APRIL 2022

A REPORT OF
THE CSIS
AEROSPACE
SECURITY
PROJECT

SPACE THREAT ASSESSMENT 2022

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Foreword
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CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

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The Aerospace Security Project (ASP) at CSIS explores the technological, budgetary, and policy issues related to the air and space domains and innovative operational concepts for air and space forces. Part of the International Security Program at CSIS, the Aerospace Security Project is led by Senior Fellow Todd Harrison. ASP's research focuses on space security, air dominance, long-range strike, and civil and commercial space. Learn more at aerospace.csis.org.

ACKNOWLEDGMENTS

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FOREWORD

IT SEEMS LIKE YESTERDAY that there was a de facto duopoly in space—the United States and Russia being the only players of significance. While there were nascent counterspace capabilities being either contemplated or demonstrated, space was an uncontested environment. And because there were so few assets on orbit, freedom of movement and operation was a given. A look at 2021 disabuses each of those notions and portends a new era where space—as we have seen with cyber—has become the domain in which every interest of adversary or competitor is affected.

This fifth and latest *Space Threat Assessment* is at once unsurprising and startling in content—unsurprising in that it continues to record the growth of space and concomitant space threats with unambiguous clarity, startling in that the situation unfolding for the past decade or so has come into such sharp operational focus with a series of singular events. China, once an afterthought in the space race, launched the most satellites of any nation last year, demonstrated its intention to project hard and soft power through the growth in on-orbit military support capabilities, and grabbed our attention and imagination with its counterspace demonstrations ranging from hypersonic missile launches to co-orbital rendezvous with other satellites. Russia, the earliest innovator in space, re-grabbed our attention with its direct-ascent ASAT test that created a threatening debris field as well as apparent GPS jamming in Ukraine that showed how counterspace is being integrated into combined operations. The proliferation of international and commercial vehicles on orbit, while presaging a new era of space use for every aspect of governmental, business, and societal advance, will demand attention on the responsible use of space as a shared environment.

As space is no longer niche, counterspace capabilities cannot be considered one-offs but rather harbingers of future operational intent. So broad and deep is our collective reliance on space and space assets that these threats—from kinetic strikes, to other actions that create physical damage, to electronic, to cyber—should impel responsive actions within the United States, with our partners, and in a way that includes the private sector.

I commend this easy read as a great point of departure for considering our future of a contested, congested space.

SUSAN M. GORDON

Former Principal Deputy Director of National Intelligence

INTRODUCTION

WELCOME TO THE FIFTH EDITION of *Space Threat Assessment* by the Aerospace Security Project at the Center for Strategic and International Studies (CSIS). Over the past five years, this assessment has used open-source information to track the developments of counterspace weapons that threaten U.S. national security interests in space. The United States has relied heavily on its space infrastructure since the first satellites were placed into orbit to track and monitor nuclear missile launches during the Cold War. Over the past six decades, the United States has grown more reliant on the information, situational awareness, and connectivity provided by military, civil, and commercial space systems. It should be no surprise that these assets are a target for adversaries attempting to gain asymmetric military advantage. In November 2021, the vice chief of space operations, General David Thompson, said that U.S. space systems are attacked "every single day" by reversible forms of counterspace weapons.[1] The *Space Threat Assessment* is critical to understanding the changing nature of the space domain and monitoring trends in space and counterspace weapons.

TOTAL SATELLITES IN SPACE

4,852[2]

TOTAL LAUNCHES IN 2021

136[3]

TOTAL TRACKED ORBITAL DEBRIS

30,040[4]

More countries are investing in space and counterspace capabilities, and some countries are realigning military organizations, doctrine, and strategy to include or better reflect space and counterspace capabilities. Additionally, two destructive kinetic physical antisatellite (ASAT) tests have occurred in the past three years, which is a worrisome trend. Also of concern is the clear use of electronic warfare capabilities to deny or degrade access to space systems, such as jamming and spoofing. The most recent example of this is the use of GPS jamming capabilities by Russia as part of its invasion of Ukraine.

This edition of the *Space Threat Assessment* is in a different structure than in years past. It provides a discussion of the technical details that define different types of counterspace weapons and a "highlight" or quick overview of the main countries being tracked—China, Russia, Iran, North Korea, India, and others. The country sections include overviews of military space organizations, as well as launch, satellite, and counterspace capabilities. Notable in this year's edition is the curated analysis; four key counterspace events in 2021 were identified and analyzed in detail, followed by a more comprehensive list of all notable counterspace activities and developments over the past year (January 2021–January 2022). The conclusion includes an analysis of notable trends and key issues to watch in the coming year.

For more detail on past counterspace weapons tests, including historical tests by the United States and the Soviet Union, please review the prior *Space Threat Assessments* (editions 2018–2021) or visit the Aerospace Security Project's interactive online timeline at **https://aerospace.csis.org/counterspace-timeline/**.

TYPES OF COUNTERSPACE WEAPONS

SPACE IS AN INCREASINGLY IMPORTANT ENABLER of economic and military power. The strategic importance of space has led some nations to build arsenals of counterspace weapons to disrupt, degrade, or destroy space systems and hold at risk the ability of others to use the space domain. However, the strategic importance of space has also spurred renewed efforts to deter or mitigate conflict and protect the domain for peaceful uses. For example, the U.S. Space Force's capstone publication on space power notes that "military space forces should make every effort to promote responsible norms of behavior that perpetuate space as a safe and open environment in accordance with the Laws of Armed Conflict, the Outer Space Treaty, and international law, as well as U.S. Government and DoD policy."[5] More recently, the United States, United Kingdom, Australia, New Zealand, Canada, Germany, and France released a joint publication known as "Combined Space Operations Vision 2031." This document articulates guiding principles for the use of space, which include freedom of access and the responsible and sustainable use of space. It specifically notes the increasing threats to space systems, and it states that "the lack of widely accepted norms of responsible behavior and historical practice increases the possibility of misperceptions and the risks of escalation."[6]

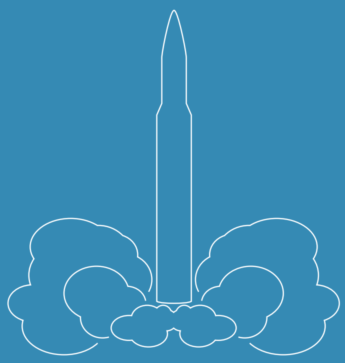


Illustration A ballistic missile can be used as a kinetic physical counterspace weapon.

Counterspace weapons, particularly those that produce orbital debris, pose a serious risk to the space environment and the ability of all nations to use the space domain for prosperity and security. This chapter provides an overview and taxonomy for different types of counterspace weapons. Counterspace weapons vary significantly in the types of effects they create, how they are deployed, how easy they are to detect and attribute, and the level of technology and resources needed to develop and field them. This report categorizes counterpace weapons into four broad groups of capabilities: kinetic physical, non-kinetic physical, electronic, and cyber.

KINETIC PHYSICAL

KINETIC PHYSICAL COUNTERSPACE weapons attempt to strike directly or detonate a warhead near a satellite or ground station. The three main forms of kinetic physical attack are direct-ascent ASAT weapons, co-orbital ASAT weapons, and ground station attacks. Direct-ascent ASAT weapons are launched from Earth on a suborbital trajectory to strike a satellite in orbit, while co-orbital ASAT weapons are first placed into orbit and then later maneuvered into or near their intended target. These maneuvers are commonly known as rendezvous and proximity operations (RPOs). Attacks on ground stations are targeted at the terrestrial sites responsible for command and control of satellites or the relay of satellite mission data to users.

Kinetic physical attacks tend to cause irreversible damage to the systems affected and demonstrate a strong show of force that would likely be attributable and publicly visible. A successful kinetic physical attack in space will produce orbital debris, which can indiscriminately affect other satellites in similar orbits. These types of attacks are one of the only counterspace actions that carry the potential for the loss of human life if targeted at crewed ground stations or at satellites in orbits where humans are present, such as low Earth orbit (LEO), where the International Space Station (ISS) resides. To date, no country has conducted a kinetic physical attack against another country's satellite, but four countries—the United States, Russia, China, and India—have successfully tested direct-ascent ASAT weapons. The former Soviet Union also tested co-orbital kinetic ASAT weapons as early as the 1960s.

NON-KINETIC PHYSICAL

NON-KINETIC PHYSICAL COUNTERSPACE weapons have physical effects on satellites or ground systems without making physical contact. Lasers can be used to temporarily dazzle or permanently blind the sensors on satellites or cause components to overheat. High-powered microwave (HPM) weapons can disrupt a satellite's electronics or cause permanent damage to electrical circuits and processors in a satellite. A nuclear device detonated in space can create a high radiation environment and an electromagnetic pulse (EMP) that would have indiscriminate effects on satellites in affected orbits. Non-kinetic attacks operate at the speed of light and, in some cases, can be less visible to third-party observers and more difficult to attribute.

Satellites can be targeted with lasers and HPM weapons from ground- or ship-based sites, airborne platforms, or other satellites. 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—technology that is costly and requires a high degree of sophistication. A laser can be effective against a sensor on a satellite if it is within the field of view of the sensor, making it possible to attribute the attack to its approximate geographical origin. An HPM weapon can be used to disrupt a satellite's electronics, corrupt data stored in memory, cause processors to restart, and, at higher power levels, cause permanent damage to electrical circuits and processors. HPM attacks can be more difficult to attribute because the attack can come from a variety of angles, including from other satellites passing by in orbit. For both laser and HPM weapons, the attacker may have limited ability to know if the attack was successful because it is not likely to produce visible indicators.

The use of a nuclear weapon in space would have large-scale, indiscriminate effects that would be attributable and publicly visible. A nuclear detonation in space would immediately affect satellites within range of its EMP and create a high radiation environment that would accelerate the degradation of satellite components over the long term for unshielded satellites in the affected orbital

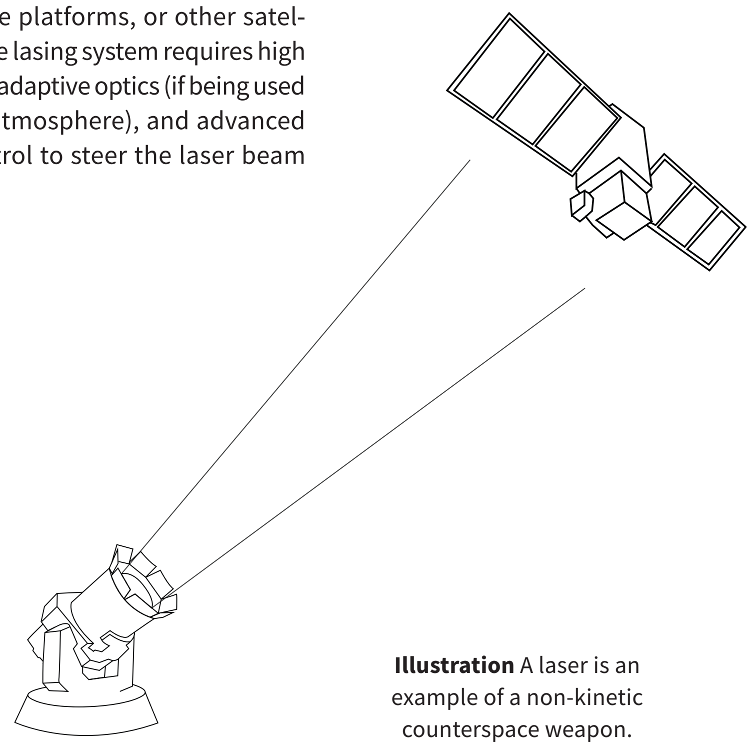


Illustration A laser is an example of a non-kinetic counterspace weapon.

regime. The detonation of nuclear weapons in space is banned under the Partial Test Ban Treaty of 1963, which has more than 100 signatories, although China and North Korea are not included.[7]

ELECTRONIC

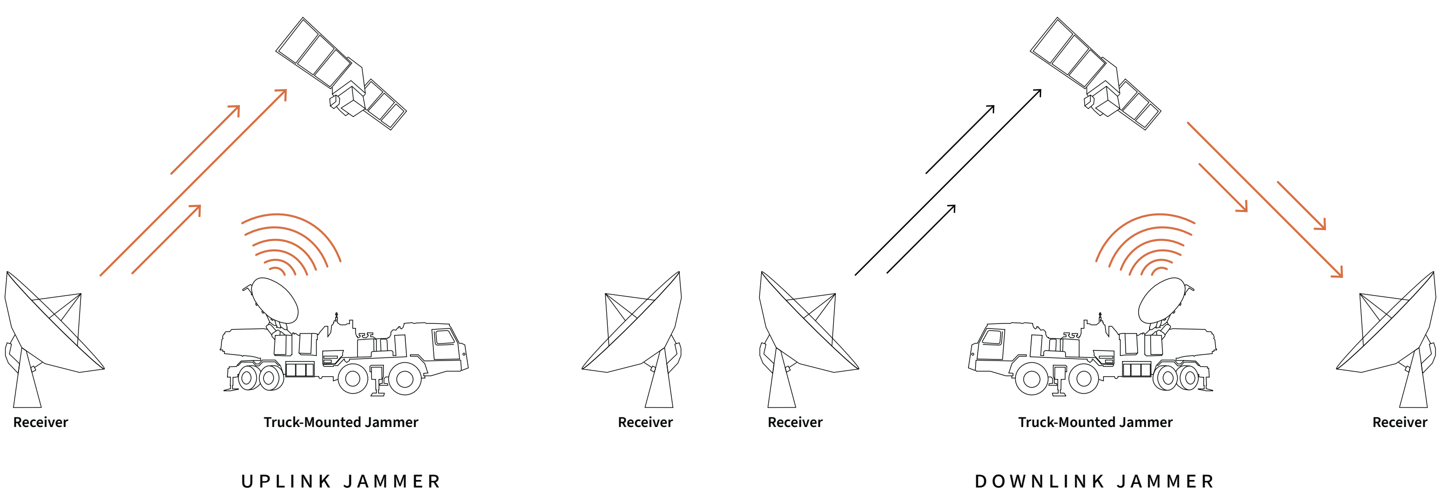
ELECTRONIC COUNTERSPACE weapons target the electromagnetic spectrum through which space systems transmit and receive data. Jamming devices interfere with the communications to or from satellites by generating noise in the same radio frequency (RF) band. An uplink jammer interferes with the signal going from Earth to a satellite, such as the command and control uplink. Downlink jammers target the signal from a satellite as it propagates down to users on Earth. Spoofing is a form of electronic attack where the attacker tricks a receiver into believing a fake signal, produced by the attacker, is the real signal it is trying to receive. A spoofer can be used to inject false information into a data stream or, in extremis, to issue false commands to a satellite to disrupt its operations. User terminals with omnidirectional antennas, such as many GPS receivers and satellite phones, have a wider field of view and thus are susceptible to downlink jamming and spoofing from a wider range of angles on the ground.[8]

Electronic forms of attack can be difficult to detect or distinguish from accidental interference, making attribution and awareness more challenging. Both jamming and spoofing are reversible forms of attack because once they are turned off, communications can return to normal. Through a type of spoofing called "meaconing," even the encrypted military P(Y) GPS signal can be spoofed. Meaconing does not require cracking the encryption because it merely rebroadcasts a time-delayed copy of the original signal without decrypting it or altering the data.[9] 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.

CYBER

WHILE ELECTRONIC FORMS OF ATTACK attempt to interfere with the transmission of RF signals, cyberattacks target the data itself and the systems that use, transmit, and control the flow of data. Cyberattacks on satellites can be used to monitor data traffic patterns, intercept data, or insert false or corrupted data in a system. These attacks can target ground stations, end-user equipment, or the satellites themselves. While cyberattacks require a high degree of understanding of the systems being

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



targeted, they do not necessarily require significant resources to conduct. The barrier to entry is relatively low, and cyberattacks can be contracted out to private groups or individuals. Even if a state or non-state actor lacks internal cyber capabilities, it may still pose a cyber threat.

A cyberattack on space systems can result in the loss of data or services being provided by a satellite, which could have widespread systemic effects if used against a system such as GPS. Cyberattacks could have permanent effects if, for example, an adversary seizes control of a satellite through its command and control system. An attacker could shut down all communications and permanently damage the satellite by expending its propellant supply or issuing commands that would damage its electronics and sensors. Accurate and timely attribution of a cyberattack can be difficult because attackers can use a variety of methods to conceal their identity, such as using hijacked servers to launch an attack.

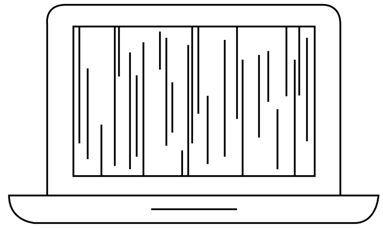


Illustration
Cyberattacks can be used to take control of a satellite and damage or destroy it.

Table 1

TYPES OF COUNTERSPACE WEAPONS

	Kinetic Physical			Non-kinetic Physical			
Types of Attack	**Ground Station Attack**	**Direct-Ascent ASAT**	**Co-orbital ASAT**	**High Altitude Nuclear Detonation**	**High-Powered Laser**	**Laser Dazzling or Blinding**	**High-Powered Microwave**
Attribution	Variable attribution, depending on mode of attack	Launch site can be attributed	Can be attributed by tracking previous-ly known oribt	Launch site can be attributed	Limited attribution	Clear attribution of the laser's location at the time of attack	Limited attribution
Reversibility	Irreversible	Irreversible	Irreversible or re-versible depend-ing on capabilities	Irreversible	Irreversible	Reversible or irreversible; attacker may or may not be able to control	Reversible or irreversible; attacker may or may not be able to control
Awareness	May or may not be publicly known	Publicly known depending on trajectory	May or may not be publicly known	Publicly known	Only satellite operator will be aware	Only satellite operator will be aware	Only satellite operator will be aware
Attacker Damage Assessment	Near real-time confirmation of success	Near real-time confirmation of success	Near real-time confirmation of success	Near real-time confirmation of success	Limited confirmation of success if satellite begins to drift uncontrolled	No confirmation of success	Limited confirmation of success if satellite begins to drift uncontrolled
Collateral Damage	Station may control multi-ple satellites; potential for loss of life	Orbital debris could affect other satellites in similar orbits	May or may not produce orbital debris	Higher radiation levels in orbit would persist for months or years	Could leave target satellite disabled and uncontrollable	None	Could leave target satellite disabled and uncontrol-lable

	Electronic			Cyber		
Types of Attack	**Uplink Jamming**	**Downlink Jamming**	**Spoofing**	**Data Interccept or Monitoring**	**Data Corruption**	**Seizure of Control**
Attribution	Modest attribution depending on mode of attack	Modest attribution depending on mode of attack	Modest attribution depending on mode of attack	Limited or uncertain attribution	Limited or uncertain attribution	Limited or uncertain attribution
Reversibility	Reversible	Reversible	Reversible	Reversible	Reversible	Irreversible or reversible, depending on mode of attack
Awareness	Satellite operator will be aware; may or may not be known to the public	Satellite operator will be aware; may or may not be known to the public	May or may not be known to the public	May or may not be known to the public	Satellite operator will be aware; may or may not be known to the public	Satellite operator will be aware; may or may not be known to the public
Attacker Damage Assessment	No confirmation of success	Limited confirmation of success if monitoring of the local RF environment is possible	Limited confirmation of success if effects are visible	Near real-time confirmation of success	Near real-time confirmation of success	Near real-time confirmation of success
Collateral Damage	Only dirupts the signals targeted and possible adjacent frequencies	Only disrupts the signals targeted and possible adjacent frequencies	Only corrupts the specific RF signals targeted	None	None	Could leave target satellite disabled and uncontrollable

CHINA

"To explore the vast cosmos, develop the space industry and build China into a space power is our eternal dream."

PRESIDENT XI JINPING[10]

FROM ITS FIRST SATELLITE LAUNCH IN 1970 to its new space station, Tiangong, in LEO, China has quickly become one of the most capable space nations. To enable its growing space and counterspace capabilities, China operates four spaceports and a family of Long March launch vehicles with a range of sizes and capabilities. In 2021, China conducted 52 successful space launches suffered three space launch failures, and reportedly conducted a non-space test launch of a hypersonic glide vehicle, which is discussed in more detail on page 23.[11] In May 2021, China successfully landed the Zhurong rover on Mars and became the second country to land and maneuver on the Martian surface. The mission continues to be a success, sending new data and observations back to Earth for further analysis.[12]

Civil, intelligence, and military space capabilities are a priority for China as it continues to invest in and plan for greater access to space in the coming decade, successfully executing on the vision statement of the 2016 white paper on space activities: “To build China into a space power in all respects.”[13] In January 2022, China released the 2021 space white paper, which continues this growing legacy. The 2021 white paper lays out a plan for Chinese space developments—civil, military, and intelligence—for the next five years. According to the paper, China plans to become a leading actor in international governance for the space domain. The white paper identifies several areas for future international cooperation, such as global governance, manned spaceflight, deep-space exploration, and personnel and academic exchanges.[14] These topics are fairly consistent with other national perspectives on key areas for international cooperation.

ORGANIZATION

Similar to the United States, China has different organizations managing its civil and military space activities; however, much of the technology for both civil and military space capabilities is produced by the same state-owned enterprises.

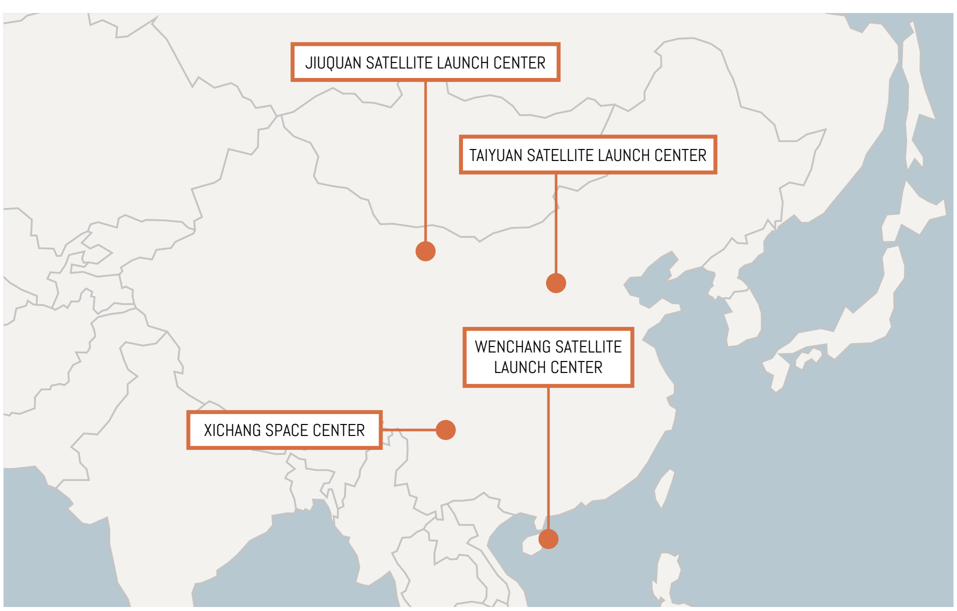
The China National Space Administration leads all civil space missions and falls within the purview of the State Council's State Administration for Science, Technology, and Industry for National Defense. China's space program primarily contracts through the China Aerospace Science and Technology Corporation, which is a state-owned enterprise with many sectors that research and develop space launch vehicles (SLVs), spacecraft, missile systems (including intercontinental ballistic missiles), and supporting ground equipment.[15] The China Aerospace Science and Industry Corporation is another state-owned enterprise which specializes in space technologies.[16]

Uniquely, the military organization for space capabilities sits alongside other information-centric domains within China's People's Liberation Army (PLA). Founded in 2015, the Strategic Support Force (SSF) manages these areas of developing warfare, along with space launch and the acquisition and operation of satellites. Within the SSF, the Space Systems Department and Network Systems Department (co-equal semi-independent branches) divide responsibilities, with the Space Systems Department taking on space and counterspace capabilities and the Network Systems Department managing cyber, electronic, and psychological warfare.[17]

LAUNCH CAPABILITIES

China continues to develop the Long March SLV family. The Long March-2 (variants C, D, and F), -3B, -4C, -5, -5B, -6, -7, and -11 rockets provide light, medium, and heavy lift capability to LEO and geostationary orbit (GEO). Some are capable of launching from a sea-based platform, but most launch from traditional ground-based launch pads. Newer Long March SLVs are being integrated into regular use, including the Long March-7A and -8. The Long March-8 successfully completed its first launch in December 2020 and was designed to have a returnable, reusable first stage (much like SpaceX's Falcon rockets). However, this capability has yet to be demonstrated.[18]

Figure 1 China's Space Launch Sites



The Chinese government may not view commercial industry as a cornerstone of space progress; however, it does consider the commercial sector to be an opportunity to replace China's reliance on international companies or suppliers.[19] In 2014, the Chinese government lifted a restrictive policy prohibiting the creation of commercial space launch companies and commercial launch technology. Since then, several Chinese commercial launch companies have been founded, and several are testing SLVs. Since the relaxation of this policy, both Chinese private and state investors have given funding to new commercial space companies.[20]

China is also investing in new launch sites. Ningbo city, in the eastern Zhejiang Province and just south of Shanghai, began awarding contracts to construction and engineering companies to build a new space launch site in April 2021. The future spaceport is anticipated to host about 100 launches per year—China carried out 55 launches in 2021 among all its launch sites—and has been compared to the United States' Cape Canaveral Kennedy launch site in its location.[21] China is also reportedly building a new sea-based space launch platform, which is expected to enter service in 2022. This investment indicates that China is looking to have a permanent and specialized sea-based spaceport, after successful sea-based launches in 2020 from converted barges.[22]

SATELLITE CAPABILITIES

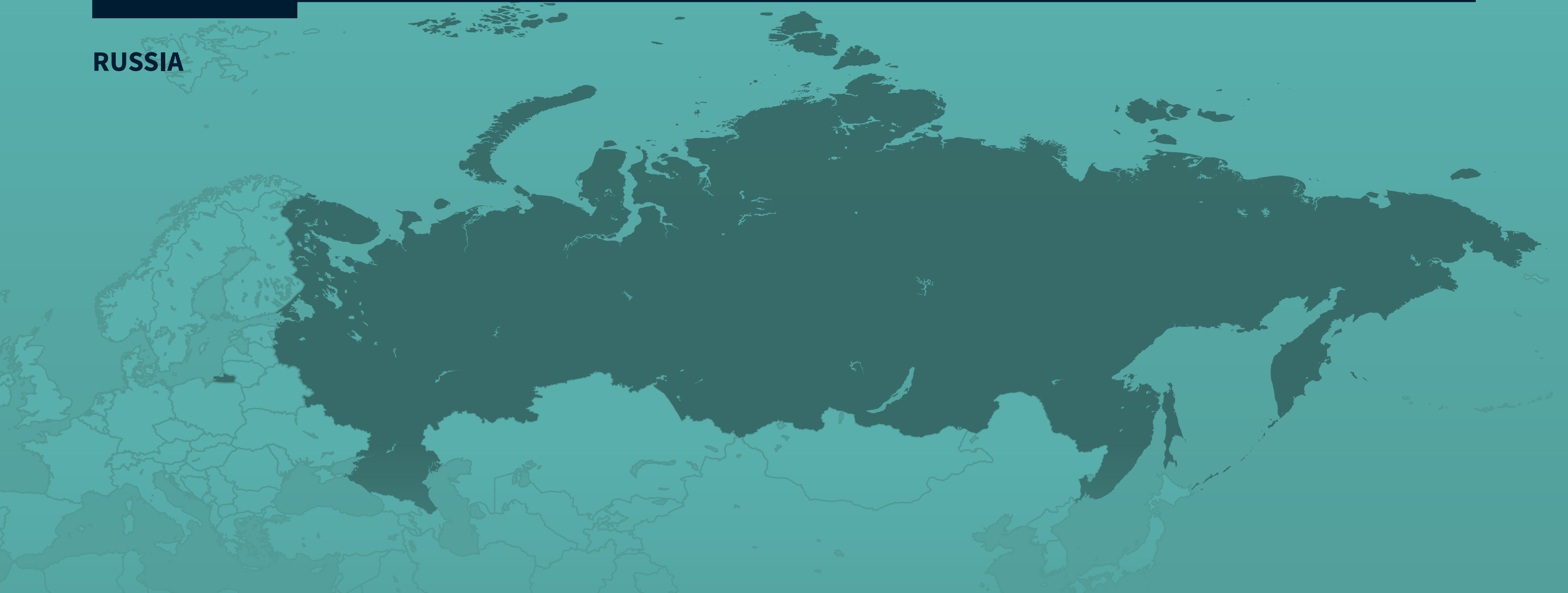
China has increasingly robust space capabilities, including advanced positioning, navigation, and timing (PNT); satellite communications; intelligence, surveillance, and reconnaissance (ISR) and missile warning; in-space logistics; and space situational awareness. The 2021 space white paper lays out specific goals for space capability investment, including those for satellite constellation upgrades and developments.[23]

The Beidou constellation, made of 35 PNT satellites, acts as China's alternative to GPS and is often used as a tool for the Belt and Road Initiative (BRI). In 2019, China introduced the Belt and Road Space Information Corridor to build out Chinese space applications and services in other nations. PNT, communications, and remote sensing services are highlighted as the key cornerstones to this new pillar of the BRI.[24] The 2021 space white paper also highlights successes of the BRI Space Information Corridor, including expanding satellite research and development infrastructure in Egypt, Pakistan, and Nigeria. Another stated goal of the 2021 white paper is to continue building on the BRI Space Information Corridor.[25]

CHINA HAS A ROBUST ARSENAL OF SPACE AND COUNTERSPACE CAPABILITIES.

COUNTERSPACE OVERVIEW

China has a robust arsenal of space and counterspace capabilities. The 2007 direct-ascent ASAT test and subsequent non-intercept tests have demonstrated that China has further developed this capability. Co-orbital technology demonstrations also prove China's ability to rendezvous with other satellites in GEO, and likely in LEO. These demonstrations are not counterspace weapons tests per se but prove that China has the experience and know-how to operate co-orbital counterspace weapons. Similar to many countries, including Russia and the United States, non-kinetic counterspace weapons, such as lasing or high-powered microwaves, remain either classified or have not been tested. However, China has proven it has a growing suite of jamming and spoofing electronic warfare capabilities to be used against space and non-space signals alike. Little is known about China's cyber counterspace capabilities, but as has been stated in previous iterations of this report, China's cyber capabilities in other domains form a solid foundation for potential cyber counterspace capabilities as well.[26]



RUSSIA

AFTER INHERITING A LARGE PORTION of the space infrastructure from the successful Soviet space program, Russia has worked to maintain the prowess the Soviet Union held in the space domain with declining success. Though its civil program has slowed in recent years, Russia's military space endeavors and covert actions in the domain mimic Russian investments in other domains by prioritizing technologies focused on information gathering, as well as those suitable to gray zone and asymmetric warfare, such as jamming and spoofing technologies and co-orbital systems capable of conducting RPOs and close inspection of other satellites.

ORGANIZATION

Similar to the United States and China, Russia's state space programs are split between civil and military organizations. The civil space agency, Roscosmos, is one of five principal partners that supports the ISS along with the civilian agencies of the United States, Japan, Canada, and Europe. Roscosmos is also responsible for the Soyuz SLV and the Global Navigation Satellite System (GLONASS), Russia's version of GPS. Military space activities are organized within the Russian Aerospace Forces, which was reorganized in 2015 to include air, space, and missile defense forces.[27] They are responsible for the operation of all space-based assets, military launches, and potential threats to space systems.[28]

RUSSIA HAS WORKED TO MAINTAIN THE PROWESS THE SOVIET UNION HELD IN THE SPACE DOMAIN WITH DECLINING SUCCESS.

LAUNCH CAPABILITIES

Russia has a storied history in space launch, and the Soyuz SLV has been a long-standing cornerstone of the global space market. After the U.S. Space Shuttle's final flight in 2011, U.S. astronauts exclusively launched out of Russia for almost 10 years before SpaceX's Dragon capsule was proven successful. At over $80 million per seat, carrying passengers to orbit made up 17 percent of the Russian space agency's annual budget in 2018.[29] Russia has launched 53 foreign astronauts to the ISS, including 34 Americans.[30] Russia had 25 orbital launches in 2021, 24 of which were successful.

Russia has a host of SLVs that have been successful since the Soviet space program. The most popular Russian SLV is the Soyuz, which launches both satellites and crewed spacecraft missions.[31] These vehicles have had over 1,680 successful launches, including 22 in 2021.[32]

Currently, Russia is continuing tests on a new SLV called the Angara. This family of SLVs will be capable of reaching both LEO and GEO once complete. Angara A5, the heavy-lift vehicle, was tested in December 2021 but missed its intended orbit due to an engine malfunction in the upper stage. This was only the third test flight of this rocket, previously tested in 2014 and again in 2020. A fourth test flight is scheduled for some time in 2022, with hopes that the vehicle will be fully functional by the late 2020s.[33]

Russia has three main launch sites in operation. The main space launch site is the Baikonur Cosmodrome in Kazakhstan, frequently used for human spaceflight to the ISS.[34] The Plesetsk Cosmodrome is located in northern Russia and has been used for space launches since 1966.[35] This launch facility is often used for missile launches, such as the November 2021 ASAT test of the Nudol system.[36] Finally, Vostochny Cosmodrome is currently under construction in eastern Russia near the Chinese border and is slated to replace the Baikonur Cosmodrome once functional.[37] As of 2019, the launch site could successfully launch Soyuz-2 rockets.[38] Additionally, Russia has used the low-latitude Guiana Space Centre operated by the European Space Agency to launch Soyuz rockets since 2011, making it the only country in the world to launch a native orbital SLV from a spaceport operated by another space agency.[39]

SATELLITE CAPABILITIES

Russia has advanced space capabilities, a reputation it has maintained since the 1960s. It operates its own satellite navigation system as an alternative to GPS, the 24-satellite GLONASS constellation. GLONASS has been in operation since 1993, and an update to the constellation has been in the works since 2017.[40]

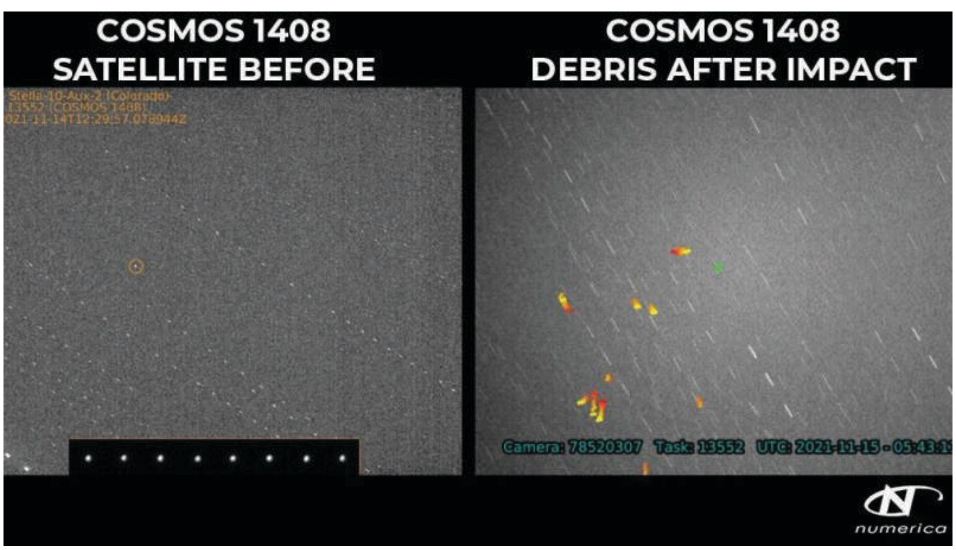
Russia is also pursuing new capabilities on orbit. It has proven the capability to have satellites that "nest" inside one another and then separate in space, as well as the ability to perform RPOs and to synchronize orbits with other satellites. A consistent reminder of Russia's aptitude in orbital operations is the GEO satellite Luch that was launched in 2014. Each year Luch continues to move around in the GEO belt, getting close to a variety of satellites from a multitude of nations. Satellites in GEO are ordinarily stationary relative to the Earth, which makes the activity of Luch highly atypical year after year.[41]

Learn more about the history of Luch's behavior, including a list of the satellite's nearest neighbors, at aerospace.csis.org/luch, and track its current location at satellitedashboard.org.

COUNTERSPACE OVERVIEW

Russia possesses counterspace weapons in all four categories: kinetic physical, non-kinetic physical, electronic, and cyber. Russia has demonstrated its kinetic capabilities frequently, including the November 2021 test of a direct-ascent ASAT weapon and successful co-orbital ASAT missions. Russia has maintained non-kinetic physical counterspace weapons through systems such as the Peresvet high-powered laser. Its electronic warfare capabilities have been on display in conflict areas where mobile electronic attack systems are jamming satellite communications and GPS signals over wide areas.

A recent focus of the space program seems to be signals intelligence satellites (SIGINT) through the Liana constellation, which is designed to intercept communications and detect objects on the ground as small as a car. Two additional satellites joined the Liana constellation in February and June 2021.[42] Additionally, Russia is developing ground-based SIGINT sites under the name Sledopyt with the capability to gain access to radio signals emitted by foreign satellites orbiting above Russian territory.[43] Russia's cyber expertise is often used for political gain by infiltrating foreign government systems. Space systems do not seem to be frequently targeted through cyber warfare, though Russia is certainly capable of doing so. In February 2022, the director of the U.S. National Reconnaissance Office, Christopher Scolese, warned of potential Russian cyberattacks against commercial and government satellites, urging satellite operators to "ensure that your systems are secure and that you're watching them very closely because we know that the Russians are effective cyber actors."[44]



Increased space debris from the Russian direct-ascent ASAT test in November 2021. This kinetic test created over 1,500 pieces of debris in LEO.

NUMERICA CORPORATION

INDIA

INDIA’S 2019 ASAT TEST SHOCKED the global space community, as it made India the fourth state with demonstrated direct-ascent ASAT capabilities. Despite this worrisome milestone, the state has had no further public demonstrations of counterspace capabilities or intentions. 2021 proved to be a slow year for Indian space activities across sectors. Only two Indian space launches took place in 2021—the second of which suffered a catastrophic failure due to a technical anomaly.[85] Reports throughout 2021 claimed that border tensions with China are driving a new wave of military space development in India.[86] However, it remains to be seen if such development is possible given the country’s ongoing budget restraints.[87]

ORGANIZATION

The Indian Space Research Organization (ISRO) is the civilian branch of India’s national space program. It superseded the Indian National Committee for Space Research in 1969 and has evolved into the sixth-largest space agency in the world.[88] ISRO operates under the Department of Space, which is headed by Prime Minister Narendra Modi.

Founded in April 2019, the Defence Space Agency (DSA) is charged with upholding India's national security concerns in space, operating under the Ministry of Defence.[89] The DSA is the result of a merger of the Defence Imagery Processing and Analysis Centre and the Defence Satellite Control Centre and is headed by Air Marshal Sujeet Pushpajar Dharkar.[90] To date, there are no comprehensive publications by the agency nor its subsidiary, the Defence Space Research Organisation, to describe its mandate, goals, or direction.[91] However, India's Defence Research and Development Organisation has been advocating for "hypersonic launch vehicle [sic], small Inter Continental Ballistic Missiles, and ASAT capability with capacity to strike both LEO and Geosynchronous Orbit (GEO)."[92] India has also been investing heavily in military intelligence satellites and focusing on the contested China-India border.

India's commercial space sector continues to grow, thanks to public-private partnerships.[93] In October 2021, Prime Minister Modi launched the Indian Space Association in an effort to allow Indian space industry actors to better engage the government.[94] During the association's launch, Modi praised the entrepreneurial spirit of India in the space sector, noting the association's future role in capitalizing on this talent.[95]

India has so far been silent in the wake of Russia's ASAT test on November 15, 2021, likely due to India's own ASAT test in 2019 and long-standing security partnership with Russia.[96] While India's test was at a lower orbit and produced less long-lasting space debris, Jim Bridenstine, the former NASA administrator, reported that over 400 pieces of orbital debris were created by the Indian ASAT test, causing a 44 percent increase in the potential risk posed to the ISS.[97] Indian space officials stated that there is no need for a second test of their ASAT capabilities, noting that the kill vehicle "had the capability to neutralise the target satellites in the entire LEO region."[98]

LAUNCH CAPABILITIES

India currently has two types of operational launchers: the Polar Satellite Launch Vehicle (PSLV) and the Geosynchronous Launch Vehicle (GSLV). The PSLV has been dubbed "the workhorse of ISRO" as it consistently delivers payloads to LEO.[99] Its most recent launch took place on February 14, 2022, when it successfully placed three satellites into orbit. This marked the 54th launch of the PSLV vehicle.[100]

The GSLV is the largest launch vehicle developed by India. It has been used 14 times since its first flight in 2001 and is primarily used to deliver payloads to geosynchronous transfer orbit and geosynchronous orbit.[101] The GSLV's most recent launch in August 2021 was unsuccessful, and the ISRO later attributed the failure to a loss of pressure in the fuel tank.[102]

India has two launch sites: the Thumba Equatorial Rocket Launch Station (TERLS) and the Satish Dhawan Space Centre (SDSC). The TERLS site is used predominantly for launching sounding rockets, while the SDSC is used primarily for space launches, although it has a special pad for sounding rockets.[103] In July 2021, the Indian government announced that it was drafting a policy to enable private companies to establish and operate launch sites both in and beyond the country.[104] It is therefore possible that more Indian-backed launch sites will develop in the coming years.

COUNTERSPACE OVERVIEW

India has demonstrated a successful kinetic direct-ascent ASAT capability, but there have been no public reports confirming non-kinetic capabilities. India has developed electronic warfare systems on the ground and has demonstrated cyber proficiency, though it not clear if India targets space systems in its electronic or cyber systems. India is also placing an emphasis on encouraging developments in the commercial sector in hopes for an increase in the space economy both domestically and internationally.[105]

IRAN

IRAN’S SPACE PROGRAM IS AMONG THE LARGEST in the Middle East, and the country’s leaders regularly invoke the program as a symbol of national strength and progress. Two failed orbital launches and one successful suborbital launch in 2021 have complicated the ongoing re-negotiations of the Joint Comprehensive Plan of Action (JCPOA) after official U.S. withdrawal in May 2018.[45] Other countries continue to insist that Iran’s civil and military space programs are transparent attempts to circumvent international sanctions for an offensive ballistic missile and nuclear program. However, Iran publicly denies any interest in pursuing such a program, claiming its right to pursue a peaceful space program as a function of state sovereignty.[46] Majid Takht-Ravanchi, the Iranian permanent representative to the United Nations, said that ballistic missiles and satellites are “essential to our security and socio-economic interests” and that Iran rejects any proposal to limit their missile and satellite programs.[47]

ORGANIZATION

Iran’s space program is divided between its civilian branch, the Iranian Space Agency (ISA), and its military branch, the Islamic Revolutionary Guard Corps (IRGC) Aerospace Force. The ISA is responsible for peaceful civilian spaceflight development and policy. It falls within the Ministry of Information and Communication Technology and under the direction of the Supreme Space Council, which is chaired by Iran’s president, Ebrahim Raisi.[48]

The IRGC Aerospace Force was created in 2009 out of the IRGC Air Force to show greater attention to space as a field of national security.[49] The Aerospace Industries Organization is a military industrial subsidiary of Iran's Ministry of Defense and Armed Forces Logistics and is responsible for the production of dozens of varieties of Iranian missiles and rockets.[50] In 2019, the organization designed a satellite for the IRGC Aerospace Force and reportedly designed launchpads for satellite launches.

While the ISA is technically separate from the IRGC Aerospace Force, there is significant bleed-through of authority and agenda.[51] Due to international sanctions against trading ballistic technology with the Iranian government, Iran's private sector has been used as a front for acquiring space launch technology to avoid import and export laws. These companies, like the Iranian government, lack transparency and accountability, and many could likely be called state-owned enterprises rather than independent businesses contracted by the government.[52]

IRAN'S PRIVATE SECTOR HAS BEEN USED AS A FRONT FOR ACQUIRING SPACE LAUNCH TECHNOLOGY TO AVOID IMPORT AND EXPORT LAWS.

LAUNCH CAPABILITIES

A February 1, 2021, suborbital test launch of the new Zuljanah rocket was successful.[53] On June 12, 2021, a Simorgh rocket was launched without success.[54] It is unclear at what stage the mission experienced failure, but the Simorgh did not successfully place any satellites into orbit. While satellite photography showed quick preparations for another launch, this launch did not occur until December 30, 2021, and the Simorgh rocket again failed to enter orbit and deliver its three payloads.[55] This was the fifth consecutive failure of a Simorgh rocket to achieve orbit.

President Raisi's comments on the country's recent space activity categorized the launch failures as "sorrowful" and "lackluster," but there appears to be real urgency on his part to get Iran's space capabilities back on track. His stated goals for the burgeoning space program include routinely launching satellites into LEO, attaining GEO by 2026, and sending an Iranian astronaut to space aboard an Iranian SLV by 2032.[56]

Vehicles

Iran's SLV and ballistic missile technology is heavily influenced by or acquired from other nations, particularly Russia and North Korea.[57] For example, the Shahab-3 series, which includes the Safir-1 and Qased SLVs, is derived from the North Korean Nodong design.[58]

The Shahab-5 series includes the Simorgh (also known as Safir-2), an updated design of the Safir-1. The Sejil series includes the Zuljanah, which has completed suborbital testing and may be the most powerful Iranian rocket to date.[59] In January 2022, the Iranian news agency Mehr shared a video of the successful firing of the new Raafe solid-fueled rocket motor.[60] Analysts have noted that the new Raafe rocket motor is the same diameter as Iran's Shahab-3 and its variants.[61]

Facilities

Iran constructed the Shahrud Missile Test Site with Chinese and North Korean assistance in the 1980s.[62] This site, located over 400 kilometers east of Tehran, was the main launch site for the Shahab rocket series throughout the 1990s and remains the primary launch site of the ISA. Shahrud was also the site from which the IRGC launched the Noor-1 satellite aboard the Qased rocket in April 2020.[63] In 2021, satellite imagery revealed a significant buildup of administrative and storage capabilities at Shahrud, likely in preparation for the solid rocket fuel-propelled Zaljanah and Raafe SLVs.[64]

Construction of the Semnan Spaceport, now officially known as the Imam Khomeini Space Center, was completed in 2008 with an inaugural launch of a Shahab rocket.[65] Following a 2012 destructive rocket launch failure and significant construction, the center reopened its doors on July 27, 2017, with the successful launch of a Simorgh SLV.[66]

COUNTERSPACE OVERVIEW

Iran appears far from developing kinetic physical or non-kinetic physical counterspace weapons. The country continues to develop electronic and cyber capabilities and has been successful in jamming and hacking against foreign governments and civilian systems. Iran is developing other space capabilities as well and is a member of the Asia Pacific Space Cooperation Organisation, a China-led association "dedicated to promote and strengthen the development of collaborative space programs among its Member States by establishing the basis for cooperation in peaceful applications of space science and technology."[67] In 2017, Iranian officials stated that Iran has a working telescope in collaboration with the group, including a domestic space situational awareness radar capability and an optical telescope capable of tracking satellites in LEO.[68]

NORTH KOREA

AS IN YEARS PRIOR, NORTH KOREAN STATE MEDIA emphasized the state's space ambitions throughout 2021. In January 2021, Kim Jong Un declared that the country would operate a military reconnaissance satellite "in the near future."[69] State media also claimed in October 2021 that "Kim Jong Un set it as an immediate goal of space development to launch a geostationary satellite into the outer space [sic] in the near future."[70] It remains to be seen if these statements will be matched with action, as no evidence of increased investment in North Korean space activities has surfaced. Throughout 2021, Pyongyang continued to conduct several controversial missile tests. These tests and those that preceded them illustrate that North Korea has adequate missile capability for some counterspace weapons, but it has yet to exhibit the necessary sensing and altitude control capabilities for a direct-ascent ASAT weapon.

ORGANIZATION

Most of North Korea's public statements on its space program continue to emphasize its peaceful intentions. Pyongyang's space activities are centralized in the National Aerospace Development Administration, founded in 2014.[71] A November 2021 report from a state propaganda platform reiterated North Korea's intention to develop its space sector "in keeping with the positive international efforts for developing and using space, a common wealth of mankind, and to developing the economy of the country."[72] Statements of this nature have been regarded

NORTH KOREA HAS ADEQUATE MISSILE CAPABILITY FOR SOME COUNTERSPACE WEAPONS, BUT IT HAS YET TO EXHIBIT THE NECESSARY SENSING AND ALTITUDE CONTROL CAPABILITIES FOR A DIRECT-ASCENT ASAT WEAPON.

with skepticism from the global community, which views North Korea's space ambitions as part and parcel of its nuclear ambitions. Observers have also noted a recent uptick in North Korean space propaganda, as evidenced by "an escalation of North Korea's messaging" on satellite launches.[73] Despite the increase in state comments on space, no major space developments have occurred in the past year.

LAUNCH CAPABILITIES

North Korea began 2022 with a bang, performing seven missile launches in the month of January alone.[74] However, no activity has been reported at North Korea's two known space launch facilities, Tonghae and Sohae, in several years. In 2016, 38 North reported that the Tonghae Satellite Launching Ground remained in "caretaker status," and no launches have been reported at this facility since 2009.[75] The Sohae launch facility was partially dismantled in 2018 following the summit between former president Donald Trump and North Korean leader Kim Jong Un.[76] The facility was restored to full functionality following the breakdown of U.S.-North Korea diplomacy.[77] Despite this restoration, no launches have occurred at Sohae since 2016, and satellite imagery of the facility in October 2021 indicated no signs of an imminent launch.[78]

North Korea's missile tests throughout January exhibited a range of launch capabilities that predominantly indicate an advanced ability to circumvent missile defense systems. Pyongyang announced that its January 5th launch was its second test of a hypersonic missile. 38 North assesses that, like the September 2021 hypersonic test, it was launched from a mobile launcher using either a medium-range ballistic missile or a boost-glide vehicle.[79] Launches three and four tested existing launch capabilities: rail-mobile KN-23 and road-mobile KN-24 short-range ballistic missiles (SRBMs).[80] While these two tests indicate "continued progress in solid-propellant SRBM deployment," they did not definitively exhibit any advances in North Korea's missile guidance systems, a requisite step toward advancing its counterspace capabilities.[81] Pyongyang wrapped up the month of January with a test of the Hwasong-12 intermediate-range ballistic missile that was first tested in 2017.[82] While this test had important political impacts—most prominently marking the end of Kim Jong Un's self-imposed moratorium on long-range missile testing—it did not significantly advance the state's counterspace capabilities.[83]

COUNTERSPACE OVERVIEW

Despite consistent claims from state officials that space is a priority for the nation, there is no indication that North Korea has made any exceptional advancements in the space domain. Its missile activity has not translated to the space program, and it remains unlikely that North Korea is actively pursuing kinetic direct-ascent or co-orbital ASAT weapons or any non-kinetic physical capabilities. However, the country has demonstrated successful electronic warfare by showcasing its jamming capabilities, and its cyberattack threat is active and viable, though most often used for economic bolstering rather than aimed at space assets. It is these latter two capabilities that have the greatest potential for counterspace applications. As the country acquires more advanced technology, likely through illicit means, and gains operating experience, threats to space systems and ground stations will likely become more credible.[84]

OTHERS

WHILE CHINA, RUSSIA, IRAN, NORTH KOREA, AND INDIA have the most public counterspace activities, other actors are advancing counterspace capabilities as well. This chapter examines the counterspace applications that other countries were developing in 2021, including public remarks and changes in doctrine and military organization.

AUSTRALIA

In May 2021, Australia announced that it would create a new military space division within the Royal Australian Air Force in early 2022.[106] This new space division will invest $7 billion AUD on military space capabilities over the next decade.[107] Australia opened up bidding on military communication satellites (as many as four) in February 2022 and intends to spend $4 billion AUD on the satellites.[108] This new space division is likely to continue building on the close relationship between Australia and the United States for national intelligence, defense, and space as a close ally and Five Eyes partner.

ISRAEL

Israel has continued to develop its ground-based laser technology systems to help intercept incoming attacks in its airspace.[109] In April 2021, the head of Israel's Missile Defense Ministry announced that this laser technology would be integrated into its Iron Dome missile defense system.[110] The development of this system has sped up in response to House Democrats' removal of $1 billion of funding for the Iron Dome system in September 2021.[111] Reports indicate that Israel aims to have this system fully operational by mid-2022.[112] However, there are many additional technical challenges for lasing a satellite from Earth that Israel has not yet demonstrated.

Israel has also been partnering with other nations in space. In the wake of the signing of the Abraham Accords in 2020, several reports indicate that Israel and the United Arab Emirates (UAE) have discussed collaboration in military space efforts.[113] Few details on the form of this collaboration have emerged, but the UAE recently inquired about obtaining a missile defense system from Israel.[114]

JAPAN

Japan continues to advance its civil and military space operations. Prior to the passage of the 2008 Basic Space Law, Japan had a national policy that prohibited the use of space for national defense.[115] The 2008 law permitted the country to begin military developments in space, and government officials have begun to speak about the development of defensive counterspace capabilities.[116] The timing of this law and the ramping up of many counterspace developments are in response to actions by China in space, such as the 2007 Chinese ASAT test.

Japan established its first military space squadron in 2021, the Space Domain Mission Unit within the Japan Air Self-Defense Force (JASDF). The squadron is slated to be fully operational by 2023, with plans to launch the first satellite for monitoring the space environment by 2026.[117] Throughout 2021, public comments by Japan on this squadron continued to emphasize its defensive posture.[118]

In November 2021, Japan announced that it will soon launch a second space defense unit that specializes in protecting its satellites from electromagnetic attacks.[119] This unit, like the first, aims to align its activities closely with the United States. Per the terms of an April 2021 memorandum of understanding signed by U.S. Space Command and JASDF, a JASDF liaison officer will be stationed full-time at U.S. Space Command's headquarters in Colorado.[120]

While Japan has not demonstrated any direct-ascent ASAT systems, the country has U.S.-made SM-3 missile defense interceptors that have a latent ability to attack space assets in LEO. In January 2022, Lockheed Martin confirmed that it had successfully integrated an enhanced radar system into Japan's Aegis Weapon System, enabling it to "detect, track and discriminate ballistic missile threats, and successfully guide interceptors to those threats."[121]

SOUTH KOREA

South Korea expanded the purview of its military forces in the space domain with the relaxation of a restriction on the country's missile and SLV production in 2020 and by pursuing several steps to work closer with the U.S. Space Force, including a formal space security partnership between the two nations.[122] South Korea tested its first domestic national SLV on October 21, 2021. Though unsuccessful at placing the test satellite into orbit, it was a significant first step for the burgeoning space nation.[123] South Korea intends to invest $13 billion from 2020 to 2030 in its domestic industry to develop military satellite technologies.[124]

COUNTERSPACE ACTIVITIES: A YEAR IN REVIEW

THIS EDITION OF THE *SPACE THREAT ASSESSMENT* highlights four key events from the year: the July 2021 Chinese hypersonic glide vehicle test; the launch and behavior of a new Chinese GEO satellite, SJ-21; the November 2021 Russian direct-ascent ASAT test in LEO; and Russia's GPS jamming in Ukraine. Two of these events, both conducted by China, are not counterspace weapons tests but received significant press coverage that regularly implied that they could be space or counterspace weapons. The curated analyses that detail the four selected key events are followed by a timeline of other counterspace incidents over the past year. For a complete timeline of counterspace activities from 1959 to 2021, visit **aerospace.csis.org/counterspacetimeline/**.

Is It a Bird? Is It a Hypersonic Glide Vehicle? Is It a Chinese FOBS Test?

One of the most significant space-related stories that emerged in 2021 was the alleged test of a Chinese hypersonic glide vehicle, which some have called a Fractional Orbital Bombardment System (FOBS) test, although the reporting on this event has been inconsistent, incomplete, and largely based on anonymous sources. Importantly, the details reported to date do not indicate that this was a test of a Chinese space or counterspace weapon.

The story first appeared in a *Financial Times* article on October 16, 2021, that claimed the test took place sometime in August.[125] Later reporting by the *Financial Times* corrected the date to July 27.[126] Both the initial report and the follow-up claim that the test involved a nuclear-capable hypersonic weapon that circled the Earth for at least one orbit. According to the *Financial Times*, the weapon deorbited and glided toward a target, missing it by two dozen miles. The initial reporting was based on five anonymous sources that leaked the classified information at roughly the same time. It is not clear if these leaks were coordinated or coincidental. The follow-up report included additional details, claiming that the hypersonic missile fired a projectile during its flight and that it was an "orbital bombardment system."[127]

Parts of the story appear to be substantiated by separate on-the-record comments from senior U.S. government officials both before and after the story appeared. In a speech on September 20, 2021, Air Force secretary Frank Kendall alluded to China developing "precision weapons with steadily increasingly range . . . including the potential for global strikes, strikes from space."[128] In follow-up questioning by reporters, he spoke in more hypothetical terms, saying that "there is a potential for weapons to be launched into space, then go through this old concept from the Cold War called the Fractional Orbital Bombardment System . . . which is a system that basically goes into orbit and then de-orbits to a target."[129]

Outgoing vice chairman of the Joint Chiefs of Staff, General John Hyten, also confirmed parts of the story in a November 2021 interview. Speaking of the reported July test, he said, "They [China] launched a long-range missile. . . . It went around the world, dropped off a hypersonic glide vehicle that glided all the way back to China, that impacted a target in China."[130] Importantly, he went on to add that these weapons "look like a first-use weapon," which could be used to launch a surprise nuclear attack.[131] Hyten made these public remarks about it being a first-use weapon as the Biden administration was considering adopting a no-first-use policy in its Nuclear Posture Review.[132] General Hyten has previously voiced his opposition to the United States adopting a no-first-use policy, and several reports and op-eds appeared around the time the *Financial Times* story leaked which argued against the United States adopting a no-first-use policy.[133]

Since the story broke, little additional evidence has emerged to clarify how U.S. intelligence determined that this was a "nuclear-capable" weapon being tested, nor has it been confirmed that a projectile was fired from the hypersonic missile in flight. It is also not clear if the test placed the hypersonic missile in orbit or merely on an extended suborbital trajectory, which would be normal for a long-range missile test. The official Space-Track.org catalog maintained by the Space Force does not include any items with a launch date from July 22 through July 28, either in orbit or having re-entered.[134]

DETAILS REPORTED TO DATE DO NOT INDICATE THAT THIS WAS A TEST OF A CHINESE SPACE OR COUNTERSPACE WEAPON.

The idea of placing a hypersonic missile into orbit around the Earth would not appear to be as advantageous as some have assumed. Traveling at a higher altitude for a longer time makes the missile more likely to be detected and tracked, and completing a full orbit around the Earth takes roughly 90 minutes. The main advantages of hypersonic glide weapons are that they travel below the typical trajectory of long-range ballistic missiles, are highly maneuverable, and can reach their targets quickly leaving little time to react. Sending one of these weapons into orbit and on a trajectory that is nearly 25,000 miles longer than necessary (the circumference of the Earth) would negate many of these advantages. Moreover, if the weapon was nuclear-armed, placing it on a trajectory that makes a full orbit would violate the Outer Space Treaty of 1967, of which China is a signatory.[135]

It is possible that two separate test events in July were conflated in the reporting: the test of a hypersonic missile on a more traditional trajectory that fired projectiles (countermeasures) in flight and a separate test of a hypersonic glide vehicle on an orbital trajectory. When responding to the initial *Financial Times* article, the Chinese Ministry of Foreign Affairs issued a statement pointing to its test of a hypersonic glide reusable spaceplane on July 16, 2021.[136]

The headlines calling this an "orbital bombardment system" may have sounded alarm bells about Chinese advancements in space weapons, but the reality appears to be much different. The complete details of the test and what the United States was able to observe (rather than infer) may never be fully revealed. However, what is clear is that nothing in the reporting suggests that this is a weapon that would be stationed in space for periods longer than one orbit, nor does it indicate that the weapon would be capable of targeting satellites. The test underscores the need for the United States and its allies to improve defenses against hypersonic weapons, but it does not appear to be a new development in space or counterspace weapons.

Busy Bee in GEO, China's SJ-21 Satellite

The Shijian-21 (SJ-21) satellite was launched on October 24, 2021, and inserted into GEO soon after. According to Xinhua, Chinese state media, the satellite's mission is to test technologies that will mitigate space debris.[137] Within its first couple of months on orbit, SJ-21 has performed several advanced tests and maneuvers, including the release of a subsatellite or apogee kick motor (AKM), close approaches with other satellites in GEO, and removal of a non-functioning satellite to a disposal orbit.

Subsatellite or Apogee Kick Motor?

One week after SJ-21's launch, the U.S. Space Force noted that a new satellite, possibly an AKM, was next to SJ-21 in GEO.[138] AKMs are additional power sources in order to place a satellite into a specific orbit, and some can detach and become unmaneuverable space debris. Since GEO is a limited and highly valued orbit, most AKMs in GEO are released in such a manner that they separate and put significant distance between the payload and the AKM so as to not interfere with that satellite's future operations. The U.S. Space Force labeled the space object as SJ-21 AKM in the Space-Track.org database. What caused concern and confusion among satellite observers was the close proximity SJ-21 AKM maintained to SJ-21. In the following weeks, SJ-21 performed several RPOs around SJ-21 AKM, a highly unusual behavior.[139]

In mid-December, SJ-21 maneuvered away from the possible AKM. Several days later, on December 22, it returned to perform more RPOs in the space nearby. As MIT's Thomas Roberts has noted, "On December 28, the two objects separated again when SJ-21 AKM suspended its westward drift, further exhibiting behavior that is unfitting for an apogee kick motor, a launch vehicle component that rarely remains in orbit after orbital insertion."[140] Given what followed these maneuvers, this series of RPOs could have been a series of on-orbit tests for the new satellite, with a relatively low-stakes space object, before moving on to the satellite's next mission.

Graveyard Tug

Following its RPOs with SJ-21 AKM, SJ-21 maneuvered westward to rendezvous with the Compass G2 satellite, part of the Chinese Beidou constellation of PNT satellites. Prior to SJ-21's encounter, Compass G2 was drifting westward and increasing in inclination. The satellite failed not long after its launch in 2009 and has been uncontrolled since.

According to Exoanalytic Solutions, a commercial space situational awareness and satellite tracking company, SJ-21 performed RPOs around Compass G2 for several days before docking with the inactive satellite on January 22, 2022. SJ-21 then began to move Compass G2 3,000 km above GEO, drifting in a westward direction. The full maneuver lasted about three days, with SJ-21 releasing Compass G2 into the GEO graveyard on January 26, 2022.[141] The GEO graveyard is several hundred kilometers higher than the geostationary belt in order to keep "dead" or inoperable satellites out of the way from active satellites. Compass G2 is now in a more sustainable location and has a negligible likelihood of interfering with active GEO satellites.

China is no novice in performing RPOs in GEO. SJ-17, another inspector satellite, has been conducting similar operations for years. However, with SJ-17 seemingly completing or pausing its mission (it has not been within 10 km of any satellite since 2020), SJ-21 may be China's next GEO demonstrator.[142] These RPO and tug capabilities are akin to other on-orbit servicing, assembly, and manufacturing satellites, and the test was not used for counterspace purposes.[143] However, the technical capabilities to perform such maneuvers, and grapple with inactive satellites, are some of the same capabilities necessary for co-orbital counterspace weapons.

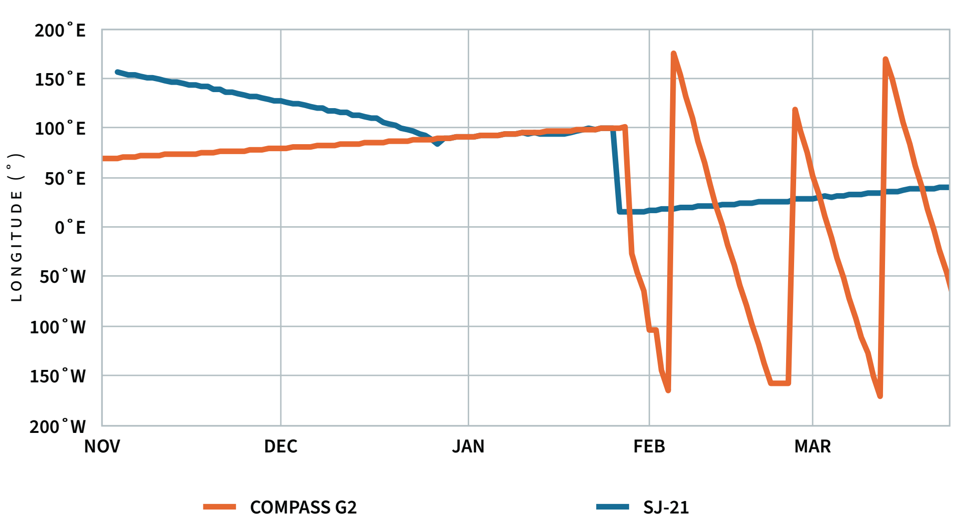


Figure 2 Historical longitudes showing the rendezvous of SJ-21 with Compass G2.

SATELLITE DASHBOARD (DATA AVAILABLE AT SATELLITEDASHBOARD.ORG)

Shot Heard around the World: Russia's 2021 ASAT Test

One of the most notable and visible counterspace activities of 2021 was a Russian ASAT test performed on November 15. A PL-19 Nudol interceptor missile was launched from the Plesetsk mobile missile launch complex and successfully hit and destroyed a defunct Russian satellite, Cosmos 1408, that had been in orbit since 1982.[144] Russia has possessed this kinetic direct-ascent ASAT capability for years. From 2015 to 2020, the Nudol system was tested 10 times, of which the last 8 were successful. Though they did not hit targets in orbit, these 8 successful tests showcased the full capability of the Nudol system, which made this kinetic impact test a surprise to many space analysts around the world. After the test, an anchor on a state-run program on Channel One indicated that Russia was capable of destroying all 32 U.S. GPS satellites, which are also used by the North Atlantic Treaty Organization (NATO) alliance—although the November test did not demonstrate such a capability.[145]

Russia's Rationale

Russia has taken great pride in being on the cutting edge of space technology since the 1960s space race, but in recent years the country has launched significantly fewer space objects. This ASAT test may have been a way to loudly remind the world that the country is still a major space power with meaningful military capabilities and ensure that Russia was not left out of any norms-building discussions surrounding ASAT weapons. Only three other countries have demonstrated this kinetic capability: China, India, and the United States. In February 2022, the United Nations General Assembly First Committee, which addresses disarmament and international security issues, was set to hold an international working group designed to thwart an arms race in space, but the discussion was delayed after Russia requested more time to prepare—likely due to its plan to invade Ukraine.[146]

Impact and Implications

ASAT tests have been widely condemned because of the amount of space debris that can be created after a demonstration. This became notable after the 2007 Chinese ASAT test—the largest single debris creation event—which created a cloud of debris in LEO.[147] The 2021 Russian ASAT test created a near-immediate debris field of over 1,500 objects according to U.S. Space Command and likely hundreds of thousands of smaller pieces of debris that are unable to be consistently tracked.[148] The debris field is so serious that two American astronauts, one German astronaut, and notably two Russian cosmonauts on the ISS had to shelter in place immediately after the test. NASA's move to protect the astronauts was at odds with the Russian Foreign Ministry, which denied any danger to the orbital space station the day after the test took place. U.S. officials from the State Department, members of Congress, and NASA were all quick to speak out against the kinetic ASAT test. UK defense secretary Ben Wallace added to these statements, as did French defense minister Florence Parly and NATO secretary-general Jens Stoltenberg.[149] In early 2022, the China National Space Administration, issued a possible collision warning between a piece of trackable debris from this test and a Tsinghua science satellite.[150] This event was shared widely by Chinese media and corroborated by U.S. space tracking data. Despite widely reporting this close approach warning, Chinese officials have not commented on the Russian ASAT test, likely because of its own history with debris-creating ASAT demonstrations and its tenuous geopolitical alliance with Russia.[151]

THE 2021 RUSSIAN ASAT TEST CREATED A NEAR-IMMEDIATE DEBRIS FIELD OF OVER 1,500 OBJECTS.

All Is Not Quiet on the Eastern Front: Russian Jamming in Ukraine

Russian forces are actively using GPS jamming and other forms of electronic attack in the escalating conflict in Ukraine. Russian troops moved jamming equipment into the areas where troops were massing ahead of the invasion. GPS jamming has become a common tool in Russia's arsenal, and the Russian military has frequently jammed GPS signals in Ukraine since 2014.[152] Well before the invasion began on the morning of February 24, 2022, Russia was actively jamming GPS signals throughout the area. This story is an ongoing development, and it is likely that events have changed between the writing of this paper and its publication.

In December 2020, the Organization for Security and Cooperation in Europe (OSCE) confirmed the presence of R-330Zh Zhitel jammers in the area. The R-330Zh Zhitel system has the capability to interfere with satellite and cellular communications.[153] However, these reports did not specify which systems are currently active in the region.

Krasukha-4 jammers were reportedly spotted near Gomel, Belarus, a city near the southern border.[154] While mainly used to jam airborne radar, Krasukha-4 also reportedly interferes with "observations of radar reconnaissance satellites." The Krasukha-4 has a 180-mile range, indicating that these systems are likely being used to hide or mask Russian troops or machinery from others' systems rather than counter the use of GPS or satellite communications within Ukraine.[155]

As early as April 6, 2021, the OSCE, which was monitoring the Russian buildup of forces around Ukraine, reported that one of their uncrewed aerial vehicles (UAVs) was unable to take off and perform its monitoring mission due to GPS interference. The press release noted that this had been a consistent issue for OSCE UAVs for several weeks, but this incident was the first that completely halted a mission. It is likely that Russian electronic warfare technology was the cause.[156] Ambassador Michael Carpenter, the U.S. ambassador to the OSCE, stated in January 2022 that "Last week monitors noted instances of GPS signal interference caused by probable jamming."[157] More recent reporting, as of mid-February 2022, notes that GPS jamming continues to hinder the OSCE monitoring mission.[158]

As shown in Figure 3, data and analysis from U.S. commercial firm Hawkeye360 was used to estimate the locations of suspected Russian GPS jammers near Varvarivka in the Donetsk region of Ukraine. Since the 2014 invasion of Crimea, two regions in particular, Donetsk and Luhansk, have been divided into Ukrainian-controlled and Russian-backed separatist areas. The suspected GPS jammers identified as the possible causes of the interference shown in Figure 3 may be operated by either Russian forces, which moved into the Donbas region early in the invasion, or separatist militias, which were already in Donetsk and Luhansk.

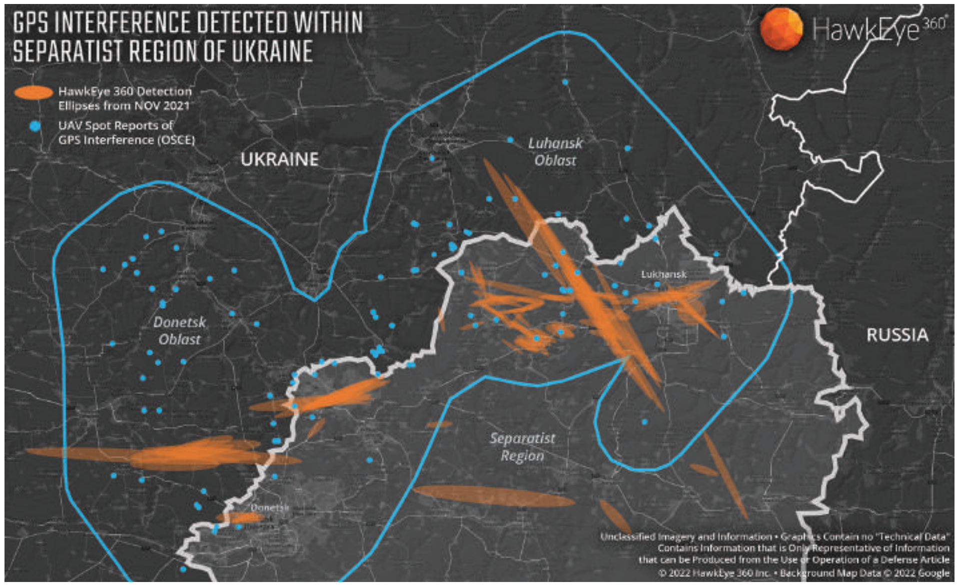


Figure 3 Map of GPS interference in November 2021.

HAWKEYE360

Emissions from the GPS jammers were detected and geolocated by the Hawkeye360 constellation of satellites. The orange ellipses in the figure indicate the estimated locations of the RF interference, and overlapping ellipses from multiple satellite passes can be used to more precisely locate a jammer. The data shown in Figure 3 was obtained between November 13, 2021, and December 1, 2021, before Russia's invasion of Ukraine. However, electronic and cyber warfare continue to be key components of Russian strategy and military operations in Ukraine, and GPS and satellite communications jamming is likely to continue or increase as the war unfolds.[159]

ELECTRONIC AND CYBER WARFARE CONTINUE TO BE KEY COMPONENTS OF RUSSIAN STRATEGY AND MILITARY OPERATIONS IN UKRAINE.

COUNTERSPACE TIMELINE, 2021

2021

- Kinetic Physical
- Non-kinetic Physical
- Electronic
- Cyber
- Other

JAN. 9, 2021 **RUSSIA**

Russia jammed GPS for NATO sources

Jamming

Russia has been intermittently jamming Ukrainian radio, cell, and satellite signals for years. With the growing presence of Russian troops in and outside of Ukraine, reports of GPS jamming have increased.[160]

JAN. 23, 2021 **INDIA**

Indian thieves attempt GPS jamming in India

Jamming

Thieves in India attempted to use localized GPS jamming devices to steal gold. The devices failed and police were able to locate the truck with the stolen goods.[161]

FEB. 1, 2021 **UNITED STATES**

Unintentional localized GPS jamming in the United States

Jamming

Localized jamming near the Wilmington airport in North Carolina was detected and disrupted air traffic. The source of the unintentional jamming was identified as a utility company's wireless control system near the airport.[162]

MAR. 12, 2021 **CHINA**

Commercial jammers that look like everyday objects

Jamming

Localized jamming equipment designed to look like everyday objects, such as USB drives or art, have been identified in China, but they are not for sale to private citizens or organizations.[163]

APR. 6, 2021 **RUSSIA**

GPS jamming of OSCE mission in Ukraine by Russian troops

Jamming

Russia uses GPS jamming throughout the growing tension on the Ukrainian border. The OSCE reports GPS interference on its UAVs that assist in the monitoring mission.[164] For more information, see page 26.

- Kinetic Physical
- Non-kinetic Physical
- Electronic
- Cyber
- Other

APR. 20, 2021 **CHINA**

SJ-17 reported to have a robotic arm

Co-orbital

In a statement to the Senate Armed Services Committee, commander of United States Space Command, General James H. Dickinson, announced that China's GEO inspector satellite SJ-17 had a robotic arm onboard, which had not previously been disclosed.[165] SJ-17 has a documented history of inspection and RPOs with other Chinese satellites in GEO. See previous issues of the *Space Threat Assessment* for more details.[166]

MAY 28, 2021

Tanker spoofs own location to hide activities

Spoofing

In late May 2021, news reports surfaced of a Cyprus-flagged oil tanker named Berlina, which had seemingly spoofed its own GPS-backed automatic identification system (AIS) signal in order to evade sanctions and transport illegal oil from Venezuela.[167] Events such as this have been occurring for years and are becoming increasingly common in order to hide illegal shipping activities from authorities.[168]

JUN. 17, 2021 **RUSSIA**

Two NATO ships' locations spoofed

Spoofing

The positions of a UK Royal Navy destroyer and a Dutch Royal Navy ship moored in Odessa, Ukraine, on the Black Sea on a mission for NATO were falsified via spoofing. The two ships' AIS signals reported them as being near a Russian naval base in Crimea, which was 180 miles away from their actual location.[169]

JUN. 30, 2021 **RUSSIA**

U.S. warship's location spoofed

Spoofing

Similar to the spoofing case in mid-June of two NATO vessels, the position of a U.S. Navy *Arleigh Burke* destroyer was also spoofed. The ship's position was similarly spoofed to indicate it was near a Russian naval base in Crimea when it was actually within Ukrainian waters.[170]

Kinetic Physical
Non-kinetic Physical
Electronic
Cyber
Other

JUL. 27, 2021 **CHINA**

Possible Chinese hypersonic weapon or FOBS test

Neither a hypersonic glide vehicle nor a FOBS capability would fall within this assessment's definition of a counterspace weapon. However, discussion is included on this event because it was widely reported as a potential space or counterspace weapon. The lack of reliable information about the Chinese test makes open-source analysis challenging. For more information, see page 23.

JUL. 29, 2021 **AUSTRALIA**

Australia announces electronic warfare project

Jamming

Australian minister for defense Peter Dutton announced the establishment of a new defense project that will explore the potential research, development, and acquisition of space electronic warfare capabilities, such as jamming and spoofing. There was no anticipated timeline for the project, dubbed Defence Project 9358.[171]

SEPT. 25, 2021 **OTHER**

Instructions for GPS spoofing easily found online

Spoofing

An article showcases that GPS spoofing code is easily found on Github and other online sites such as YouTube. Similar to how public instructions for GPS jammers flooded the open market years ago, this wave of spoofing instructions could lead to the wholesale of cheap spoofing equipment worldwide.[172]

OCT. 23, 2021 **CHINA**

On-Orbit ASAT capture and destruction

Co-orbital

Chinese scientists publish a paper in a journal entitled *Electronic Technology and Software Engineering*, organized by the Chinese Association for Science and Technology and the Chinese Institute of Electronics. The paper describes how an explosive device could be placed on an enemy satellite via another satellite. According to the paper, the research was funded by the Chinese government.[173]

NOV. 1, 2021 **CHINA**

SJ-21 performs first RPOs in GEO

Co-orbital

Chinese satellite SJ-21, launched in late October 2021, was observed performing RPOs with either a subsatellite or the satellite's AKM. This new satellite was labeled by the U.S. Space Force's 18th Space Control Squadron as SJ-21 AKM in the Space-Track database.[174] For more information on SJ-21 and its activities, see page 24.

- Kinetic Physical
- Non-kinetic Physical
- Electronic
- Cyber
- Other

NOV. 15, 2021 **RUSSIA**

Russia tests a direct-ascent ASAT capability in LEO

Direct-Ascent

Russia conducted a live fire test of a ground-based kinetic physical direct-ascent ASAT weapon in LEO, at about 400–500 km above the Earth's surface. The warhead impacted a long defunct Soviet satellite and created significant amounts of space debris.[175] For more information, see page 25.

NOV. 21, 2021 **CHINA**

New facilities for electronic warfare built on Hainan Island

Jamming

Satellite imagery analysis shows new signals intelligence facilities being built on Hainan Island, likely for Chinese operations in the South China Sea. These facilities may contribute to the interception and collection of satellite signals, potential jamming technology, or other electronic warfare capabilities.[176]

NOV. 29, 2021 **RUSSIA**

Russia threatens GPS on state TV

Direct-Ascent

On Russian state TV, the Kremlin warned that the direct-ascent ASAT capability it tested days earlier could destroy U.S. GPS satellites in space. This indicates that the system tested may have the capacity to reach higher altitudes than where it was tested in LEO. The comments also indicated that Russia has enough missiles (or warheads) to target and destroy all 32 GPS satellites simultaneously.[177]

DEC. 29, 2021 **RUSSIA**

S-550 missile could be used against satellites

Direct-Ascent

Russia's new long-range interceptor missile, the S-550, was brought online and "entered combat duty" in December 2021. A state media outlet, TASS, reported on comments by Russian defense officials who stated that the new missile system was capable of intercepting intercontinental ballistic missiles as well as satellites in orbit.[178]

- Kinetic Physical
- Non-kinetic Physical
- Electronic
- Cyber
- Other

JAN.–DEC. 2021 **INDONESIA**

Delivery drivers using jamming and spoofing

Spoofing

Delivery drivers in Indonesia have begun to spoof their own GPS signal in order to circumvent food delivery app locations. This allows them to remain under cover instead of in an open parking lot or be on the move delivering one order and receiving instructions for a second one simultaneously. While not harmful to nation-states, these activities further highlight the ease, accessibility, and proliferation of electronic counterspace systems.[179]

2022

JAN. 7, 2022 **UNKNOWN**

Undersea cable cut to Nordic ground station

Ground Station Attack

An undersea cable between Norway and the Svalbard archipelago in the Arctic Ocean was severed. This was announced by Space Norway AS, a state-run company that maintains the fiber-optic cable and operates the Svalbard Satellite Station.[180] There has been no identification of the attacker. The system had redundancy built in and was fully reliant on the second undersea cable until January 21, 2022, when the damaged cable was restored.[181]

FEB. 24, 2022 **RUSSIA**

Suspected hack of Viasat ground terminals in Eastern Europe, including Ukraine

Denial of Service

Viasat, a space broadband communications company, reported severe disruption to its ground terminals in Eastern Europe, including Ukraine, beginning on the day of the Russian invasion into Ukraine.[182] Russian involvement in this cyber denial of service attack is suspected, but has not been confirmed.[183]

WHAT TO WATCH

UNFORTUNATELY, MANY PREDICTIONS FROM PREVIOUS assessments have been realized over the past five years. The 2020 edition noted that "the rate of satellite jamming and spoofing incidents will only increase as these capabilities continue to proliferate and become more sophisticated" and that "more nations may continue to reorganize and elevate space forces within their militaries both to focus attention internally and to signal externally."[184] The 2021 edition of this report predicted that Russia was the "most likely nation" to conduct additional counterspace testing, which proved true only months later.[185] These and other identified trends signal that counterspace weapons are no longer emerging technologies—many are fully developed, tested, and operational systems. While more sophisticated counterspace weapons, such as direct-ascent ASAT missiles, belong to only a handful of nation states, many nations have access to electronic and cyber counterspace technologies, and these capabilities are proliferating among non-state actors and individuals as well. This has created a self-reinforcing cycle of more nations investing in counterspace weapons, both offensive and defensive, to deter attacks in space and provide the ability to respond in kind if deterrence fails.

ELECTRONIC WARFARE

Notably, this year's assessment highlights the proliferation of electronic warfare to counterspace capabilities, particularly GPS. The proliferation is twofold; this year saw an increase in both the amount of activity and the depth and complexity of the attacks being used. The cases noted in the timeline section of thieves in India, food delivery drivers in Indonesia, illegal shipping, and open access to spoofing code on Github all serve to denote the ease of access to localized jamming and spoofing capabilities and how they are proliferating around the globe. Moreover, the use of GPS jamming in Russia's war on Ukraine and the Chinese military's advancement of electronic warfare capabilities in the South China Sea showcase the uses this technology has for nation-states both before and during a potential conflict. These trends are likely to continue, as the denial of GPS or satellite communications can have a great effect, be conducted with little risk for the user, and has already been shown to not pass the threshold of triggering or escalating a conflict.

MANY PREDICTIONS FROM PREVIOUS ASSESSMENTS HAVE BEEN REALIZED OVER THE PAST FIVE YEARS.

RUSSIAN ASAT TEST

The importance of the debris-creating direct-ascent ASAT test conducted by Russia in November 2021 cannot be overstated. The motivations are still largely unknown as to why Russia broke its decades-long moratorium on debris-producing tests after its Nudol system had been proven successful time and time again through tests that did not create orbital debris. The international uproar following the test, and many collision avoidance warnings to the occupied ISS, may have discouraged Russia from conducting a similar test in the near future. Nonetheless, the 2021 test has shaken the international space community's belief in the sanctity and safety of the space environment for all nations. The international condemnation from this test may also sway other nations from testing debris-creating ASAT weapons or ensure that such tests are conducted at an altitude where less debris will remain in orbit, as India did in 2019.

COUNTERING COUNTERSPACE

A growing trend is the increasing number of countries interested in defensive counterspace weapons or active defenses to protect valuable space assets and deter aggression in space (see *Defense Against the Dark Arts in Space* for more details on space defense).[186] Over the course of the past five years, more countries have reorganized their national security space enterprises and have begun to speak more openly about defending space assets. This wave of countries includes Australia, China, France, Germany, South Korea, the United Kingdom, and the United States. NATO has also signaled an expanded focus on military operations in the space domain.

At NATO's 2021 summit in Brussels, leaders announced that an attack on a NATO member's space assets could result in an invocation of Article 5, which provides that an attack on one ally is an attack on all.[187] In January 2022, NATO published its first public space policy for the alliance, which notes that potential adversaries are pursuing a wide range of counterspace capabilities designed to impair NATO's access to space.[188] In 2020, NATO members decided to establish a joint space center in Ramstein, Germany, to coordinate the allies' space activities, as well as a Space Center of Excellence in Toulouse, France.[189]

In 2021, Germany stood up a military space unit, joining other NATO members, namely the United States, United Kingdom, Italy, and France, in taking similar steps. France has also publicly stated its intent to develop defensive anti-satellite laser weapons which would be able to blind, but not destroy, an adversary's satellite.[190] A key trend to watch in the coming year is whether NATO mem-

A GROWING TREND IS THE INCREASING NUMBER OF COUNTRIES INTERESTED IN DEFENSIVE COUNTERSPACE WEAPONS.

U.S. Space Force chief General Raymond briefing NATO in 2019.

NATO[193]

bers and other non-NATO allies continue establishing national space commands and military space units to focus more directly on the challenges they face in the space domain.

The United States government is also publicly discussing the advantages of building better protections against counterspace attacks. In June 2021, chief of space operations General John "Jay" Raymond publicly stated that the Space Force was pursuing research and development of directed-energy weapons to defend satellites from attack.[191] With the establishment of the Space Force in 2019, conversations about how to better protect valuable space assets, such as GPS and ISR satellites, have provided insight into the priorities of the newest military service and how it views the utility of defensive counterspace capabilities.

China is also investing in defensive counterspace technologies. A recent article by Chinese scientists announces that they have pioneered a way for satellites to remain operational during and after an HPM or EMP attack. This new technology protects and absorbs the extra electromagnetic energy in order to protect the satellite's electrical circuits.[192] As the threat of counterspace weapons proliferates, and as China becomes increasingly reliant on its own space systems for economic activity and national security, researching and integrating defenses into satellites will become a more important consideration.

CONFLICTS ON EARTH AFFECTING COOPERATION IN SPACE

The potential geopolitical ramifications of conflicts on Earth for international space cooperation cannot be ignored. Russia's invasion of Ukraine highlights long-standing tensions and shifts in global relationships, even those in space. While NASA and Roscosmos have thus far continued their working relationship on the ISS, the future remains uncertain as sanctions impact the Russian aerospace sector and other space agreements come into question.[194] Roscosmos director general Dmitry Rogozin has been outspoken against sanctions and implied on Twitter that further U.S. sanctions may destroy the relationship with NASA, including on the ISS. Rogozin rhetorically questioned the future of the ISS based on the fact that the Russian Progress cargo capsules and the Russian servicing module provide primary propulsion and orbit raising maneuvers for the station. At the end of a tweet thread about the ISS's reliance on Russia, Rogozin rhetorically asks the United States "Do you want to destroy our cooperation on the ISS?"[195] After the European Union imposed sanctions on Russia, Roscosmos pulled out of all agreed launches of Soyuz rockets from the European Spaceport in French Guiana and withdrew its workforce from the region.[196] The joint ExoMars program with European Space Agency and Roscosmos was supposed to launch in 2022 from the Baikonur Cosmodrome. The European Space Agency has since announced that "the sanctions and the wider context make a launch in 2022 very unlikely."[197]

The ripple effects from the Russian war on Ukraine are certainly spreading. With the end of life of the ISS in sight, ISS partner nations, including the United States and Russia, have started making plans for the next phase of space science, habitation, and exploration. The divide between Russia and the United States was already growing in this respect, as Russia has not signed on to the Artemis Accords nor contributed to the U.S.-led Lunar Gateway and instead has pledged to establish a joint lunar base with China.[198] This divide may further deepen and alter a long-standing partnership between the United States and Russia in human spaceflight, which dates to the Cold War and the successful Apollo-Soyuz test project.

CONCLUSION

In summary, 2021 was a year of transition, surprises, and disappointments in space security. While the United States and many other nations shifted their attention to building norms of responsible behavior in space, Russia reminded the world with its destructive ASAT test in November 2021 that space remains a contested warfighting domain.

Furthermore, 2022 may prove to be a pivotal turning point in space security as the conflict in Ukraine rages. If the conflict further extends into space with more aggressive attacks against space systems, such as laser dazzling of imagery satellites or cyberattacks against satellite ground stations, it could become the first major conflict in which counterspace weapons play a significant role. Even if conflict does not directly extend into space, the geopolitical fallout could rupture relationships and the decades-long cooperation between Russia and the United States, Europe, Japan, Canada, and all of the ISS partners. While cooperation in space science and exploration has endured crises in the past, including the 2014 Russian invasion and occupation of Crimea, it is not yet clear if the partnership will survive this latest challenge. Should cooperation with Russia on the ISS end abruptly, the implications for space security could be far reaching.

Prior to the February 2022 Russian invasion of Ukraine, there was a growing hope in the international space policy community because of the new UN open-ended working group on space weapons, norms of behavior, and best practices for space-faring nations. How recent events will affect this working group remains to be seen. If nations can move past geopolitical conflict to establish better rules and regulations for space, curbing the development and deployment of space weapons may still be within reach. At the least, it is possible that debris-creating events, such as direct-ascent ASAT testing, may be limited by international agreement, which would certainly contribute to a safer and more sustainable space environment.

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