technology and Intelligence Task Force, and serves on a number of corporate and nonprofit advisory boards. She graduated from the Massachusetts Institute of Technology with a degree in aeronautics and astronautics and was a 2002 National Reconnaissance Office technology fellow.

Makena Young is a fellow with the Aerospace Security Project at CSIS. Her research interests include international collaboration, space security, and orbital debris. Prior to joining CSIS, Ms. Young worked for the Federal Aviation Administration as an aerospace engineer, focusing on automatic dependent surveillance-broadcast certification and integration in small aircraft. She holds a BS in aeronautical and astronautical engineering from Purdue University with minors in international relations and environmental engineering.

Madeleine Chang joined the Aerospace Security Team at CSIS through the Horizon Fellowship, a yearlong program designed to bring subject matter experts in emerging technologies into the policy world. Before CSIS, she worked at Lockheed Martin as a satellite software engineer within the National Security Space business area. In the past, Madeleine has worked in liquidity risk management at Goldman Sachs and galaxy evolution research at the American Museum of Natural History. Her research interests include de-escalation and deterrence, norm-setting, and public international law. Madeleine holds a Master of Engineering Management and a dual BA in computer science and astronomy from Cornell University.

Stephanie Songer was a research intern with the Aerospace Security Project at CSIS. Her research interests include space diplomacy, international politics, and space sustainability. Prior to joining CSIS, Ms. Songer was an intern at the United Nations Office for Outer Space Affairs. She holds an MA in international public affairs from Central European University and a BA in linguistics from Temple University.

Jeremy Tammelleo was a research intern with the Aerospace Security Project at CSIS. He is interested in the intersection of space, policy, and science, technology, engineering, and math. His research focused on tactically responsive space, space security operations, and export controls. He is currently a research intern in the Space Division at BryceTech. Before joining CSIS, Mr. Tammelleo conducted his master's thesis consulting with the U.S. Space Force on policy recommendations to reach the goals of its tactically responsive space program. He holds a Master in Public Policy from the Harvard Kennedy School and a BA in economics and political science from the University of Massachusetts Boston.

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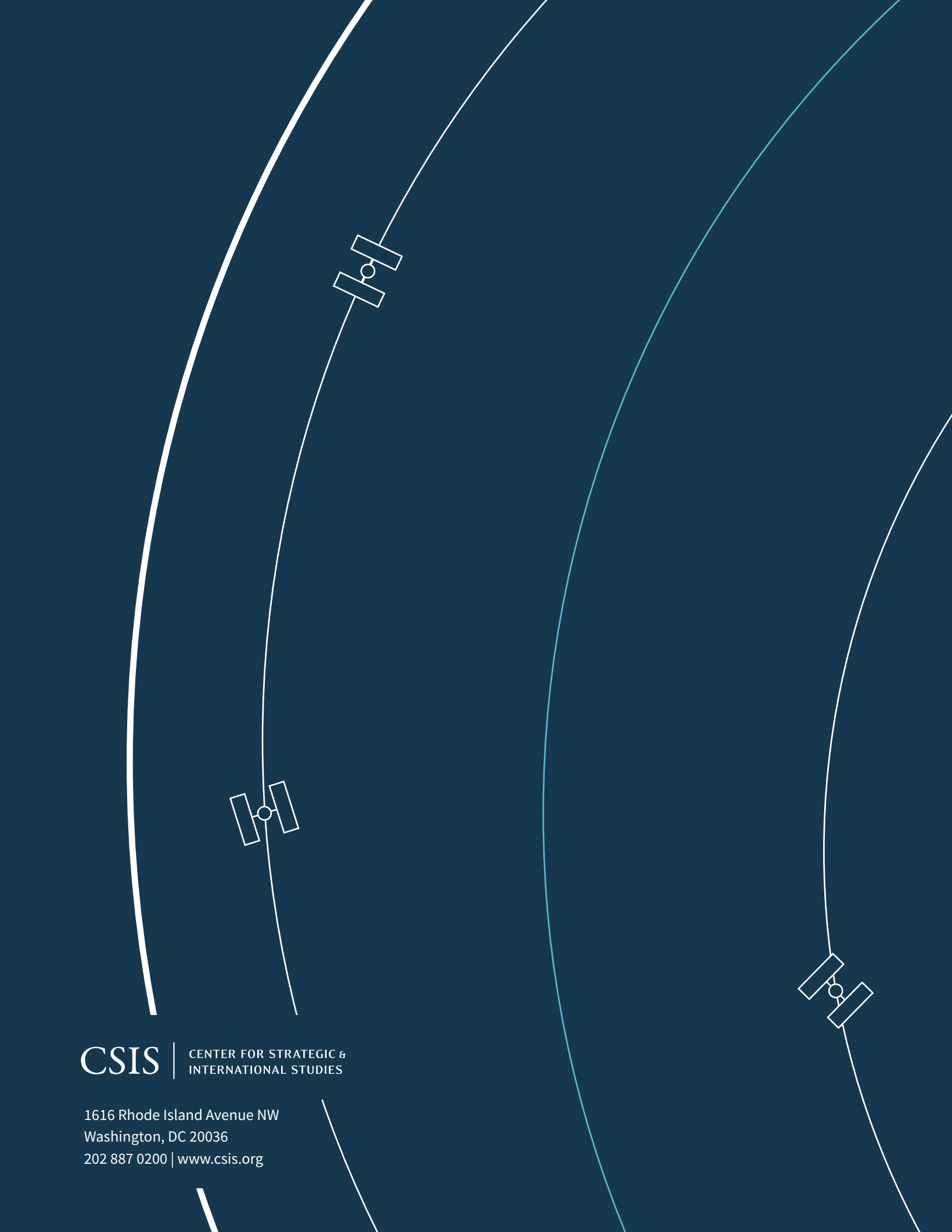

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